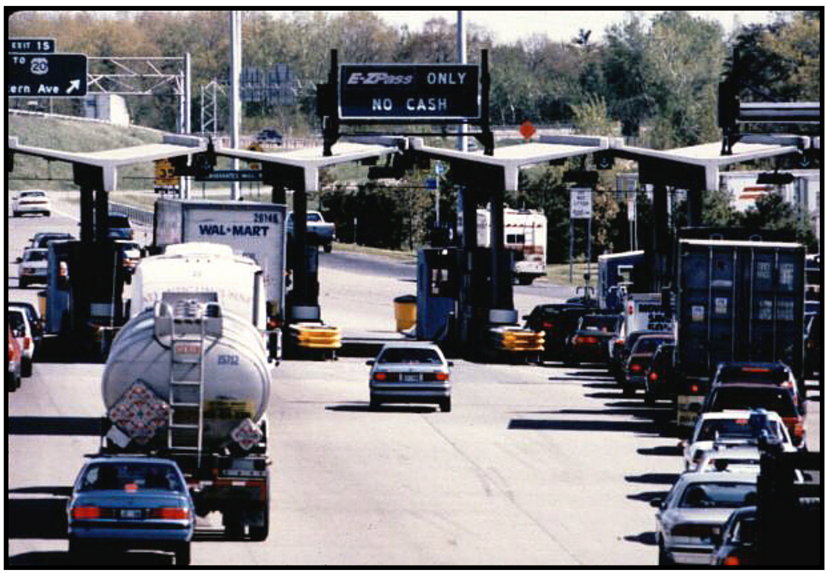
ATTACHMENT 1: Appendices

Electronic Toll Collection/Electronic Screening Interoperability Pilot Project

Supplement to the Final Report

DTFH61-96-C-00098

IPAS I Task 9834



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16. Abstract: In 1998, ITS America established a Blue Ribbon Panel on electronic commerce to study the convergence of transportation and electronic payment systems. Panel members included senior managers from government, toll agencies, motor carrier industry, and service providers. The panel's goal was to achieve national interoperability of Electronic Toll Collection (ETC), electronic screening (E-screening), and other dedicated short-range communication standards (DSRC) applications. The panel provided a successful forum for discussion, while moving toward a solution to the national interoperability problem.

In March 2001, the I-95 Corridor Coalition approved funding for an ETC/E-Screening Interoperability Pilot Project for regional interoperability between ETC and E-screening. The long-term goal was to provide a model for national interoperability of DSRC applications. The project combined testing a single dual-mode DSRC transponder for both ETC and E-screening, and developing administrative and organizational structures to support interoperability beyond the Pilot Project. The Pilot Project's intent was to coordinate the Northeast's interoperable ETC program, E-ZPass, with the CVISN E-screening deployments planned by Maryland and Connecticut. The Pilot Project was designed as a series of five incremental builds to incrementally establish functionality and address institutional and technical challenges that could potentially impact interoperability.

The Pilot Project evaluation structure is based on standard evaluation practices originally developed by USDOT. The following five evaluation goals were identified: 1) Assess the impact of interoperability on motor carrier mobility; 2) Assess the impact of electronic screening on motor carrier safety; 3) Identify industry and government efficiency gains from ETC/ E-screening; 4) Assess the impact of electronic screening on the environment, in particular, reduction in diesel emissions; and 5) Assess overall customer satisfaction, both government and industry.

The Pilot Project successfully demonstrated the following: 1) Interoperable applications using a single transponder are both technically and institutionally feasible; 2) The CVISN model of electronic screening, where motor carriers are issued a transponder but not given a guarantee that simply having the transponder will result in a weigh station bypass, is both technically and operationally feasible; 3) The results of the mobility and efficiency tests demonstrate that interoperable applications do result in quantifiable benefits to the motor carrier industry; and 4) The application of ITS/CVO technologies and systems produces significant environmental benefits through reduced truck idling and emissions.

The resulting lessons learned include: 1) Flexible Approach to Project Management – One of the key successes of the project has been the flexible approach to project management adopted by the project team; and 2) Need for Process Re-Engineering – The ETC/E-screening project has demonstrated the importance of process re-engineering to support the deployment of new technologies and systems.

The resulting recommendations include: 1) Expand Environmental Impact Assessment to conduct a more comprehensive environmental impact analysis using actual emissions data; 2) Conduct an Expanded Safety Analysis when market penetration has reached the point where statistically valid data can be obtained; 3) Expand Interoperability Applications to promote transponder use in commercial vehicles; 4) Identify Additional Opportunities for Expanding Interoperability to aid in congestion mitigation and management at seaports, airports, and intermodal facilities.

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PREFACE

This document contains the following seven separate documents used as an attachment to support the ETC/E-Screening Interoperability Pilot Project report published in January 2005. In effect, these documents are being presented as a series of seven unique appendices and are identified as follows:

- Section 1: Evaluation Methodology
- Section 2: ETC/E-Screening Facility Descriptions
- Section 3: Test Results and Findings
- Section 4: Total Truck Counts by Facility
- Section 5: Safety Documents Summary
- Section 6: Motor Carrier Survey
- Section 7: Literature Review – Environmental Assessment

The Abbreviations list compiled for this document contains abbreviations that are relevant to these seven unique appendices.

ABBREVIATIONS

AAR	American Association of Railroads
ANOVA	Analysis of Variance
AVI	Automated Vehicle identification
CAA	1970 Clean Air Act and its amendments
CDT	Connecticut Department of Transportation
CMEM	Comprehensive Modal Emissions Model
CO	Carbon Monoxide
Coalition	I-95 Corridor Coalition
CSP	Connecticut State Police
CT	Connecticut
CT DMV	Connecticut Department of Motor Vehicles
CV	Commercial Vehicle
CVED	Commercial Vehicle Enforcement Division
CVIEW	Commercial Vehicle Information Exchange Window
CVISN	Commercial Vehicle Information Systems and Networks
CVO	Commercial Vehicle Operations
CVSA	Commercial Vehicle Safety Alliance
CVSU	Commercial Vehicle Safety Unit
D.C. / District	District of Columbia
DOT	Departments of Transportation
DSRC	Dedicated Short-Range Communication Standards
EIZ	Emissions Influence Zone
E-screening	Electronic Screening
ETC	Electronic Toll Collection
FHWA	Federal Highway Administration
FMCSA	Federal Motor Carrier Safety Administration
FTP	Federal Test Procedure
GWB	George Washington Bridge
HAPs	Hazardous Air Pollutants
HDD	Heavy-Duty Diesel (vehicles)
I-	Interstate
IAG	Inter-Agency Group
ID	Identifier
IFTA	International Fuel Tax Agreement

IRP	International Registration Plan
ISS	Inspection Selection System
ISTEA	Intermodal Surface Transportation Efficiency Act
ITS	Intelligent Transportation Systems
MD	Maryland
MDOT	Maryland Department of Transportation
MdTA	Maryland Transportation Authority
MMTA	Maryland Motor Truck Association
MOBILE	USEPA mobile source emissions factor model
MOBTOX	MOBILE Toxics
MSP	Maryland State Police
NAAQS	National Ambient Air Quality Standards
NORPASS	North American Preclearance
NOX	Oxides of Nitrogen
NY	New York
NYSMTA	New York State Motor Truck Association
NYSTA	New York State Thruway Authority
O_3	Ozone
PB	Lead
PM	Particulate Matter
ROC	Roadside Operations Computer
rpm	revolutions per minute
SAFER	Safety and Fitness Electronic Records
SHA	State Highway Association
SIPs	State Implementation Plans
SO_2	Sulphur Dioxide
SPD	Speed Profile Discretization technique
SwRI	Southwest Research Institute
TEA-21	Transportation Equity Act for the 21st Century
UCS	Union of Concerned Scientists
USDOT	U.S. Department of Transportation
USEPA	U.S. Environmental Protection Agency
VMT	Vehicle Miles Traveled
VPN	Virtual Private Network
WIM	Weigh-in-Motion

1 EVALUATION METHODOLOGY

This section discusses the methodologies used to conduct the evaluation. The first section discusses the methodologies used to conduct the customer satisfaction and institutional/ technical issues studies. The second section discusses the methodologies used to collect quantitative data on truck travel times and truck counts. This data was used to conduct the mobility and efficiency studies. The final section discusses the methodology used to conduct the environmental impact test.

1.1 CUSTOMER SATISFACTION AND INSTITUTIONAL/TECHNICAL ISSUES STUDY

Background information on the ETC and E-screening programs and interoperability project was obtained through a comprehensive literature review and interviews with project stakeholders (see Section 5 for the Safety Documents Summary). The findings from these activities were used to develop the overall evaluation strategy and specific methodology used to identify both quantitative and qualitative data requirements and sources.

Initially, the Evaluation Team had planned on collecting qualitative data by conducting a series of focus groups with a variety of customers, including enforcement officials, motor carriers, and commercial vehicle drivers. These focus groups were to be followed by a quantitative survey of each customer group.

As the project developed, it became clear that this approach would need to be modified somewhat. For example, the population of enforcement officials in Connecticut and Maryland was so small that it seemed more appropriate to speak with each group of officials in a focus group setting, both before and after the E-screening technology deployment.

Following discussions with industry representatives, the Evaluation Team also determined that administering a driver survey was not a cost-effective means of obtaining data. This decision was based on low market penetration for transponders at the time of the evaluation. Since the evaluation was focused on the interoperability of ETC and E-screening technologies, it is important to be able to identify drivers who had experience with both technologies in order to obtain an accurate assessment of the benefits of interoperability. The study team made a determination that it would be difficult and costly to identify a large enough sample of drivers to be able to obtain statistically valid results. Due to the low market penetration of the transponders, it was also determined that the results may not be representative of a larger population of drivers. Therefore, the decision was made to survey only the motor carriers for the “After” project assessment (see Section 6 for the Motor Carrier Survey).

1.1.1 “Before” Focus Groups

Baseline “Before” focus groups were conducted with the following customer groups:

- Maryland motor carriers
- New York motor carriers
- Truck drivers in Baltimore, Maryland
- Truck drivers in Albany, New York

- Maryland enforcement officials

In addition, a survey of enforcement officials in Connecticut was conducted. Though the Evaluation Team attempted to organize a focus group of enforcement officials in Connecticut, the Connecticut Department of Motor Vehicles preferred to participate in a survey rather than a focus group. Therefore, the Evaluation Team developed a survey for the Connecticut enforcement officials.

The purpose of the focus groups and survey was to gain an understanding of the issues important to customers and to use this understanding to design the “After” surveys of enforcement personnel, motor carriers, and commercial vehicle operators.

The Maryland Motor Truck Association (MMTA) and the New York State Motor Truck Association (NYSMTA) recruited participants for the motor carrier and driver focus groups. Both State associations were brought on board as subcontractors to support these activities and the After project motor carrier survey, in particular, the distribution of blank surveys and the collection of completed surveys. The Maryland State Police (MSP) and the Maryland Transportation Authority (MdTA) Police identified participants for the law enforcement focus group. For the Connecticut survey, a survey was sent to each enforcement official involved in roadside operations at a weigh station.

1.1.2 “After” Focus Groups

Only one “After” project focus group was conducted with the MdTA Police, as this was the only enforcement group that had had experience with E-screening during the course of the evaluation. Due to delays in deploying E-screening capabilities in Connecticut and at the MSP-operated weigh stations, no additional weigh stations were brought online or implemented E-screening during the evaluation’s period of performance. The MdTA Police recruited participants for the focus group. This focus group included representatives from motor carrier inspectors, uniformed officers, and information technology staff who had experience with E-screening technology.

1.1.3 Focus Group Methodology

For the baseline focus groups, issues and questions posed to focus group members were derived from the literature review and stakeholder interviews conducted during the evaluation strategy development period. Each focus group was facilitated by an Evaluation Team member and supported by a second Evaluation Team member who served as the note taker.

The facilitator opened each focus group with an overview stating the evaluation’s purpose and discussed the overall evaluation goals and objectives. Participants were then asked a series of questions and all answers were recorded on a flip chart and by the note taker. At the conclusion of each focus group, the facilitator summarized all notes and comments recorded on the flip chart to ensure that all information was accurately recorded.

Motor carrier and driver focus groups were conducted at the respective State motor carrier association offices. The Maryland enforcement focus group was conducted at the MDOT headquarters.

The After project enforcement focus group was conducted at the MdTA facility at the Perryville weigh station. The focus group participants were asked a series of questions intended to update their baseline perceptions of E-screening based on their experience with the project. The questions posed to participants were developed using the results of the baseline focus groups to identify appropriate institutional and technical challenges.

Notes taken during the focus group activities were transcribed and a copy sent to focus group participants for review. The intent was to ensure that the notes properly reflected all comments and challenges identified, and that no incorrect information was recorded or relevant information not included. All focus groups, including baseline Before and After project groups, were approximately 1.5 hours in length. Focus group results were presented in summary form, and no particular focus group participant was identified by name, agency, or business.

1.1.4 Post-Deployment Survey Design and Implementation

Based on the results of the focus group, questions on the post-deployment survey were designed to fall into the following classifications:

- Questions related to industry use and acceptance of the technology.
- Questions related to mobility benefits.
- Questions related to safety benefits (E-screening only).
- Questions related to operational benefits.
- Questions related to cost benefits.
- Questions related to E-ZPass customer service (ETC only).
- Questions related to promotion and registration (E-screening only).

The information gained from the focus groups and surveys was used to develop the post-deployment quantitative surveys. As the preliminary results from the focus groups are qualitative and not representative of the population, the goal of the surveys is to obtain more quantitative information and to survey a sample that will be representative of a particular population of customers, namely those motor carriers belonging to the MMTA and the NYSMTA.

1.1.5 Survey Design

The post-deployment survey was designed with the following elements in mind:

- Fill information gaps.
- Investigate emerging trends in preliminary data.

These elements are described in more detail in Sections 1.1.5.1 and 1.1.5.2.

1.1.5.1 Fill Information Gaps

The next goal in designing the After survey was to fill in the following information gaps as identified from the motor carriers' focus groups and the survey:

- Perceptions of safety impacts.
- Perceptions of cost implications.

Survey questions were formulated to specifically address each of these critical information gaps.

1.1.5.2 Investigate Emerging Trends in Preliminary Data

Another goal in designing the After survey was to investigate trends that emerged in the preliminary data. For example, with respect to the customers' perceptions of E-screening, the following trends emerged in the data from the focus groups:

- Motor carriers, while less negative than enforcement officials, seem to be "riding the fence" when it comes to the potential benefits of E-screening.
- Although motor carriers reported that they could the potential advantages of the technology, they had not yet realized the benefits.

Questions were formulated to help investigate whether these trends hold true amongst a larger sample of customers.

1.1.6 Sampling Methodology

Motor carrier survey respondents included members from the MMTA and NYSMTA. Surveys were distributed to the entire membership of each association, including 910 to the MMTA and 441 to the NYSMTA.

1.2 TRAVEL TIMES AND TRUCK COUNTS

Travel times and truck counts were collected in three states: New York (NY); Maryland (MD); and Connecticut (CT) (see Section 4for total truck counts by facility).

- In New York, travel times and truck counts were collected on Interstate 90 outside of Albany at the Barrier 23 and 24 toll facilities and at two toll bridges in New York City (George Washington and Tappan Zee bridges). No data from weigh stations were collected in New York.
- In Maryland, travel times and counts were obtained at one toll facility and four weigh stations.
- In Connecticut, travel times and counts were collected at the weigh stations in Union and Greenwich.

Table 1-1 summarizes the State, location, facility type, and data collection dates of travel times and truck counts (see Section 2 for a detailed description for each data collection site facility).

Table 1-1. Data Collection Sites and Dates for Travel Times and Truck Counts

State	Location	Facility	Collection Dates
NY	Albany: I-90 at Exits 23 & 24	Toll	October 16 – 17, 2002
	NYC: I-95 George Washington Bridge	Toll	Archived data from Port Authority of NY-NJ for 2002 through 2003 inclusive; also from January – August 2004
	NYC: I-87/I-287 Tappan Zee Bridge	Toll	December 14, 2004
MD	Perryville: I-95 near Exit 93	Toll	October 23 – 24, 2002
	Perryville: I-95 near Exit 93	Weigh Station	October 22 – 23, 2002
	Hyattstown: I-270 near Exit 22	Weigh Station	December 2 – 3, 2002
	West Friendship: I-70 near Exit 80	Weigh Station	December 9 – 10, 2002
	New Market: I-70 near Exit 62	Weigh Station	January 21 – 22, 2003
CT	Union: I-84 near Exit 73	Weigh Station	May 19, 2003
	Greenwich: I-95 near Exit 2	Weigh Station	May 21, 2003

The main goal of the data collection effort was to obtain a sample of travel times and counts for traffic conditions during a typical work week. To minimize the effects of weekend travel, the Evaluation Team collected data at all sites during a standard work week (no holidays), and either on Monday, Tuesday, or Wednesday. With the exception of the George Washington and Tappan Zee bridges, and the Union weigh station, data were collected during four time periods (morning, noon, evening, and night) to obtain a sampling of travel times at various times of the day. The time span for day and times were identified as: Morning (7:30 to 9:30 a.m.); Noon (11:30 a.m. to 1:30 p.m.); Evening (4:30 to 6:30 p.m.); and Night (9:30 to 11:30 p.m.).

The toll authorities in New York and Maryland provided truck counts that were used in the Evaluation Team's analyses. At weigh stations in Maryland and Connecticut, tubes and vehicle counters were placed across the roadways to obtain counts for trucks entering the weigh stations.

1.1.6.1 Software Data Collection Tool

Prior to data collection, a software data collection tool was developed to record travel times. The software provided an interface to allow the researchers to create a time/date stamp as trucks entered and exited the toll or weigh station facility. The software was operated on laptop computers and utilized the computer's internal clock functions to generate the time/date stamp as each truck enrolled in the program entered or exited a designated weigh station. In addition to entry and exit times, the researcher could record in the database the payment type (cash, ETC, or unknown) and any comments. The software also provided editing (or overwrite) functions to enable Evaluation Team members to correct database records should errors occur during data entry. Figure 1-1 shows the “Enter Toll Data” data entry screen from the software interface tool used to collect toll facility travel times.

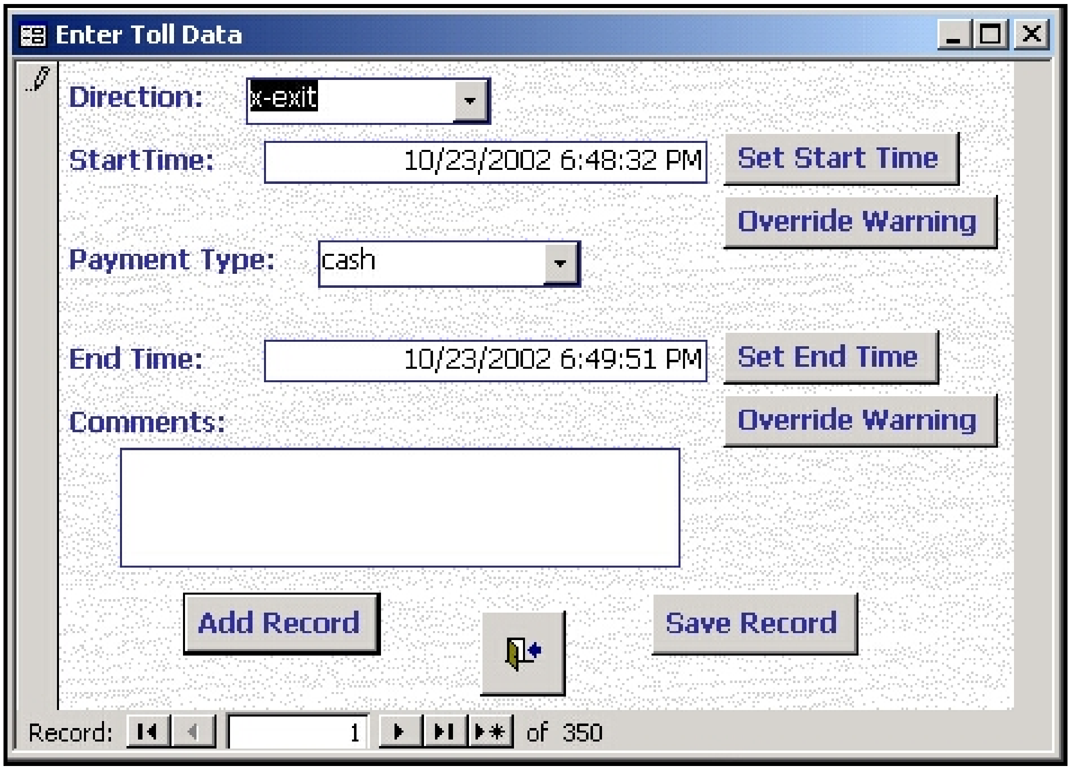

Figure 1-1. Data Entry Screen Used to Collect Travel Times at Toll Facilities.

1.1.6.2 Toll Facilities

Evaluation Team member pairs worked as separate teams to collect travel time data at the designated toll facilities. The teams were stationed in cars strategically and safely parked at locations near the respective toll facilities such that the team members could watch trucks as they approached/ exited the toll facility. One team member (the spotter) was responsible for identifying and visually tracking a truck from a predetermined start point (upstream landmark) through the toll booth. The recording protocol required that the start time be recorded when the truck crossed the upstream landmark. The end time and type of payment was recorded after the truck left the toll booth. The second team member (recorder) was responsible for operating the computer and entering the start/end times and payment type into the computer.

Truck counts were obtained from data archived at the New York State Thruway Authority (NYSTA) and MdTA. Each agency maintained vehicle classification records and counts that had entered/exited the toll facilities.

1.1.6.3 Weigh Stations

Since the distances between entering and exiting weigh stations were longer, Evaluation Team members needed to use the software tool to record the entry/exit times. The collection methods were modified to collect travel time data, and protocol required two Evaluation Team pairs (teams) with laptop computers for recording purposes. One pair, designated as the entry point team, was located near the weigh station entry point. The second pair, designated as the exit point team, was located at the weigh station exit point. Both teams were strategically located in a car parked off the roadway where they could safely watch trucks approaching/exiting the weigh station. The entry point team selected a truck and recorded the start time in its computer as the truck crossed a predetermined upstream landmark. Figure 1-2 displays the "Record Entry Times" data entry screen used to record weigh station entry times.

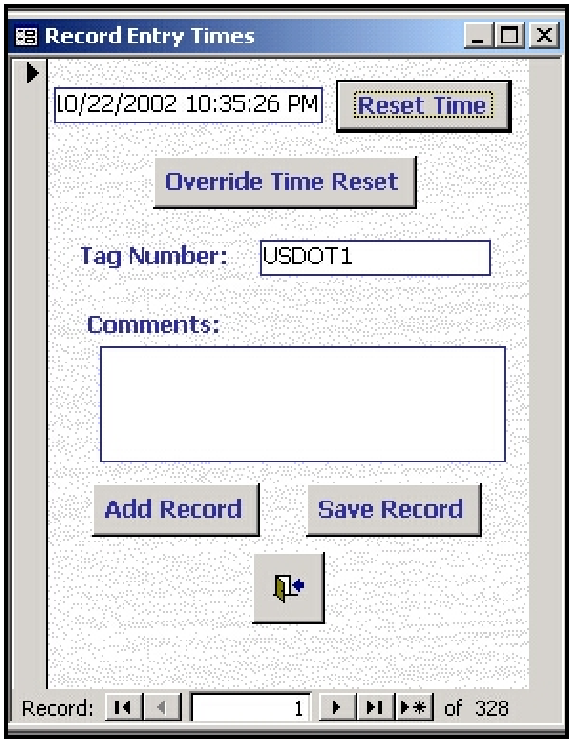

Figure 1-2. Data Entry Screen for Weigh Station Entry Times.

As the truck entered the weigh station, the entry point team radioed the exit point team the tag number or description of the truck. The exit point team then recorded the tag number or description into its laptop computer, along with the exit time as the truck left the weigh station, and entered a comment note if the truck used the bypass lane. Figure 1-3 shows the "Record Exit Times" data entry screen used to record weigh station exit times.

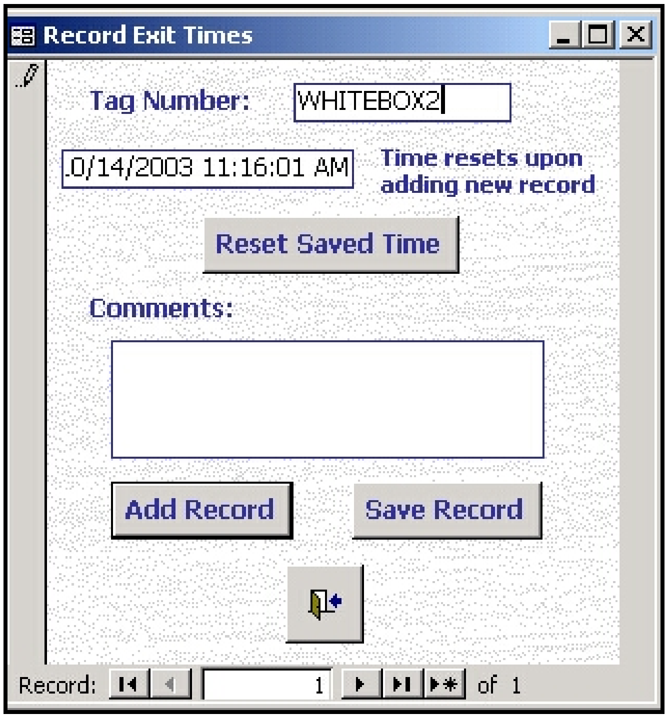

Figure 1-3. Data Entry Screen for Weigh Station Exit Times.

After the data collection activities were completed, the entry and exit point databases were merged and prepared for data analyses. The entry time and exit time was used to calculate the travel time through the facility for each truck identified by its respective tag number or description. These travel times were used as a basis for comparison and analysis for this evaluation.

To obtain truck counts, portable vehicle counters were placed on the ramp leading into the weigh stations. The tubes were placed such that each vehicle entering the weigh station was counted and classified by the portable counter. The counts were collected around the clock on the same days as travel times were collected. The resulting counts were aggregated into 15-minute intervals.

2 ETC/E-SCREENING FACILITY DESCRIPTIONS

Maryland

2.1 PERRYVILLE WEIGH AND INSPECTION STATION

Quick Facts	
Name:	Perryville Weigh and Inspection Facility
Location:	Perryville, MD – Southbound I-95
Completed:	November, 1995
Operational:	February, 1996
Owner:	Maryland Transportation Authority (MdTA)
Operator:	MdTA Police Commercial Vehicle Safety Unit (CVSU)
Annual Volume:	1,055,448 (southbound scales)
Annual Operating Cost:	$3,290,000
Annual Man-Hours:	75,840
E-screening Capability / Operational:	Yes / Yes

The Perryville Weigh and Inspection Station is located approximately 16 miles west of the Maryland/Delaware state border in Cecil County, Maryland. Situated on the southbound lanes of Interstate 95 (I-95) between Baltimore and the Delaware state line, this modern facility weighs and inspects over 1 million commercial vehicles a year. The geographic location of the facility is important to both the trucking industry and the commercial enforcement community.

Perryville is located between two major metropolitan areas (Philadelphia and Baltimore/Washington, D.C.) along one of the most important routes used by the commercial vehicle industry. I-95 is the primary North/South corridor on the East Coast and it gives easy access to major freight terminals, ports, and freight transportation hubs along the eastern seaboard. Additionally, many major East/West corridors connect to I-95 and give commercial vehicles direct access to the rest of the major transportation hubs in the mid-western, southern, and western sections of the contiguous United States. The heavy volume of commercial vehicle traffic is a primary reason why Perryville is a logical location to feature the E-screening technology.

E-screening technology is relatively new, and Perryville is the only weigh station in the State of Maryland with this operational capability. MdTA installed new informational highway signs on I-95 upstream from the weigh facility to indicate the site's E-screening capability. The weigh station signs advise commercial vehicles that E-screening is operational at this particular facility and they are required to move to the right lane (see Figure 2-1). Drivers that have a proper transponder (Mark IV Fusion, North American Preclearance [NORPASS] Program transponder, etc.) may not necessarily have to come into the weigh station. The driver awaits the response back from the system and if a green light is given, the driver knows that he or she is cleared to continue on the mainline.

Figure 2-1. E-Screening Notification Sign.

The first component of the E-screening equipment at Perryville is located approximately 1 mile upstream of the weigh station. An advanced automated vehicle identification (AVI) reader, which is about the size of a pizza box, is located on an arm mast that hangs over the right hand lane. This first AVI reader is key component of the first step in the E-screening process. The purpose of the advance AVI reader is to identify the vehicle by its unique transponder identifier (ID) and acquire the vehicle and carrier information that is provided when the vehicle registers and enrolls in the E-screening program. Vehicles enrolled in the E-screening program receive a transponder and are required to attach it to the vehicle's front windshield. The AVI reader electronically reads the transponder's unique ID number using a dedicated short-range communication (DSRC) frequency. Important information regarding the vehicle's safety record, inspection history, and other background history that is attached to the unique transponder ID is gathered from the E-screening computer. The information is analyzed by the E-screening software and, based on the pre-set minimum requirements, the vehicle is cleared to either bypass the site, or is not cleared and forced to enter the facility.

In addition to the AVI reader, there is a Weigh-In-Motion (WIM) scale embedded in the pavement of the right hand lane. The WIM weighs vehicles at highway speed so that the information can be included in the E-screening process. The transponder-equipped and E-screening-enrolled vehicles are required to be in the right lane to be electronically screened and weighed because the advanced AVI reader and WIM are only operational in the right hand lane.

A second AVI reader is located downstream from the weigh station entrance ramp. The reader is on an arm mast that hangs over all three lanes of the mainline. Unless the weigh station is physically closed, the only trucks that are allowed to bypass the weigh station are those with transponders that have been given a green light. The purpose of the second AVI reader is to read the transponders of the trucks bypassing the station and verify that they did indeed receive a green light. MdTA Commercial Vehicle Safety Unit (CVSU) personnel monitor the E-screening computer systems and the trucks that bypass the station and ensure they match up accordingly. Those vehicles not given green lights are most likely illegally passing the weigh station and are tracked down by an MdTA CVSU trooper.

Another feature of the Perryville facility is the presence of a ramp WIM scale. On the main entrance ramp leading to the static scales, there is a WIM embedded in the roadway. The ramp WIM scale weighs trucks entering the facility with more accuracy than the one on the mainline. Vehicles move a lot slower on the ramp than on the mainline so the ramp WIM gives enforcement personnel better information on the actual weight of each vehicle. Trucks weighing less than 80,000 pounds may be allowed back onto the mainline without having to come across the static scales. MdTA CVSU has the ability to signal each vehicle by using an electronic sign located just prior to the sorter ramp. The electronic sign has two basic messages: Proceed to I-95 or Proceed to Static Scales. Each driver gets a message based on their own vehicle's ramp WIM information and they will be instructed to either head back to the mainline via the sorter ramp or continue down the main ramp to the static scales. The sorter exit ramp is located in between the entrance ramp and the static scales.

The other main features of the weigh station are the static scales, scale house, and inspection shed. The static scales are the most accurate scales at the weigh facility and are located near the end of the ramp directly in front of the scale house. CVSU personnel operate and monitor the facilities using computers and other equipment housed in the static scales. Vehicles that CVSU personnel believe are not complying with safety regulations may need to be inspected in more detail. The inspection shed is where vehicles are inspected more thoroughly by trained, experience commercial vehicle inspectors. This inspection shed is located in the large parking lot behind the static scales and scale house. A schematic representation of the Perryville Weigh and Inspection station is shown in Figure 2-2.

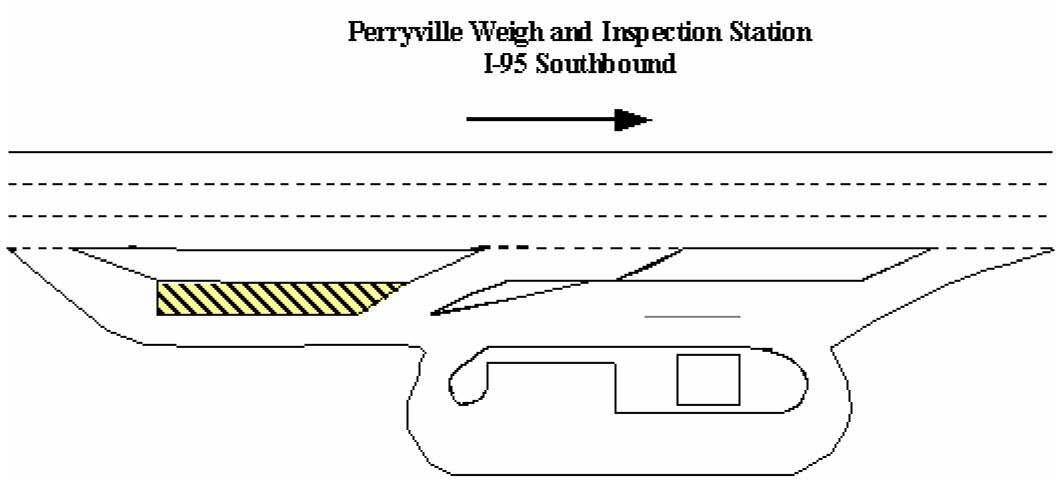

Figure 2-2. Perryville Weigh and Inspection Station Facility Layout.

2.2 PERRYVILLE TOLL COLLECTION FACILITY

The Perryville Toll Collection Facility is a part of the John F. Kennedy Memorial Highway and is owned and operated by the MdTA. It is located approximately 16 miles west of the Maryland/Delaware state border in Cecil County, Maryland, in northbound lanes of I-95. The toll collection facility utilizes twelve toll lanes to process vehicles leaving the stretch of I-95 designated the John F. Kennedy Memorial Highway. The MdTA is a member the E-ZPass Electronic Toll Collection (ETC) technology program.

Quick Facts	
Name:	John F. Kennedy Memorial Highway Toll Facility
Location:	Perryville, MD – Northbound I-95
Completed:	November 14, 1963
Owner:	Maryland Transportation Authority (MdTA)
Operator:	MdTA
Annual Operating Cost:	$16 million
Annual Man-Hours:	540,800
ETC Capability / Operation	Yes / Yes (EZ- Pass)

E-ZPass ETC is used by many toll agencies in the northeastern United States and is popular with many commuters and commercial vehicle operators that travel in and around that region of the country.

Due to the popularity of ETC with commuters and other passenger vehicle drivers, MdTA allows cars with toll transponders to use all 12 lanes of the facility. Each lane has an ETC reader attached to the toll facility's roof. The readers are about the size of a pizza box and they use DSRC to read the E-ZPass transponders to collect the toll from the account connected to the transponder. Two of the 12 lanes are dedicated for just ETC. Vehicles without the E-ZPass transponders are not permitted to use these lanes and are required to use one of the lanes that accept cash or tickets.

Commercial vehicles that participate in ETC (and the E-screening/ETC interoperability project) do have the ability to use the ETC-dedicated lanes and must use the right 5 lanes, indicated as lanes 8 – 12 in Figure 2-3. Commercial vehicles using ETC tags do not get the same benefit as passenger vehicles because they do not have an E-Z Pass Only Lane for commercial vehicles. All commercial vehicles, paying by ETC or cash/ticket, must use the same 5 lanes. Those commercial vehicles that have ETC sit in queues that would otherwise not exist in an E-ZPass Only Lane. Toll enforcement is the primary reason that commercial vehicles are not allowed to utilize these lanes.

Currently, enforcement cameras are only capable of taking pictures of vehicles' rear license plates. Rear license plates on a trailer unit are not always the same as those on the tractor and it is the owner/driver of the tractor unit that is ultimately responsible for paying a toll. Cameras are not capable of taking pictures of tractors that are pulling trailers and the trailers are not necessarily owned and registered by the same person or company driving the tractor. MdTA does have plans for investing in the proper enforcement technologies to allow commercial vehicles to use E-Z Pass Only Lanes and hopes to offer this feature to the trucking community in the future.

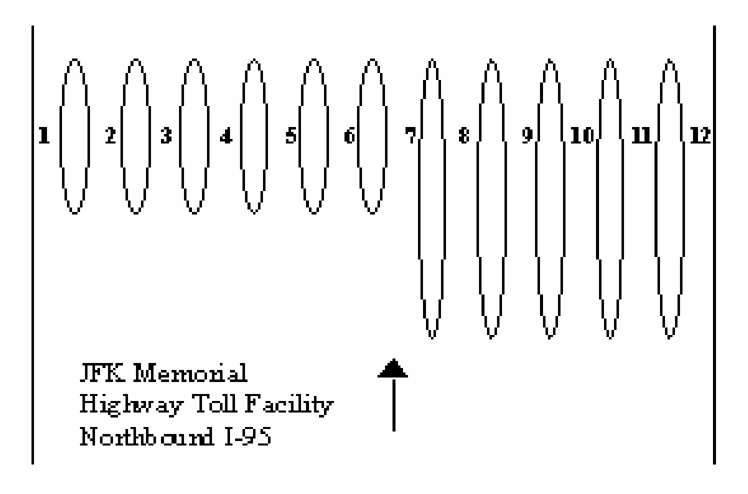

Figure 2-3. Perryville Toll Facility Layout.

2.3 HYATTSTOWN WEIGH AND INSPECTION STATION

Quick Facts	
Authority/Facility Name:	Hyattstown Weigh and Inspection Station
Location:	Hyattstown, Maryland – Southbound I-270
Owner:	MDOT/SHA
Operator:	Maryland State Police Commercial Vehicle Enforcement Division (MSP CVED)
E-screening Capability / Operational	No / No

The Hyattstown Weigh and Inspection Station is located approximately 12 miles south of Frederick, Maryland, along Interstate 270 (I-270). Facilities exist on the northbound and southbound sides of the highway; however the southbound facility is operated more frequently. Hyattstown is located on I-270 between Frederick, Maryland and the Washington, DC Metropolitan area. I-270 connects the I-495/I-95 (National Capital Beltway) to I-70. The National Capital Beltway is an 8-lane interstate that circles around Washington, D.C., and runs through surrounding suburban areas of Northern Virginia and Maryland. I-70 is a major East/West route that begins at the Baltimore Beltway (I-695) and runs west through Frederick, Maryland, and into the mid-western section of the United States

The Hyattstown Weigh Station was built and is owned by the Maryland State Department of Transportation State Highway Administration (MDOT/SHA) The Maryland State Police Commercial Vehicle Enforcement Division (MSP/CVED) is responsible for operating the site. The MSP/CVED operated the southbound facilities during all of the baseline data collection activities.

New Market is one of the older facilities in Maryland and is relatively small when compared to newer facilities such as Perryville in Maryland and Union in Connecticut. The site does not have the capability to electronically screen vehicles at the present time.

The primary features of the Hyattstown Weigh Station include the scale house, static scales, and inspection pit. The static scales are located near the end of the ramp directly in front of the scale house. CVED personnel operate and monitor the facilities using computers and other equipment housed in the static scales. Vehicles that CVED personnel believe are not complying with safety regulations may need to be inspected in more detail. The inspection pit is where vehicles are inspected more thoroughly by trained, experience commercial vehicle inspectors. This inspection pit is located in the large parking lot behind the static scales and scale house. A schematic layout of the facility is shown in Figure 2-4.

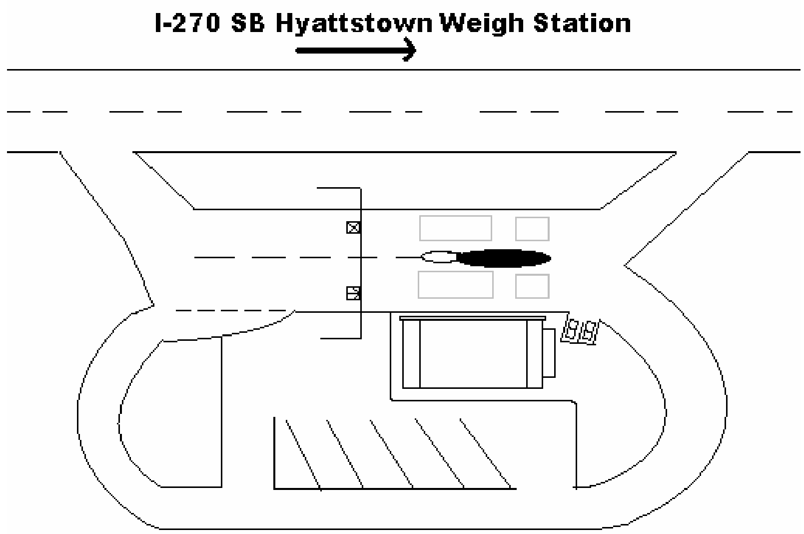

Figure 2-4. Hyattstown Weigh Station Layout.

2.4 WEST FRIENDSHIP WEIGH AND INSPECTION STATION

The West Friendship Weigh and Inspection Station is located approximately 15 miles south of west of Baltimore, Maryland along I-70. West Friendship is located on I-70 between Frederick, Maryland, and the Baltimore metropolitan area. I-70 is a major East/West route that begins at the Baltimore Beltway (I-695) and runs west through Frederick, Maryland, and into the mid-west portion of the United States.

Quick Facts	
Authority/Facility Name:	West Friendship Weigh and Inspection Station
Location:	West Friendship, Maryland – Westbound I-70
Owner:	MDOT/SHA
Operator:	Maryland State Police Commercial Vehicle Enforcement Division (MSP CVED)
E-screening Capability / Operational	No / No

The West Friendship facility was built, and is owned by, the MDOT/SHA. The MSP/CVED is responsible for operating the site.

West Friendship is one of the older facilities in Maryland and is relatively small when compared to newer facilities such as Perryville in Maryland and Union in Connecticut. The site does not have the capability to electronically screen vehicles at the present time; however the facility does have a ramp WIM to help reduce queues at the static scales.

The primary features of the West Friendship facility include the scale house, static scales, and inspection pit. The primary features of the Hyattstown Weigh Station include the scale house, static scales, and inspection pit. The static scales are located near the end of the ramp directly in front of the scale house. CVED personnel operate and monitor the facilities using computers and other equipment housed in the static scales. Vehicles that CVED personnel believe are not complying with safety regulations may need to be inspected in more detail. The inspection pit is where vehicles are inspected more thoroughly by trained, experience commercial vehicle inspectors. This inspection pit is located in the large parking lot behind the static scales and scale house. The weigh and inspection station layout is shown in Figure 2-5.

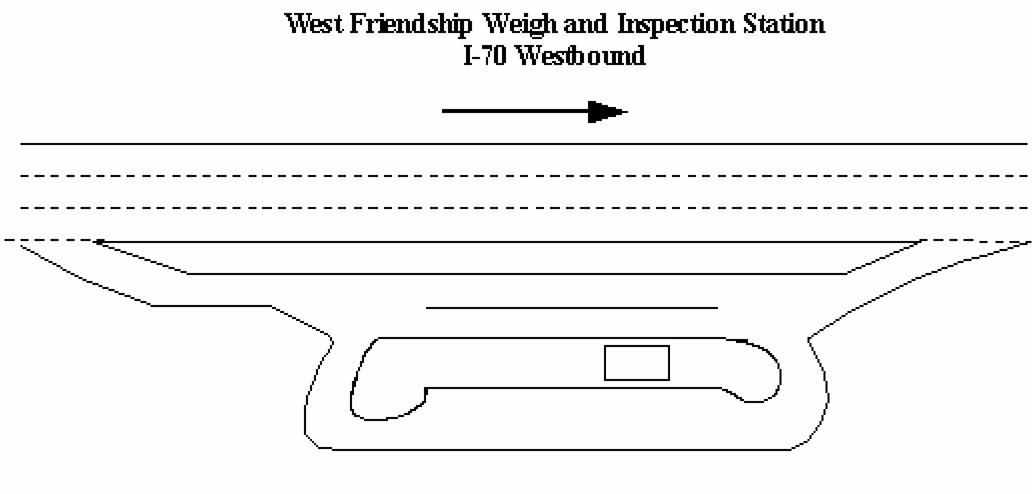

Figure 2-5. West Friendship Weigh and Inspection Station Layout.

2.5 NEW MARKET WEIGH AND INSPECTION STATION

The New Market Weigh and Inspection Station is located approximately 10 miles east of Frederick, Maryland along I-70. New Market is located on westbound I-70 between Frederick, Maryland, and the Baltimore metropolitan area. I-70 is a major East/West route that begins at the Baltimore Beltway (I-695) and runs west through Frederick, Maryland, and into the mid-west portion of the United States.

Quick Facts	
Authority/Facility Name:	New Market Weigh and Inspection Station
Location:	New Market, Maryland – Westbound I-70
Owner:	MDOT/SHA
Operator:	Maryland State Police Commercial Vehicle Enforcement Division (MSP CVED)
E-screening Capability / Operational	No / No

The New Market facility was built and is owned by the MDOT/SHA. The MSP/CVED is responsible for operating the site.

New Market is one of the older facilities in Maryland and is relatively small when compared to newer facilities such as Perryville in Maryland and Union in Connecticut. The site does not have the capability to electronically screen vehicles at the present time.

The primary features of the New Market facility include the scale house, static scales, and inspection pit. The static scales are located near the end of the ramp directly in front of the scale house. CVED personnel operate and monitor the facilities using computers and other equipment housed in the static scales. Vehicles that CVED personnel believe are not complying with safety regulations may need to be inspected in more detail. The inspection pit is where vehicles are inspected more thoroughly by trained, experience commercial vehicle inspectors. This inspection pit is located in the large parking lot behind the static scales and scale house. A schematic layout is shown in Figure 2-6.

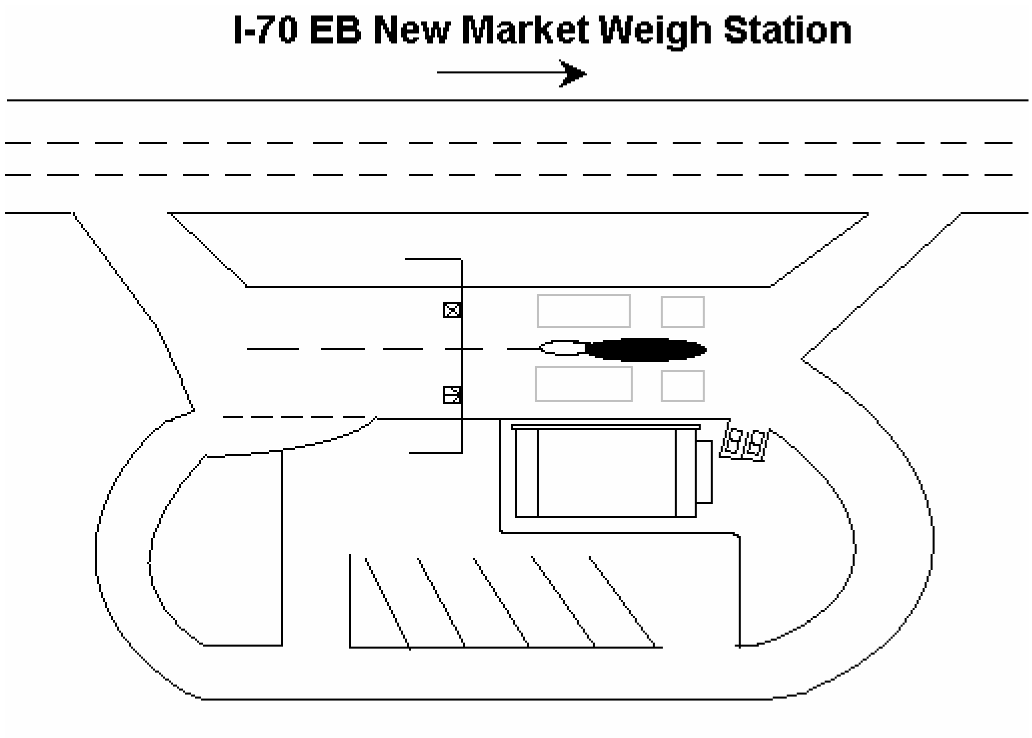

Figure 2-6. New Market Weigh Station Layout.

New York

2.6 ALBANY TOLL FACILITIES

The Albany Toll Facilities are a part of the New York State Thruway, which is the longest toll highway system in the United States. Owned and operated by the New York State Thruway Authority (NYSTA), the Thruway connects to other key highway corridors such as the Connecticut and Massachusetts Turnpikes, and the Garden State Parkway in New Jersey.

Quick Facts	
Authority/Facility Name:	Governor Thomas E. Dewey Thruway – Albany Barrier
Location:	Albany, NY - Thruway Exits 23 and 24
Completed:	December 23, 1960 (Original 559 miles of Thruway)
Owner:	New York Thruway Authority
Operator:	New York Thruway Authority
Annual Operating Cost:	NY Thruway System - $275.5 million
ETC Capability / Operation	Yes / Yes

Commercial vehicle traffic utilizes these important routes to get around the northeast and points south and west. Albany, the capital of New York State, has two distinct exit/entrance points along the New York Thruway. Exit 23 (Downtown) and Exit 24 (I-90 & I-87) are the two main access points for commercial vehicles traveling to and from Interstates 90, 87, and 787 in the Albany metropolitan area. I-90 and I-87 intersect at Exit 24 which is located northwest of downtown Albany on the Thruway. I-87 and I-787 intersect at Exit 23, which is south of downtown Albany.

The NYSTA is one of the founding agencies of the E-ZPass Program. E-ZPass is popular in New York due to extensive toll facility network that exists in the State. The Thruway does accept cash and tickets; however E-ZPass is used by a large majority of toll customers. Commercial vehicles do have the ability to utilize E-ZPass Only Lanes. The number of available lanes for vehicles entering and exiting the Thruway sometimes fluctuates, however Figure 2-7 and Figure 2-8 indicate all the possible configurations of Entrance (E) and Exit (X) lanes at both Exit 23 and Exit 24 in Albany.

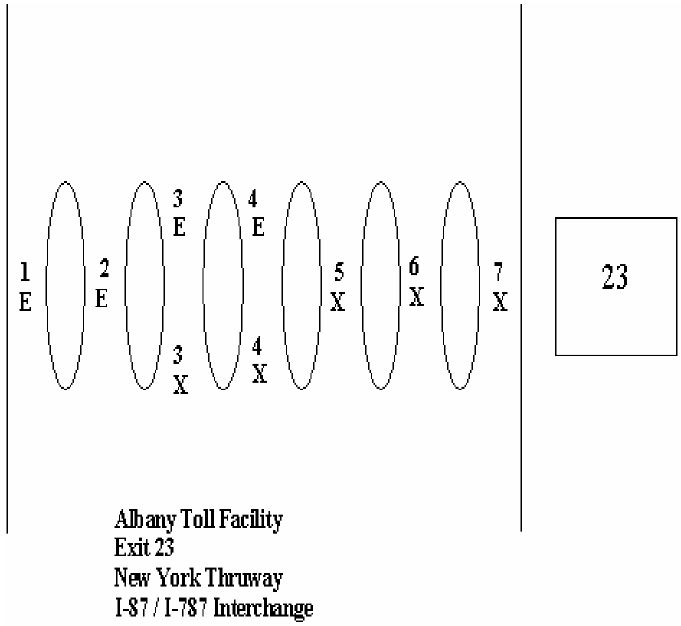

Figure 2-7. Albany Exit 23 Layout.

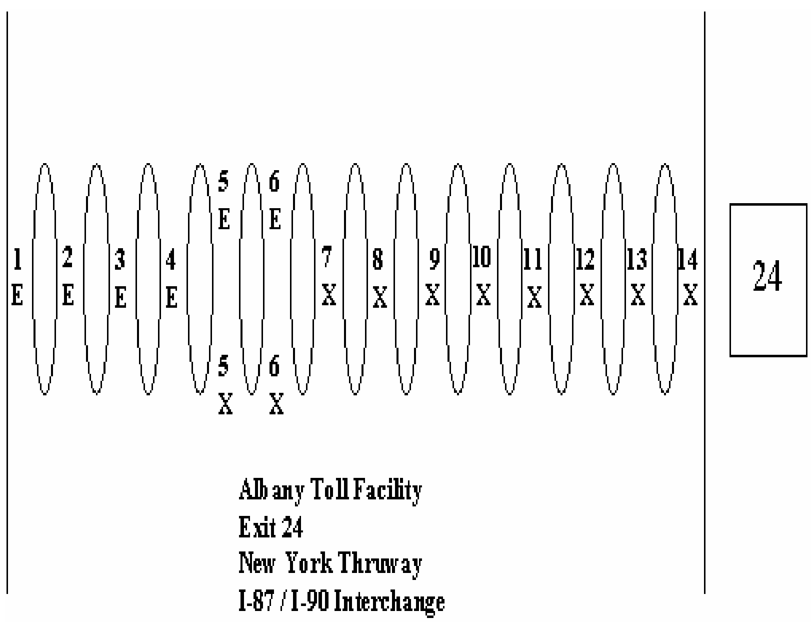

Figure 2-8. Albany Exit 24 Layout.

2.7 GEORGE WASHINGTON BRIDGE TOLL FACILITIES

The two-level George Washington Bridge (GWB) crosses the Hudson River between upper Manhattan (West 178th Street) and Fort Lee, New Jersey, and forms part of Interstate Highway I-95.

Quick Facts	
Authority/Facility Name:	Port Authority of New York/New Jersey – The George Washington Bridge
Location:	Between upper Manhattan (West 178th Street) and Fort Lee, New Jersey
Completed:	October 25, 1931
Owner:	Port Authority of New York/New Jersey
Operator:	Port Authority of New York/New Jersey
Annual Operating Cost: (NA)	Cost of original structure: $59,000,000 P.A. Total investment as of December 31, 2003: $898,510,000
ETC Capability / Operation	Yes / Yes

In New Jersey, the roadways leading to the bridge permit motorists to use either the upper or lower level. Two four-lane approach and departure roadways connect to the upper level, with connections to and from the lower level via two three-lane tunnels through the Palisades. Commercial Vehicle Traffic is limited to the upper level.

The New Jersey approach system provides connections between both levels of the bridge and highways US-1, US-9W, US-46, NJ-4, I-80, I-95 and the Palisades Interstate Parkway. The 12-lane Trans-Manhattan Expressway, extending eastward from the bridge to the Harlem River between 178th and 179th Streets, connects both levels of the bridge with Amsterdam Avenue, the Harlem River Drive and the 181st Street Bridge over the Harlem River. The Expressway connects directly with the Alexander Hamilton Bridge, which spans the Harlem River as part of the Cross Bronx Expressway (I-95), and the Major Deegan Expressway (I-87). Both the upper and lower levels connect to the Henry Hudson Parkway and Riverside Drive on the West Side of Manhattan.

The toll plazas are on the west (New Jersey) side of the bridge approach. The plaza servicing the upper level (and all commercial traffic) has 12 even numbered toll lanes. Depending on day of week and time of day, the E-ZPass configuration is changed. Lanes 2, 4, 6, and 8 are always E-ZPass; lanes 16,18 and 22 are mixed mode depending on day of week and time of day; and lanes 10,12,14, and 24 are always cash. The toll configuration is illustrated in Figure 2-9.

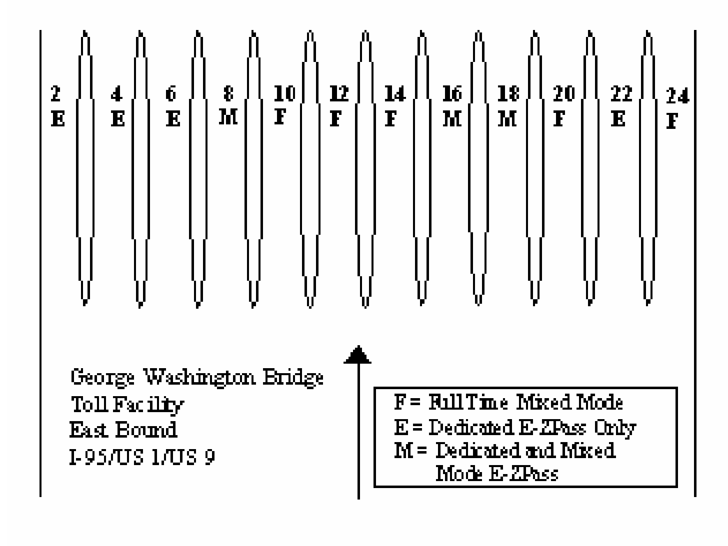

Figure 2-9. George Washington Bridge Upper-Level Layout.

2.8 GOVERNOR MALCOM WILSON TAPPAN ZEE BRIDGE TOLL FACILITIES

The Governor Malcom Wilson Tappan Zee Bridge, opened in 1955, spans the Hudson River between Tarrytown and Nyack, New York. The total length of the bridge and approaches is 16,013 feet (just over 3 miles, about 4.9 km). The cantilever span is 2,416 feet (736 meters) providing a 138-foot (42 meter) clearance over the water.

The bridge is part of the New York Thruway highway system, designated as I-87 and I-287. The span carries seven lanes of automotive traffic (approximately 130,000 vehicles per day), with the center lane being switchable between eastbound and westbound traffic depending on the prevalent commuter direction. This is accomplished via a movable center barrier.

Quick Facts	
Authority/Facility Name:	Governor Thomas E. Dewey Thruway – The Governor Malcolm Wilson Tappan Zee Bridge
Location:	Tarrytown and Nyack, NY
Completed:	December 15, 1955
Owner:	New York Thruway Authority
Operator:	New York Thruway Authority
Annual Operating Cost:	NY Thruway System - $275.5 million
ETC Capability / Operation	Yes / Yes

The Tappan Zee Bridge Toll Plaza currently has a capacity of 12 toll lanes. A round-trip toll is collected from eastbound (South) vehicles, while no toll is collected from westbound (North) vehicles. As illustrated in Figure 2-10, lanes 2, 9, 10, 11, and 12 are always dedicated E-ZPass lanes. Lanes 7 and 8 are E-ZPass or cash (in the afternoon/evening peak) and lanes 3, 4, 5, and 6 are mixed-mode E-ZPass/cash at all times. Lane 1 is cash at all times.

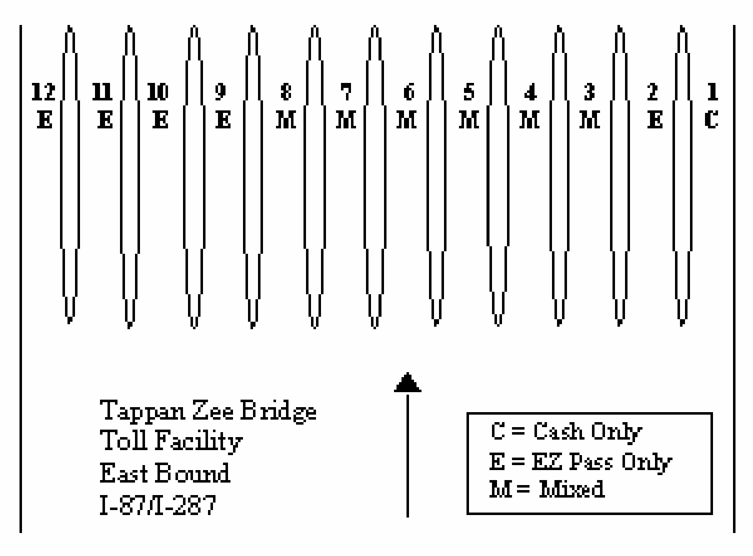

Figure 2-10. Governor Malcom Wilson Tappan Zee Bridge Layout.

Connecticut

2.9 UNION WEIGH STATION

Quick Facts	
Name:	Union Weigh and Inspection Facility
Location:	Union, CT – Eastbound I-84
Owner:	Connecticut Department of Transportation
Operator:	Connecticut State Police / Connecticut Department of Motor Vehicles
E-screening Capability / Operational:	Yes / No

The Union Weigh and Inspection Station is located in northeastern Connecticut, along the westbound lanes of Interstate 84 between Boston, Massachusetts and Hartford, Connecticut. The modern facility was built by the Connecticut Department of Transportation (CDT) and is co-operated by the Connecticut State Police (CSP) and Connecticut Department of Motor Vehicles (CT DMV).

Strategically located just 4 miles south of the Massachusetts and Connecticut State Line, the Union facility was chosen as a site for the evaluation because it been equipped with the infrastructure and software to conduct E-screening of commercial vehicles. The system was not operational during the baseline data collection activities, however the infrastructure and equipment is in place and it is expected to be running the E-screening system once all the technical components are configured and working reliably.

The E-screening system is similar to the system in place in Perryville, Maryland. The first component of the E-screening equipment at is located approximately 1mile upstream of the weigh station. An advanced AVI reader is located on an arm mast that hangs over the right hand lane. The first advanced AVI reader begins the first step of the E-screening process. In addition to the AVI reader, there is a WIM scale embedded in the pavement of the right hand lane. The WIM weighs vehicles at highway speed so that the information can be included in the E-screening process. The transponder-equipped and ETC-enrolled vehicles are required to be in the right lane to be electronically screened and weighed because the advanced AVI reader and WIM are only operational in the right hand lane.

There is a second AVI reader that is located downstream from the weigh station entrance ramp. The reader is on an arm mast that hangs over both of the lanes on the mainline. Unless the weigh station is physically closed, the only trucks that are allowed to bypass the weigh station are those with transponders that have been given a green light. The purpose of the second AVI reader is to read the transponders of the trucks bypassing the station and verify that they did indeed receive a green light. CT DMV or CSP personnel monitor the E-screening computer systems and the trucks that bypass the station and ensure they match up accordingly. Those vehicles not given green lights are most likely illegally passing the weigh station and are tracked down by enforcement personnel.

Another feature of the Union Weigh Station is the presence of a ramp WIM scale. On the main entrance ramp leading to the static scales, there is a WIM embedded in the roadway. The ramp WIM scale weighs all trucks entering the facility with more accuracy than the one on the mainline. Vehicles move a lot slower on the ramp than on the mainline so the ramp WIM gives enforcement personnel better information on the actual weight of each vehicle. Trucks weighing less than 80,000 lbs may be allowed back onto the mainline without having to come across the static scales. Connecticut enforcement personnel have the ability to signal each vehicle by using two lighted directional signs (see Figure 2-11) just prior to the sorter ramp.

Figure 2-11. Sorter Ramp Signage.

Enforcement personnel can manually signal either a green straight arrow light or a red **X** in both main ramp lane (left side) and the static scales entrance lane (right side). Each driver gets an individual response from enforcement personnel based on their own vehicles' ramp WIM information. Drivers that are given a green arrow on the left side are allowed to head back to the mainline by continuing down the ramp. If the red **X** appears on the left side, the driver must proceed to the static scales around back of the weigh station. The sorter WIM is not directly tied into the E-screening process, however it does help to reduce the queue at the static scales.

The other main features of the weigh station are the static scales, scale house, and inspection shed. The static scales are the most accurate scales at the weigh facility and are located near the end of the ramp directly in front of the scale house. Connecticut enforcement personnel operate and monitor the facilities using computers and other equipment housed in the static scales. Vehicles that enforcement personnel believe are not complying with safety regulations may need to be inspected in more detail. The inspection shed is where vehicles are inspected more thoroughly by trained, experience commercial vehicle inspectors. This inspection shed is located in the large parking lot behind the static scales and scale house. The Union facility layout is shown in Figure 2-12.

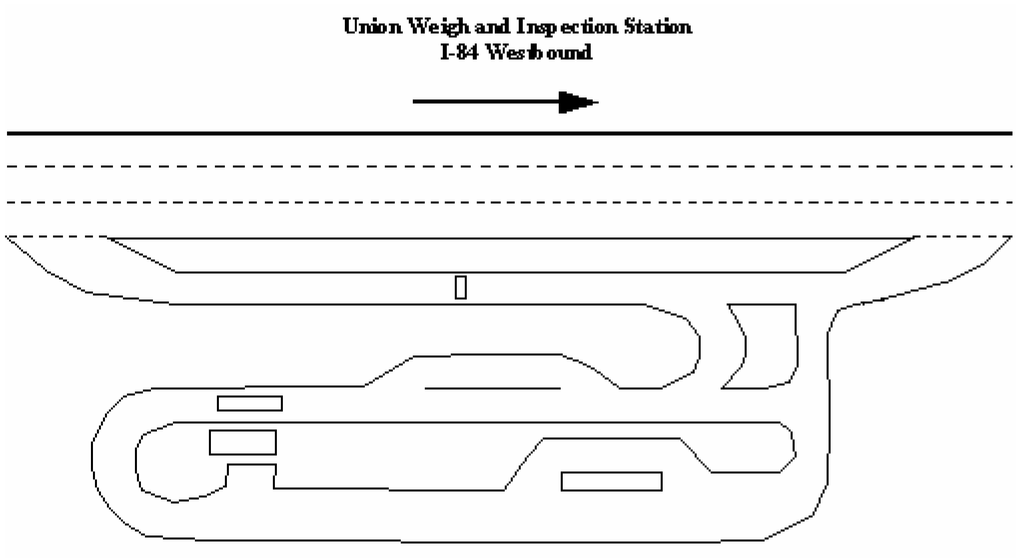

Figure 2-12. Union Facility Layout.

2.10 GREENWICH WEIGH STATION

Quick Facts	
Name:	Greenwich Weigh and Inspection Facility
Location:	Greenwich, CT – Northbound I-95
Owner:	Connecticut Department of Transportation
Operator:	Connecticut State Police / Connecticut Department of Motor Vehicles
E-screening Capability / Operational:	No / No

The Greenwich Weigh and Inspection Station is located in southwestern Connecticut, along the northbound lanes of I-95. Similar to the Union Weigh Station, Greenwich was built by CTDOT and is co-operated by the CT DMV and CSP. Located only 25 miles northeast of New York City, this weigh facility receives a very high volume of commercial vehicle traffic.

Commercial vehicles traveling to places such as Hartford, Boston, and upper New England are coming from New York City and other locations along I-95. The Greenwich site does not currently have E-screening capability; however, this site may be a good candidate for receiving the technology due to the high volume of traffic it gets.

Similar to the other sites that are not capable of E-screening commercial vehicles, the main features of the Greenwich facility include a scale house with static scales and area to inspect vehicles in a detailed manner. This site does not have an actual inspection shed; however, there is a lane next to the static scale that allows commercial vehicle inspectors to take a close look at vehicles that may require more attention or are picked in a random spot check. The Greenwich Weigh Station layout is shown in Figure 2-13.

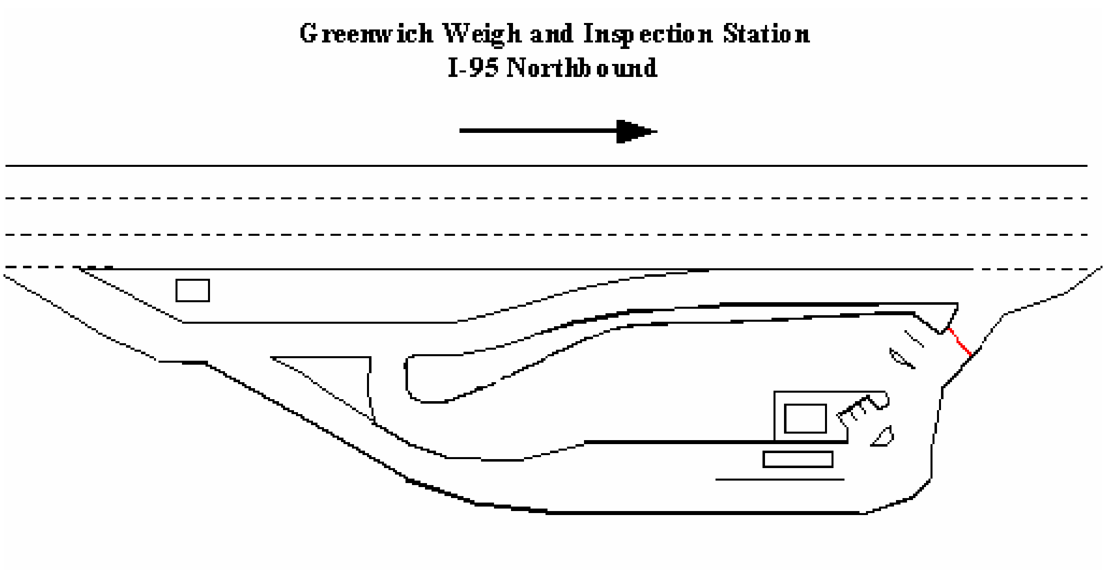

Figure 2-13. Greenwich Weigh Station Layout.

3 TEST RESULTS AND FINDINGS

3.1 MOBILITY TEST (TRAVEL TIMES, TT VARIABILITY, COUNTS, CLOSINGS)

The following sections describe the evaluation of Electronic Toll Collection and E-screening technologies and their impact on improving the mobility of commercial vehicles at toll collection facilities and weigh stations.

3.1.1 Methods and Results for Toll Facilities

This section describes the specific data collection methodologies and results obtained from field measurements at the toll facilities in New York and Maryland.

3.1.1.1 Albany, New York

Travel times were recorded for trucks traveling through the toll facility barriers at Barrier 23 on I-787 and Barrier 24 on I-90. The travel times were measured for trucks as they crossed an upstream landmark until the truck passed through the toll barrier. On October 16 – 17, 2002, travel times for a total of 261 trucks were collected at Barrier 23 and 402 travel times were collected at Barrier 24. Travel times were recorded during the following eight time periods:

- Morning (7 – 9:30 a.m.) on Wednesday, October 16, 2002
- Noon (12:00 – 2 p.m.) on Wednesday, October 16, 2002
- Evening (5 – 7 p.m.) on Wednesday, October 16, 2002
- Night (9:40 – 11:40 p.m.) on Wednesday, October 16, 2002
- Morning (7 – 9:30 a.m. on Thursday, October 17, 2002
- Noon (11:30 a.m. – 1:45 p.m.) on Thursday, October 17, 2002
- Evening (4:45 – 7 p.m.) on Thursday, October 17, 2002
- Night (9:30 – 11:15 p.m.) on Thursday, October 17, 2002

Entering the Thruway at Barrier 23. At Barrier 23, eastbound vehicles entered onto the New York (Thomas E. Dewey) Thruway and either picked up a ticket from a toll booth operator or passed through an E-ZPass reader (see Figure 3-1). Travel times were collected for 149 trucks entering Barrier 23 (101 for E-ZPass and 48 for non-E-ZPass). Figure 3-2 shows the average travel time (and 95 percent confidence interval) for trucks entering the Thruway at the Barrier 23 toll barrier during the four time periods (Morning, Noon, Evening, and Night).

As shown in Figure 3-2, E-ZPass entries were quicker than non-E-ZPass entries. The largest time savings was found during the evening commute where, on average, trucks using E-ZPass had a time savings (or reduction in delay) of approximately 60 seconds compared to trucks not using E-ZPass. Trucks using E-ZPass entering the Thruway during the evening period at Barrier 23 took approximately 40 seconds to enter versus about 100 seconds for those waiting to pick up a ticket following a cash payment.

Figure 3-1. Entering the Thruway at Barrier 23.

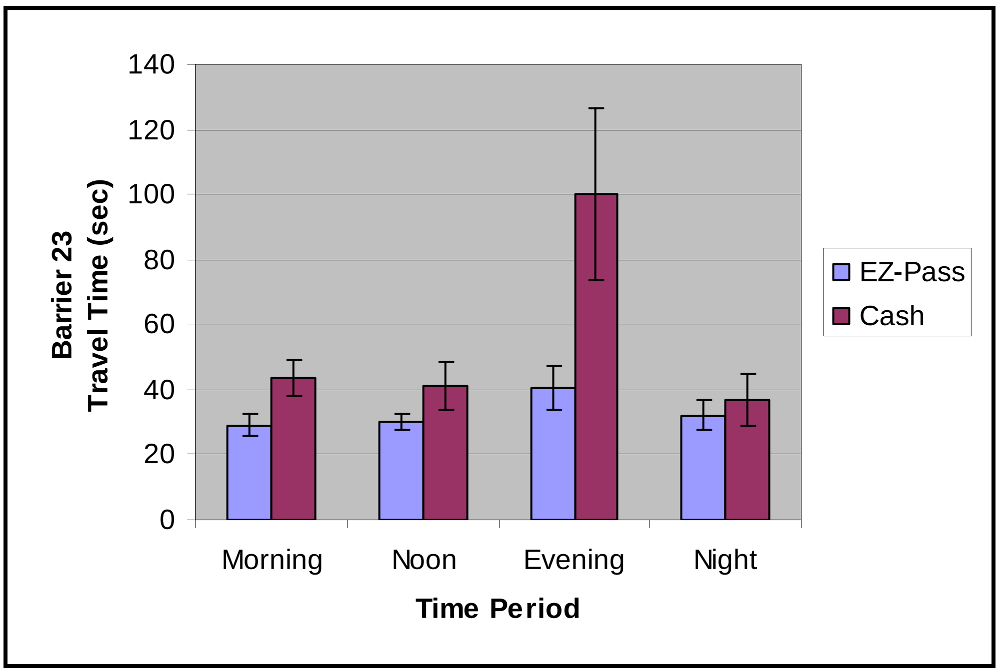

Figure 3-2. Travel Times for Entering the Thruway at Barrier 23.

Exiting the Thruway and Paying Tolls at Barrier 23. At Barrier 23, westbound vehicles were required to pay tolls when exiting the Thruway. In this direction, all drivers were required to complete a payment transaction either manually or electronically via E-ZPass. At the toll booth, drivers could either (manually) hand a ticket to a toll booth operator and pay the toll or pass through an E-ZPass reader using electronic payment. Of the 112 travel times collected for trucks exiting the Thruway at Barrier 23, 72 were E-ZPass and 40 were non-E-ZPass.

Figure 3-3 shows the average travel time (and 95 percent confidence interval) for trucks exiting toll Barrier 23 at the Morning, Noon, Evening, and Night periods. In general, regardless of time of day, trucks using E-ZPass took between 20 to 25 seconds to approach the toll barrier and complete the payment transaction. Trucks not paying by E-ZPass took between 60 and 97 seconds to approach the toll barrier, give the toll booth operator the ticket, and make a cash payment. At this barrier the most pronounced time benefit to using E-ZPass was during the Evening time period.

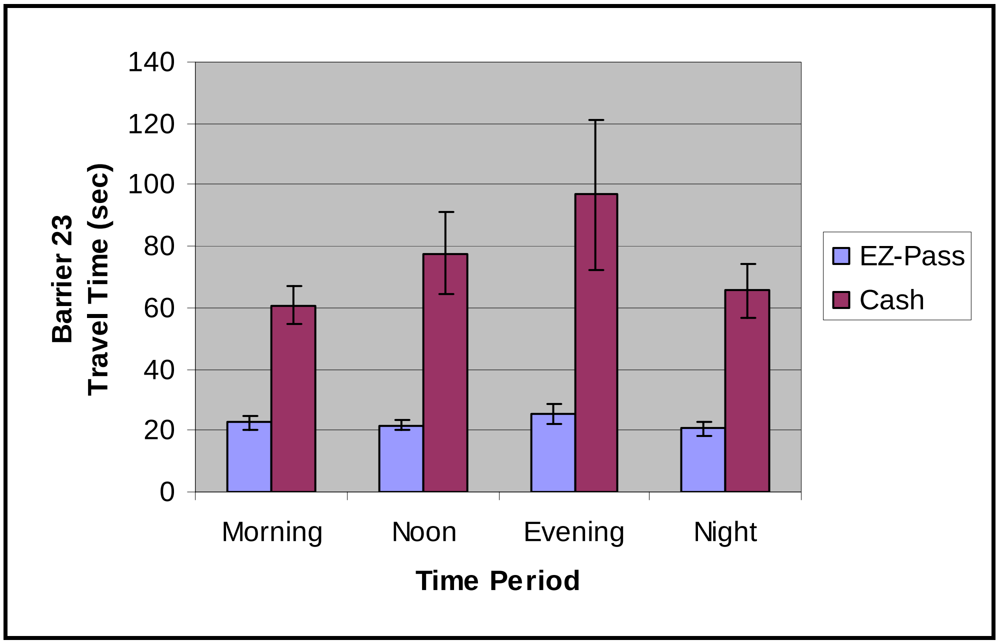

Figure 3-3. Travel Times for Exiting the Thruway at Barrier 23.

Hypothesis Testing for Barrier 23. An analysis of variance (ANOVA) was performed to determine whether the travel time differences between E-ZPass and non-E-ZPass were consistent enough to be statistically reliable. When traveling eastbound and entering the Thruway at Barrier 23, the travel time differences were found to be significant during the Morning ($F(1,33)=22.36$, $p<0.001$), Noon ($F(1,47)=13.03$, $p<0.001$), and Evening ($F(1,38)=31.69$, $p<0.001$) time periods.

Consequently, the travel times experienced by the E-ZPass trucks entering the Thruway were consistently shorter than those trucks not using E-ZPass. However, during the Night period (see Figure 3-3) there was no statistical difference in travel times for trucks entering the Thruway at Barrier 23 ($F(1,23)=1.10$, $p=0.31$). Although no traffic counts were available, anecdotal observations by the Data Collection Team suggests that the lack of a travel time difference between E-ZPass/non-E-ZPass during the Night period may be due to light traffic conditions.

When traveling westbound and paying the toll to exit the Thruway at Barrier 23, the travel times experienced by the E-ZPass trucks were consistently shorter than those trucks not using E-ZPass during all four time periods (Morning ($F(1,23)=196.42$, $p<0.001$), Noon ($F(1,36)=105.88$, $p<0.001$), Evening ($F(1,31)=58.53$, $p<0.001$), and Night ($F(1,14)=127.80$, $p<0.001$)). It was concluded that when paying the toll and exiting the Thruway at Barrier 23, the E-ZPass trucks had a consistently shorter travel time than those trucks not using E-ZPass. Depending on the time of day, E-ZPass trucks experienced an average time savings of between 38 to 71 seconds.

Based on these results it appears that in most instances E-ZPass provides a time savings benefit for both entering and exiting the Thruway at Barrier 23, although a larger E-ZPass time savings was found when paying the toll when exiting the Thruway.

Entering the Thruway at Barrier 24. At Barrier 24, vehicles traveling west through the toll barrier entered the Thruway and either picked up a ticket from a toll booth operator or passed through an E-ZPass reader (see Figure 3-4). Travel times were again recorded from the upstream landmark through payment transaction completion. A total of 131 times were recorded for trucks entering at Barrier 24 (72 were E-ZPass and 59 were non-E-ZPass).

Figure 3-4. Entering the Thruway at Barrier 24.

Figure 3-5 shows the average travel time for trucks entering the Thruway at Barrier 24 during four time periods (Morning, Noon, Evening, and Night). The marking above/below each bar value represents the range of variability where 95 percent of the travel times would be expected to occur.

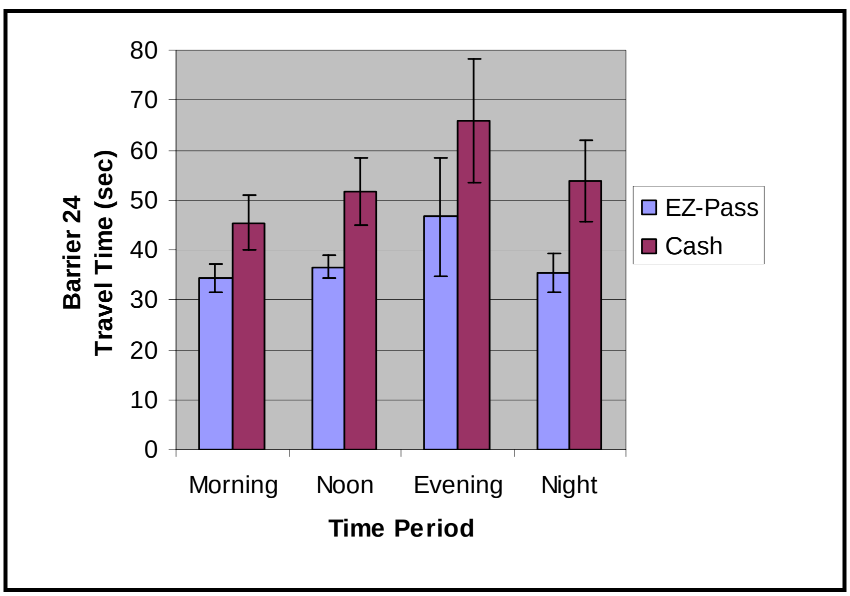

Figure 3-5. Travel Times for Entering the Thruway at Barrier 24.

In general, E-ZPass entries were 10 to 20 seconds faster than non-E-ZPass entries and the times appear to be quite reliable. The largest time savings was found during the evening commute where, on average, E-ZPass trucks saved approximately 20 seconds compared to trucks waiting to pick up a ticket. The evening was also the time of greatest travel time variability.

Exiting the Thruway and Paying Tolls at Barrier 24. Vehicles traveling east through the toll barrier exited the Thruway and either handed a ticket to a toll booth operator and paid manually or passed through an E-ZPass reader to pay electronically. Travel times were again recorded from the upstream landmark through payment transaction completion. Of the 271 travel times collected for trucks exiting the Thruway at Barrier 24, 151 were E-ZPass and 120 were non-E-ZPass.

Figure 3-6 shows the average travel time for trucks exiting the Thruway at Barrier 24 at the Morning, Noon, Evening, and Night periods. The 95 percent confidence interval markings above/below each bar shows the range where 95 percent of the travel times would be expected to occur. Due to traffic congestion, trucks using E-ZPass saved between 35 to 70 seconds to approach the toll barrier and complete the payment transaction electronically. Once again, the most pronounced E-ZPass time benefit was during the Evening time period.

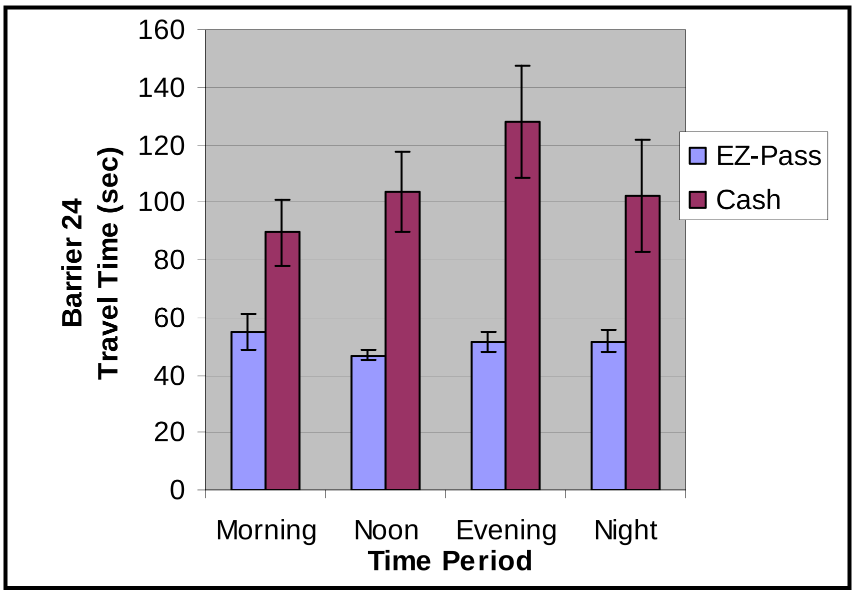

Figure 3-6. Travel Times for Exiting the Thruway at Barrier 24.

Hypothesis Testing for Barrier 24. An ANOVA was also performed on the Barrier 24 travel time data to determine whether the differences between E-ZPass and non-E-ZPass times were statistically reliable. For entering the Thruway at Barrier 24, the travel time differences were found to be significant during all four time periods: Morning ($F(1,39)=14.84$; $p<0.001$), Noon ($F(1,36)=22.72$, $p<0.001$); Evening ($F(1,34)=4.64$, $p<0.05$); and Night ($F(1,14)=14.09$, $p<0.005$).

For exiting the Thruway at Barrier 24, the travel time differences were also found to be significant during all four time periods: Morning ($F(1,61)=33.20$, $p<0.001$); Noon ($F(1,91)=76.94$, $p<0.001$); Evening ($F(1,73)=61.83$, $p<0.001$); and Night ($F(1,38)=30.70$, $p<0.001$).

As was found with Barrier 23 travel times, the Barrier 24 results indicate that in most instances, E-ZPass provides a time savings benefit for both entering and exiting the Thruway at Barrier 24, although, again, larger E-ZPass time savings were found when exiting the Thruway and paying the toll electronically.

3.1.1.2 New York City: George Washington Bridge

For the George Washington Bridge (GWB), cash versus E-ZPass payment transactions times were obtained from the Port Authority of New York and New Jersey for those trucks entering the I-95 GWB toll facility. The transaction times were recorded for eastbound trucks from the time the truck began entering the toll booth to make a payment until the truck began leaving the toll facility (see Table 3-1).

Transaction times were disaggregated for small and large trucks. Trucks with four or less axles were classified as small trucks and those with five or more axles were considered large trucks. Average transaction times were calculated from a total of 1,895 trucks recorded between November 24, 2003 and December 12, 2003 during peak and off-peak times. Of the total number of times collected, 126 were E-ZPass transactions and 1,769 were cash transactions.

Toll Payment at George Washington Bridge. Vehicles traveling through the GWB toll facility paid the toll either manually to a toll booth operator or passed through an E-ZPass reader to pay electronically. Table 3-1 shows the average toll payment transaction times for cash versus E-ZPass payments for small and large trucks. For small trucks, the average cash transaction took approximately 20.4 seconds versus 9.8 seconds for E-ZPass transactions. Small trucks using E-ZPass had an average time savings of about 10.6 seconds. For large trucks, the average cash transaction was 27.9 seconds. E-ZPass transactions took about 13.4 seconds, which resulted in an average time savings of 14.5 seconds per large truck E-ZPass transaction.

Table 3-1. George Washington Bridge Toll Payment Transaction Times

Transaction Type/Time	Small Truck (Seconds)	Large Truck (Seconds)
Cash Transaction	20.4	27.9
E-ZPass Transaction	9.8	13.4
Time Savings	10.6	14.5

3.1.1.3 New York City: Tappan Zee Bridge

For the Tappan Zee Bridge, cash versus E-ZPass payment transactions times were obtained by manually timing/recording those trucks entering the Tappan Zee Bridge toll facility on December 14,2004. Transactions times during peak and off-peak traffic conditions were recorded for eastbound trucks from the time the truck began slowing down to make a payment until the truck began leaving the toll facility (see Table 3-2).

Transaction times were recorded for both small and large trucks, though no differentiation was made in the data collection between the type categories. Average transaction times were calculated from a total of 548 trucks recorded during peak and off-peak times. Of the total number of times collected, 305 were E-ZPass transactions and 243 were cash transactions.

Toll Payment at Tappan Zee Bridge. Vehicles traveling through the Tappan Zee Bridge toll facility paid the toll either manually to a toll booth operator or passed through an E-ZPass reader to pay electronically. Table 3-3 shows the average toll payment transaction times for cash versus E-ZPass payments for trucks. The average cash transaction took approximately 45.8 seconds versus 6.7 seconds for E-ZPass transactions, which resulted in an average time savings of 39.1 seconds per truck E-ZPass transaction.

Table 3-2. Tappan Zee Bridge Toll Payment Transaction Times

Transaction Type/Time	All Trucks (Seconds)
Cash Transaction	45
E-ZPass Transaction	7
Time Savings	38

3.1.1.4 Perryville, Maryland

Travel times were recorded for trucks traveling through the Perryville toll facility on I-95. Consistent with the methods used in Albany, New York, the travel times were measured for trucks as they crossed an upstream landmark until the truck passed through the toll barrier. Travel times for a total of 752 trucks were measured between October 23 and 24, 2002. Travel times were recorded for trucks traveling through the Perryville toll facility on I-95. Consistent with the methods used in Albany, New York, the travel times were measured for trucks as they crossed an upstream landmark until the truck passed through the toll barrier. Travel times for a total of 752 trucks were measured between October 23 and 24, 2002. Of the total number of times collected, 302 were E-ZPass transactions and 450 were non-E-ZPass. Times were recorded during four 2-hour time periods:

- Evening (4:45 – 6:45 p.m.) on Wednesday, October 23, 2002
- Night (9:15 – 11:15 p.m.) on Wednesday, October 23, 2002
- Morning (7:15 – 9:15 a.m.) on Thursday, October 24, 2002
- Noon (11 a.m. – 1 p.m.) on Thursday, October 24, 2002

Truck Counts During Data Collection. Truck counts during the data collection time periods are shown in Figure 3-7 and Figure 3-8. The total number of 5-axle trucks at the Perryville toll facility was obtained from the Maryland Toll Authority for the two data collection dates.

Figure 3-7 depicts the truck volume during the Evening (4:45 to 6:45 p.m.) and Night (9:15 to 11:15 p.m.). Figure 3-8 shows the truck count during the morning (7:15 to 9:15 a.m.) and noon (11:00 a.m. to 13:00 p.m.) time periods. Figure 3-9 presents the overall vehicle volume between the evening and night periods. The number of overall vehicle volume in Figure 3-9 and Figure 3-10 exhibit the same trend.

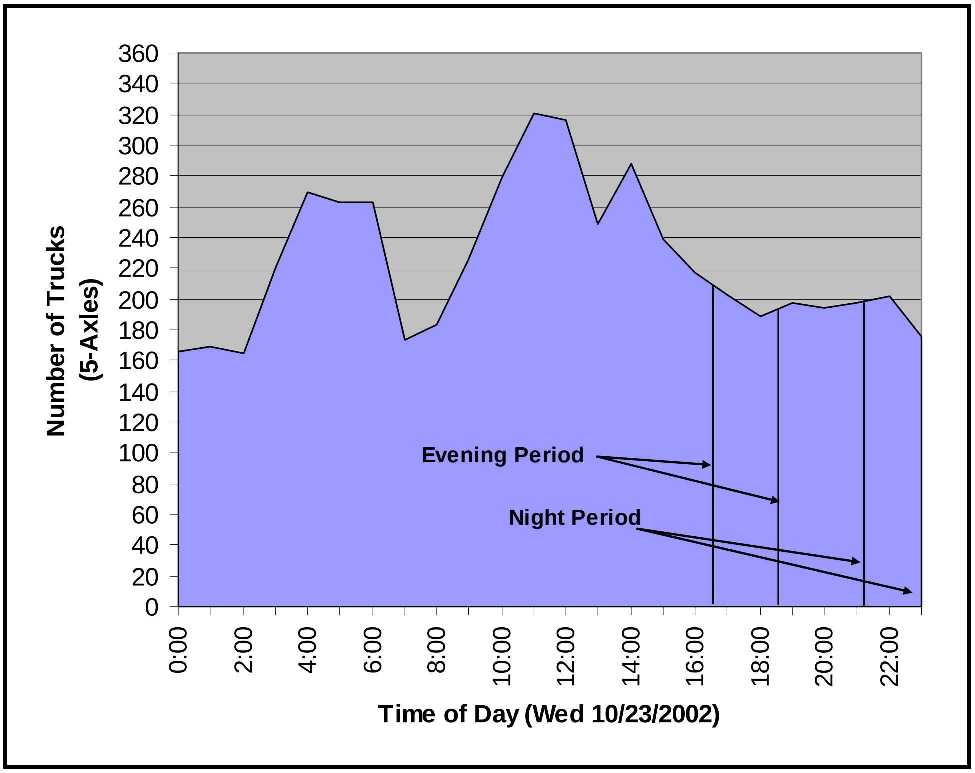

Figure 3-7. Perryville Truck Volume During Evening and Night Periods.

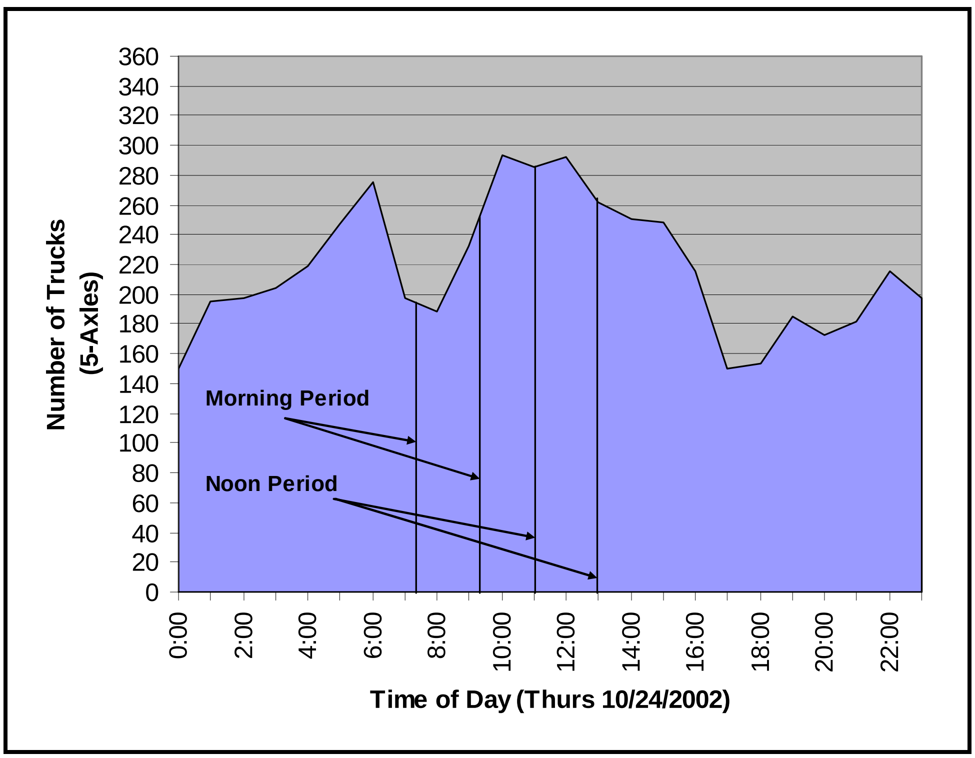

Figure 3-8. Perryville Truck Volume During Morning and Noon Periods.

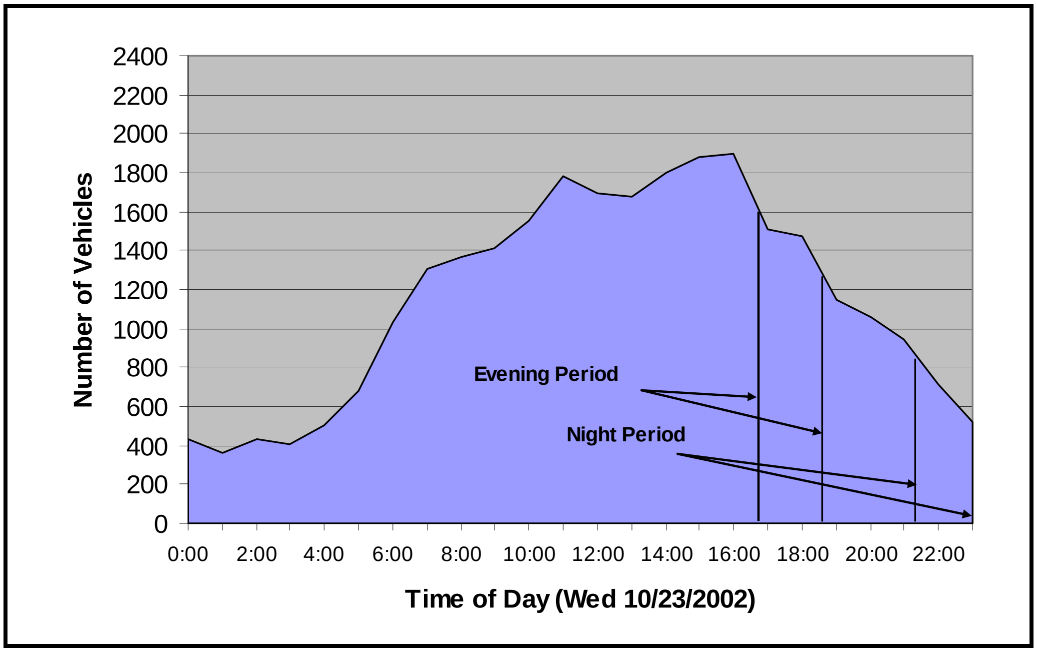

Figure 3-9. Overall Vehicle Volume During Evening and Night Periods.

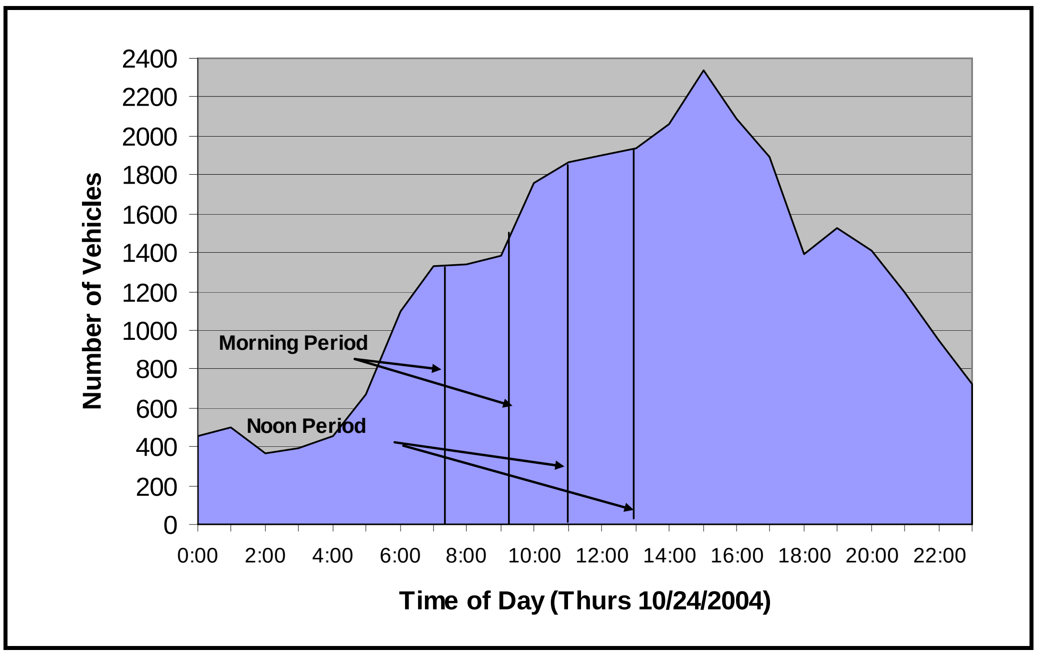

Figure 3-10. Overall Vehicle Volume During Morning and Noon Periods.

Toll Payment at Perryville. Vehicles traveling north on I-95 through the Perryville toll facility at present are required to enter truck-only lanes. Vehicles pay the toll either manually to a toll booth operator or pass through an E-ZPass reader for electronic payment. Figure 3-11 shows two E-ZPass lanes (below the yellow and white overhead signs) monitored during data collection activities at the Perryville Toll Plaza during October 23 – 24, 2002.

Figure 3-11. Entering the Perryville Toll Facility.

Figure 3-12 shows the average travel time (and 95 percent confidence interval) for trucks paying tolls during the Morning, Noon, Evening, and Night periods. During the Morning period, 96 E-ZPass and 120 non-E-ZPass toll payment transactions were recorded, with the average E-ZPass travel time recorded at 48 seconds versus about 73 seconds for non-E-ZPass. During the Noon period, 66 E-ZPass transactions versus 132 non-E-ZPass were recorded, with the average times for E-ZPass and non-E-ZPass at 64 and 88 seconds, respectively. In the Evening period, 95 E-ZPass and 113 non-E-ZPass transactions were recorded, with the average travel times at 55 and 79 seconds, respectively. For the Night period, there were 45 E-ZPass and 85 non-E-ZPass transactions recorded, with the average travel times at 59 and 87 seconds, respectively.

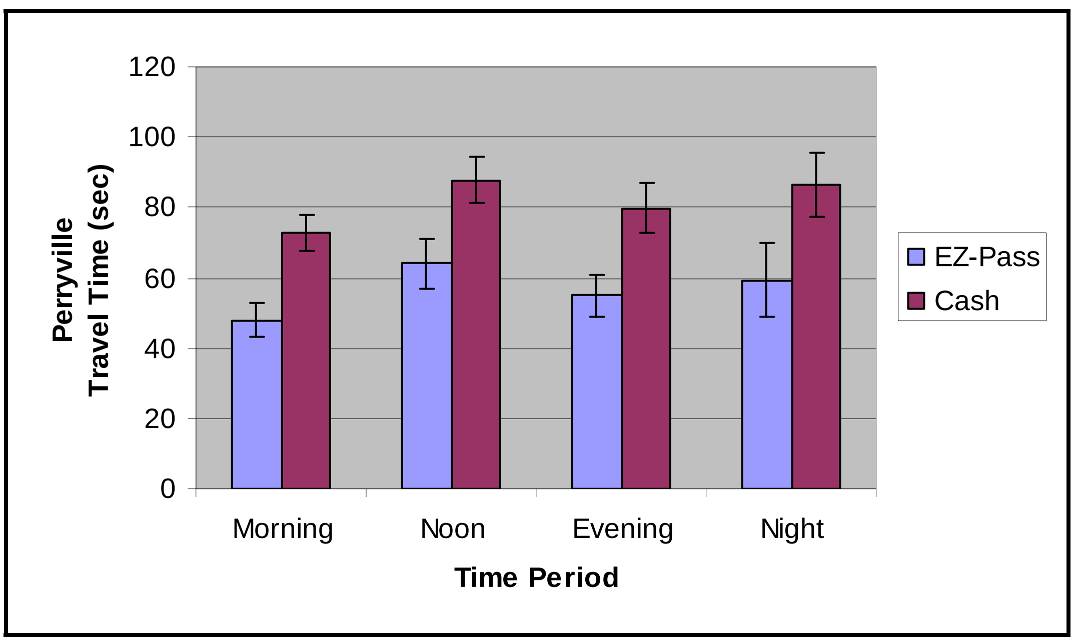

Figure 3-12. Travel Times for Entering the Perryville Toll Facility.

Hypothesis Testing for Perryville Tolls. An ANOVA was conducted on the Perryville travel time data to determine if the time differences between E-ZPass and non-E-ZPass were statistically robust. The ANOVA results indicated that the travel time differences were reliable during all four time periods: Morning ($F(1,214)=48.10$, $p<0.001$); Noon ($F(1,196)=20.70$, $p<0.001$); Evening ($F(1,206)=28.21$, $p<0.001$); and Night ($F(1,128)=14.09$, $p<0.001$). The use of E-ZPass resulted in consistently shorter travel times as compared to trucks not using E-ZPass. Trucks completing the payment transaction using E-ZPass saved 24 to 28 seconds over the trucks not using E-ZPass.

3.1.2 Methods and Results for Weigh Stations

This section describes the data collection methodologies, analyses, and results of travel time measurements at the weigh station facilities in Maryland and Connecticut. In Maryland, measurements were recorded at four facilities: Perryville; Hyattstown; West Friendship; and New Market. In Connecticut, measurements were recorded at the Greenwich and Union facilities.

Most facilities had a similar design configuration. Commercial vehicles entering a weigh station facility were required to leave the interstate highway via a single lane off-ramp. Upon approaching and entering the facility, the off-ramp widened into two lanes; then upon exiting the facility, the lanes merged back into one lane at the on-ramp leading onto the highway. Figure 3-13 shows an upstream view of the Perryville weigh station (left foreground); static scale and bypass lanes in front of the weigh station; and the off-ramp leading trucks to the scales (in the distant background).

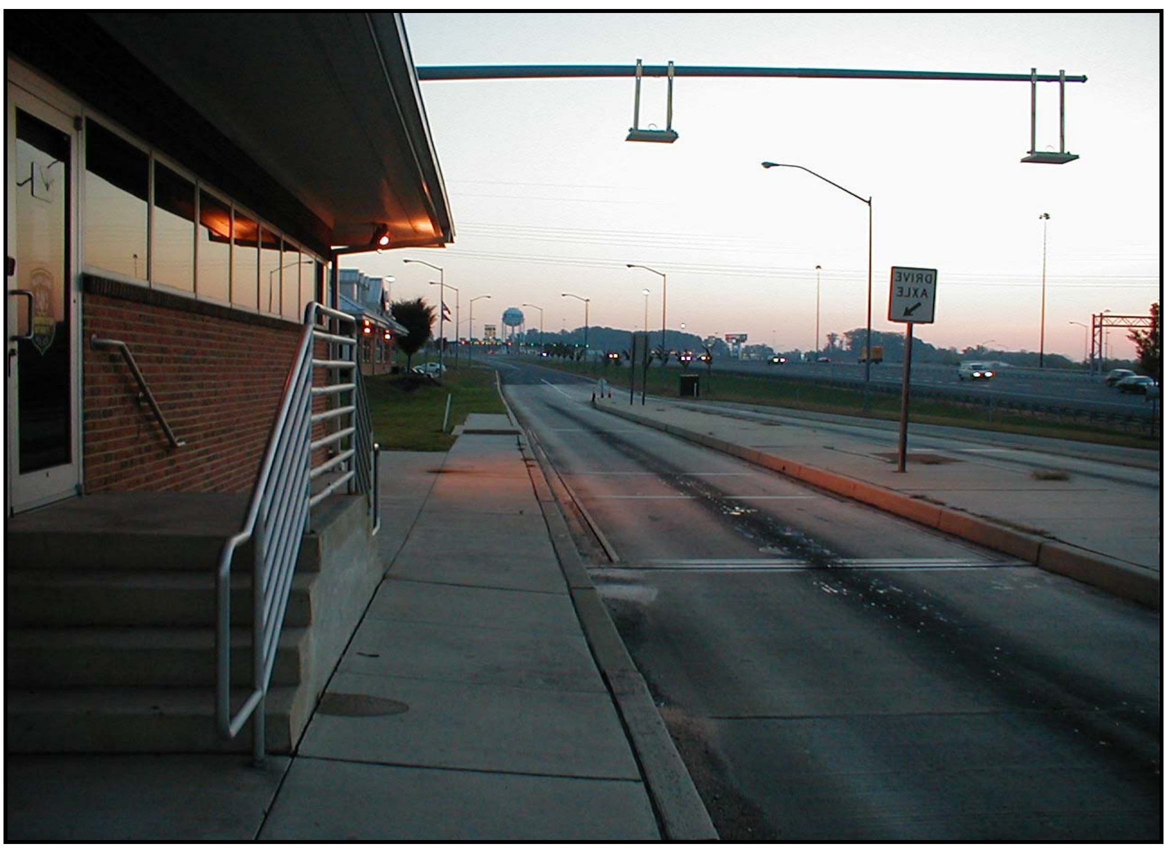

Figure 3-13. Upstream View of Static Scale and Inspection Lane (left) and Bypass Lane (far right).

Off-ramps often incorporated a WIM, which could be used by inspectors to direct trucks to either the static scale lane or the bypass lane back onto the highway. The approach view of the Perryville facility in Figure 3-14 shows a tower structure used to direct trucks to either the static scale (right lane) or bypass lane (left lane).

Figure 3-14. Long View of the Static Scales and Approach to Perryville Inspection Facility.

The lane leading to static scales was frequently congested. Trucks directed to the static scale were required to pull up to the scale, stop, and wait for instructions from inspection personnel before proceeding to either the inspection yard or back onto the highway.

Figure 3-15 shows a close-up view of a truck leaving the static scale to re-enter the highway. The bypass lane, usually located between the static scale lane and the highway, led trucks past the weigh station but not over the static scale. Trucks using this lane were not required to stop and wait for instructions but could proceed directly back onto highway. This lane was often clear and uncongested.

Travel times for trucks entering the weigh station facility were measured from an upstream landmark (near the beginning of the off-ramp leading to the facility), past the scales, and to the point where the truck passed a downstream landmark just beyond the weigh station facility. Due to differences in landmark locations, travel times between locations are not directly comparable because of differences in location specific distances. As needed, location-specific differences and variations in the data collection methodology is noted.

Figure 3-15. Truck Leaving Static Scale.

3.1.2.1 Perryville, Maryland

Travel times were recorded for trucks entering/leaving the Perryville weigh station on southbound I-95. The weigh station facility configuration was similar to the typical configuration described in Section 3.1.2.

During a 2-day period during October 22 – 23, 2002, travel times were collected for a total of 245 trucks. Of this total, 112 trucks took the entrance ramp and used the bypass lane past the weigh station facility. The other 133 trucks took the entrance ramp and were directed to pull onto the scales before proceeding past the downstream landmark. Following are the travel times collected for both groups during four 2-hour time periods:

- Evening (4:30 – 6 p.m.) on Tuesday, October 22, 2002
- Night (10 – 11:30 p.m.) on Tuesday, October 22, 2002
- Morning (7:30 – 9:30 a.m.) on Wednesday, October 23, 2002
- Noon (12 – 1:45 p.m.) on Wednesday, October 23, 2002

The travel times are shown in Figure 3-16. The 95 percent confidence interval markings above/below each bar shows the range where 95 percent of the travel times would be expected to occur. During the Morning period, trucks that were directed to pull onto the scales spent about 146 seconds (on average) before proceeding past the downstream landmark and re-entering I-95. The average time for a truck that used the bypass lane past the weigh station facility was about 71 seconds before re-entering I-95. Based on these averages, trucks that bypassed the scale saved about 75 seconds each.

During the Noon and Night periods, similar results were obtained. During the Noon period, the average bypass truck saved about 100 seconds. During the Night period, trucks saved on average about 70 seconds. (Unfortunately, for the Evening time period, technical problems caused a loss of the bypass travel time data, so no such comparison is available.)

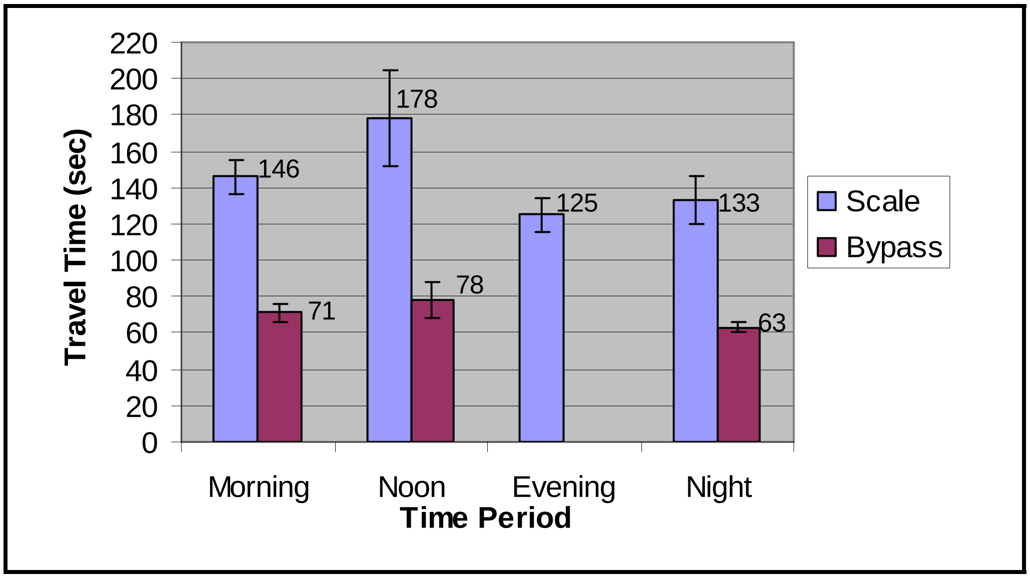

Figure 3-16. Travel Times Through Perryville Weigh Station as a Function of Time of Day and Weigh Station Lane.

During the Noon period data collection effort, a small sample (n=2) of trucks traveling along I-95 at mainline speeds were also measured and recorded. The mainline travel times were collected to provide a snapshot of comparable travel times for trucks traveling at mainline speeds.

Figure 3-17 depicts the average travel times for the two mainline trucks (44 seconds), 112 bypass trucks (70 seconds), and 133 non-bypass trucks (145 seconds). The mainline travel times provided an indication of the minimum achievable travel time for a truck that completely bypasses the Perryville weigh station. The mainline time demonstrates an ideal travel time that could be achieved if an electronic screening system did not require a truck enter the weigh station.

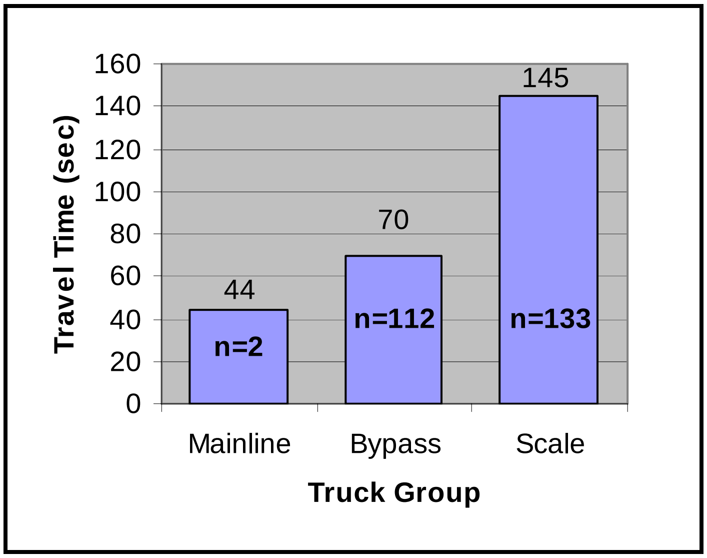

Figure 3-17. Comparison of Mainline Travel Time at Highway Speed to Bypass and Scale Travel Times.

Hypothesis Testing for Perryville Weigh Station Travel Time Benefit. The travel times during Morning, Noon, and Evening time periods were compared to determine if the time differences were statistically reliable. An ANOVA indicated that the times were significant during the three periods: Morning ($F(1,115)=177.33$, $p<0.001$); Noon ($F(1,51)=44.23$, $p<0.001$); and Night ($F(1,67)= 140.92$, $p<0.001$). These travel time data indicate that the bypass time differences were statistically reliable, consistently shorter, and not very likely to have occurred due to chance.

3.1.2.2 Hyattstown, Maryland

Travel times for trucks heading in the I-270 southbound direction at the Hyattstown weigh station were recorded over a 2-day period on December 2 – 3, 2002. The configuration of the facility was similar to the Perryville weigh station in that trucks taking the weigh station off-ramp could use one of two lanes, a static scale lane or a bypass lane (see Figure 3-18).

Figure 3-18. Hyattstown Weigh Station.

During the 2-day period, travel times for a total of 432 trucks were recorded, of which 41 trucks were directed to use the bypass lane beyond the static scales. The other 391 trucks took the entrance ramp and pulled onto the scales before proceeding past the downstream landmark. Travel times for both truck groups were collected during four 2-hour time periods:

- Evening (4:45 – 6:45 p.m.) on Monday, December 2, 2002
- Night (9:30 – 11:30 p.m.) on Monday, December 2, 2002
- Morning (7:15 – 9:15 a.m.) on Tuesday, December 3, 2002
- Noon (11:30 a.m. – 1:30 p.m.) on Tuesday, December 3, 2002

Unfortunately, the Morning and Evening time periods did not yield enough bypass travel times to make a meaningful comparison with those trucks directed to the scales. During the Noon period, 111 trucks were directed to the scales and spent (on average) about 135 seconds before proceeding past the downstream landmark and re-entering I-270. There were 25 timed bypass trucks that averaged about 50 seconds per truck (or about 85 seconds less). During the Night period, 78 trucks were timed going over the scale; 14 were timed bypassing the scale. The scale trucks took about 146 seconds versus 76 seconds for bypass trucks. The average travel times (and 95 percent confidence interval) are shown in Figure 3-19 (mainline travel times were not recorded).

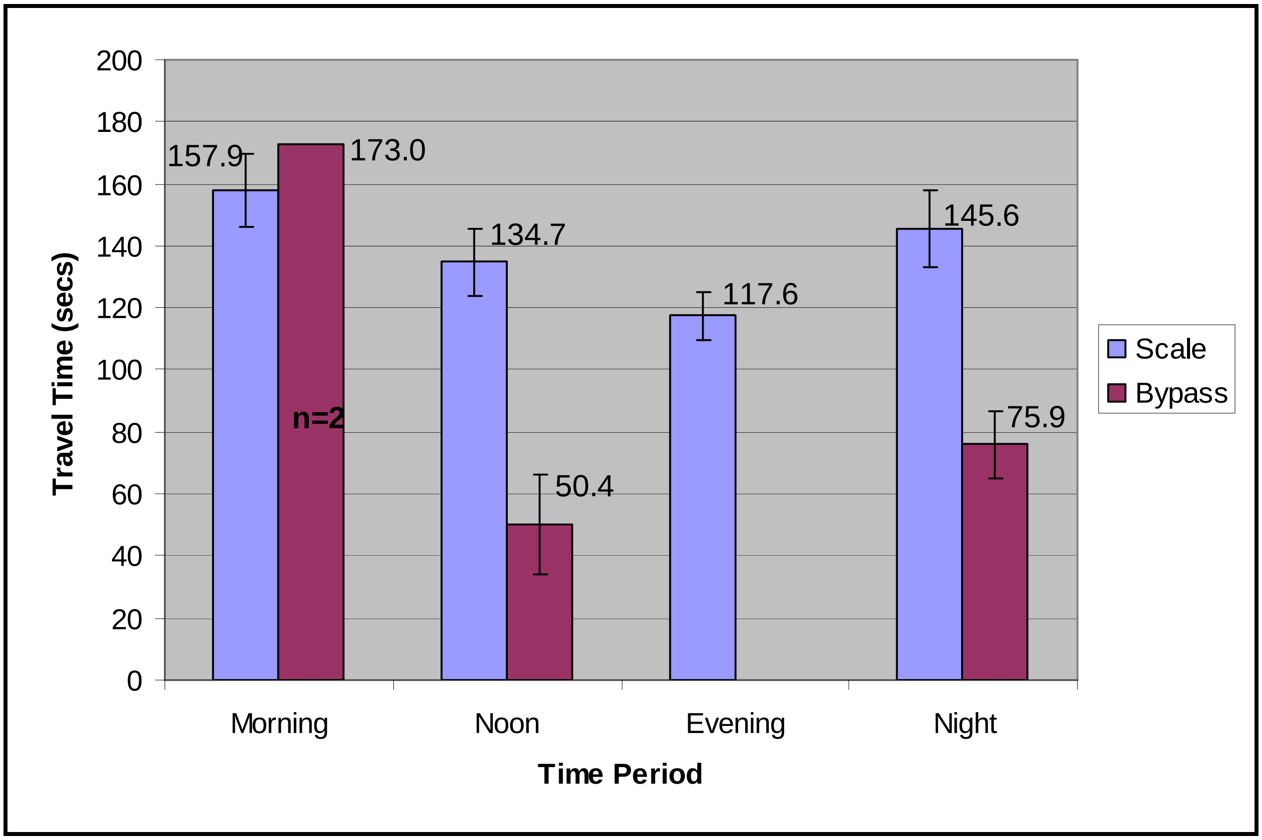

Figure 3-19. Travel Times at the Hyattstown Weigh Station Facility.

Hypothesis Testing for Hyattstown Weigh Station Travel Time Benefit. The scale and bypass travel times were compared within the Noon and Night periods to determine if the time differences were statistically significant. The ANOVA indicated that the times within the Noon and Night periods were significant: Noon ($F(1,134)=50.03$, $p<0.001$); Night ($F(1,90)=21.63$, $p<0.001$). Based on these results, the bypass travel times are consistently shorter and not likely to have occurred due to chance.

3.1.2.3 West Friendship, Maryland

The West Friendship weigh station facility configuration on I-70 was similar to the typical configuration described in Section 3.1.2. Travel times for trucks entering/exiting the West Friendship weigh station on I-70 were collected over a 2-day period on December 9 – 10, 2002. Travel times were collected during four 2-hour time periods:

- Evening (5:14 – 7:14 p.m.) on Monday, December 9, 2002
- Night (9:40 – 11:40 p.m.) on Monday, December 9, 2002
- Morning (7:16 – 9:16 a.m.) on Tuesday, December 10, 2002
- Noon (11:06 a.m. – 1:06 p.m.) on Tuesday, December 10, 2002

A ramp WIM was installed at West Friendship and became operational in August 2002. All vehicles entering the weigh station pass over the ramp WIM and are then signaled to either continue to the static scale or to exit the weigh station via a bypass lane.

Figure 3-20 shows the average travel time (and 95 percent confidence intervals) of trucks through the weigh station (mainline travel times were not recorded). Trucks using the scale lane and waiting for instructions on average took between 95 and 130 seconds. Trucks using the bypass lane and not having to stop on the scales took considerably less time (30 to 50 seconds on average) to get through the weigh station. The largest time difference between scale and bypass lanes was found during the Noon period.

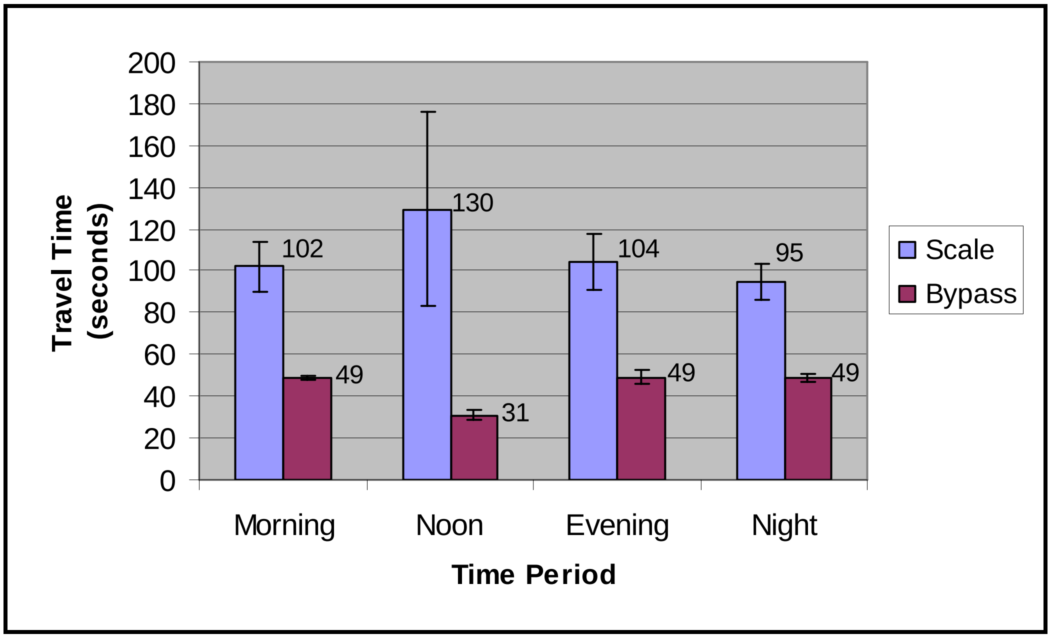

Figure 3-20. Average Travel Times by Time of Day and Weigh Station Lane.

Hypothesis Testing for West Friendship Weigh Station Travel Time Benefit. The scale and bypass travel times were compared within the time periods to determine if the time differences were statistically significant. The ANOVA indicated that the travel time differences within each time period were significant: Morning ($F(1,212)=300.37$, $p<0.001$), noon ($F(1,101)=168.64$, $p<0.001$), Evening ($F(1,102)=125.77$, $p<0.001$), and Night ($F(1,124)=218.89$, $p<0.001$). As evident in Figure 3-20, the bypass time savings were between 46 to 99 seconds shorter on average than the non-bypass (scale) times.

3.1.2.4 New Market, Maryland

Travel times at the New Market weigh station on eastbound I-70 were recorded on January 21 – 22, 2003. The weigh station facility was designed similar to the other weigh station facilities in Maryland (i.e., Hyattstown, West Friendship, etc.), in that, trucks taking the weigh station off-ramp could use one of two lanes, a scale lane, or a bypass lane (see Figure 3-21).

Figure 3-21. New Market Weigh Station.

Travel times for trucks using both types of lanes were collected during four 2-hour time periods:

- Evening (4:30 – 6:30 p.m.) on Tuesday, January 21, 2003
- Night (9:45 – 11:45 p.m.) on Tuesday, January 21, 2003
- Morning (8:00 – 9:45 a.m.) on Wednesday, January 22, 2003
- Noon (11:30 a.m. – 1:30 p.m.) on Wednesday, January 22, 2003

During the 2-day data collection period, travel times were collected for a total of 531 trucks. Of this total, 112 trucks took the entrance ramp and used the bypass lane past the weigh station facility. The other 419 trucks took the entrance ramp but were directed to pull onto the scales before proceeding past the downstream landmark.

During the morning time period, trucks that were directed to pull onto the scales spent about 195 seconds (on average) before proceeding past the downstream landmark and re-entering I-70. On the other hand, the (average) truck that used the bypass lane past the weigh station facility spent about 87 seconds before re-entering I-70. Based on these averages, a truck that bypassed (no stopping at the scale) saved 108 seconds. Similar results were obtained for travel time measurements during the Noon and Evening periods. During the Noon period, the average bypass truck saved about 108 seconds (194 versus 86 seconds) and about 81 seconds (217 versus 136 seconds) in the evening. However, due to a relatively low truck volume during the evening, bypass times are based on only three trucks. This same low truck volume circumstance resulted in zero bypass travel times being recorded during the Night period. A graphical representation of average travel times (and the 95 percent confidence intervals) is shown in Figure 3-22 (mainline travel times were not recorded).

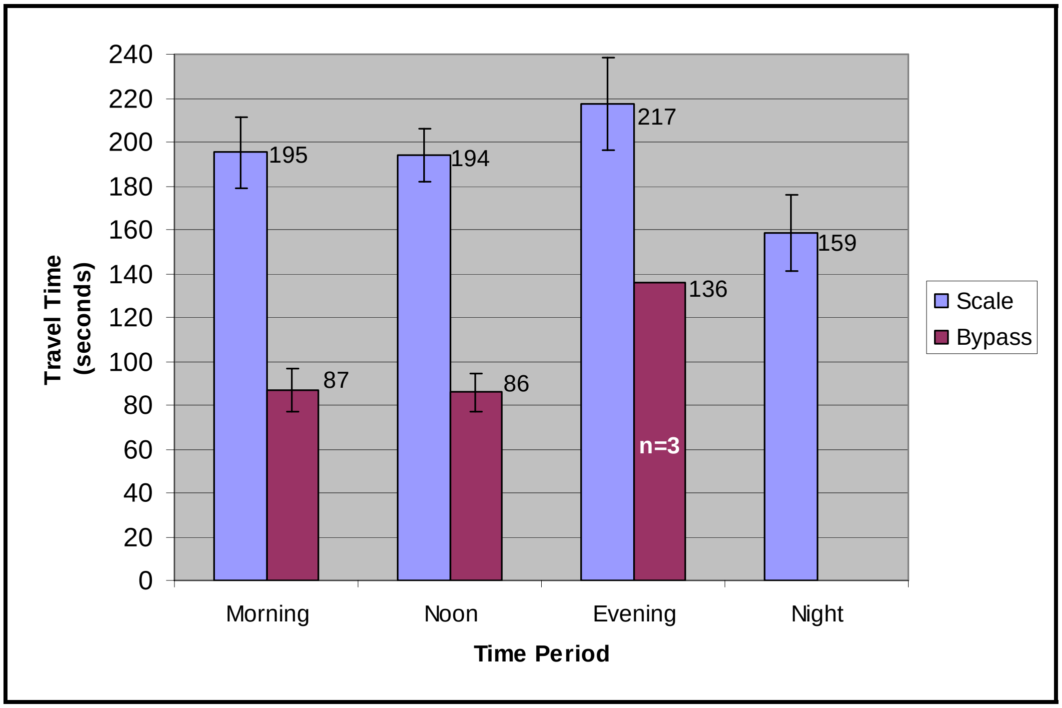

Figure 3-22. Average Travel Times by Time of Day and Weigh Station Lane.

Hypothesis Testing for New Market Weigh Station Travel Time Benefit.
The scale and bypass travel times were compared within the time periods to determine if the time differences were statistically significant. The ANOVA indicated that the travel time differences within the morning and noon time periods were statistically reliable: morning ($F(1,127)=117.42$, $p<0.001$) and noon ($F(1,168)=124.11$, $p<0.001$). No statistical tests were performed for the Evening and Night periods, due to insufficient data.

3.1.2.5 Greenwich, Connecticut

Travel times were recorded for trucks entering/exiting the Greenwich weigh station on northbound I-95. The weigh station facility in Greenwich was configured differently than those in Maryland. The configuration of the weigh station facility required trucks to enter the facility using a single lane, cross the WIM scales, and await instructions from an inspector in a roadside booth. If so directed, a truck entered the facility yard for additional inspections or weighing on the static scale. Most trucks, however, were directed to proceed back onto the I-95 highway. Figure 3-23 shows a truck crossing over the WIM past the orange inspection booth and heading back toward I-95. (If the truck had been directed to enter the inspection yard, the truck would have turned toward the yellow barrels to enter the yard.)

Figure 3-23. Truck Successfully Crosses the Greenwich WIM to Re-Enter I-95.

Travel times for trucks entering the weigh station facility were measured from near the beginning of the I-95 off-ramp leading to the facility (the upstream landmark), past the scales, and to the point where the truck passed a downstream landmark just as it re-entered I-95.

During data collection on May 21, 2003, travel times were collected for a total of 692 trucks. Of this total, 669 trucks took the entrance ramp and were directed to bypass the inspection facility. The other 23 trucks took the entrance ramp, crossed the WIM, and were directed to pull into the inspection yard before proceeding past the downstream landmark. Travel times for both groups of trucks were collected during four 2-hour time periods:

- Morning (8 – 10:45 a.m.)
- Noon (11:30 a.m. – 1:15 p.m.)
- Evening (4:30 – 6:30 p.m.)
- Night (9:30 – 11:00 p.m.)

A graphical comparison of average travel times is shown in Figure 3-24. The dashed line shown in the figure at 22 seconds represents the average time for a truck to traverse the same distance on I-95. During the Morning period, trucks that crossed the WIM and were directed to enter the inspection yard spent about 430 seconds (based on an average of 11 trucks) before proceeding past the downstream landmark and re-entering I-95.

The (average) truck that crossed the WIM and bypassed the inspection yard spent about 90 seconds before re-entering I-95. Based on these averages, a truck that was permitted to bypass the inspection yard saved about 340 seconds. Similar results were obtained for travel time measurements during the Noon, Evening, and Night periods, although all of the inspection travel times are based on very small sample sizes (five trucks during Noon, four in the Evening, and three at Night). In general, the largest time savings occurred during the Morning and Noon periods, saving about 340 and 348 seconds, respectively. During the Evening and Night periods the time savings were smaller at 186 and 223 seconds, respectively.

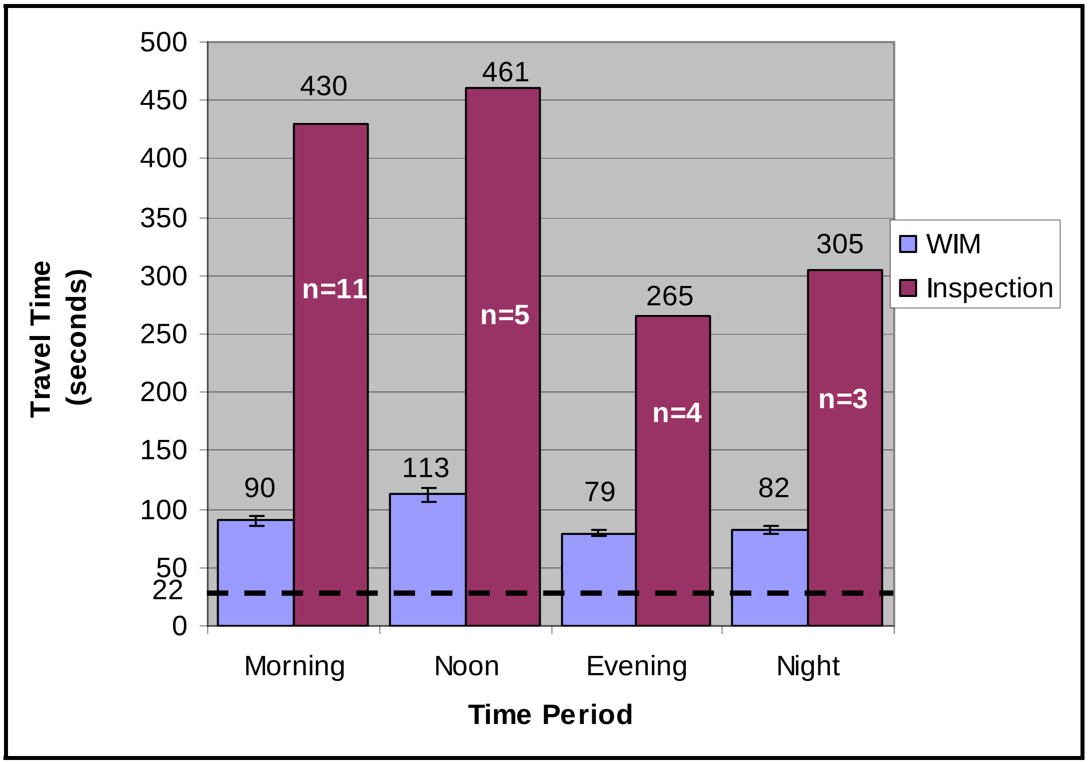

Figure 3-24. Average Travel Times by Time of Day and Weigh Station Lane.

Hypothesis Testing for Greenwich Weigh Station Travel Time Benefit. Due to insufficient data, no statistical tests of travel time differences were performed. Although a sufficient number of travel times were collected for WIM trucks, a very small number of travel times were available for trucks entering/leaving the inspection yard. Consequently, the calculation of the time savings should be viewed cautiously as the inspection travel times may be biased due to the small number of trucks being measured.

Despite the inability to compare the travel times for trucks using the WIM versus inspection yard, the amount of time an E-screening transponder can save participating truck can be demonstrated. Assuming the mainline travel time (of 22 seconds) is achievable for E-screen participants that are allowed to bypass the weigh station. By subtracting the mainline travel times from the WIM times produces a travel time savings for participating in the E-screening program.

Table 3-3 shows the amount of travel time savings that could be achieved if an E-screening truck bypassed the Greenwich weigh station at mainline speeds. The Operational Efficiency study describes analyses that examine additional “cost” parameters related to this time savings.

Table 3-3. Travel Time Savings between WIM and Mainline by Time of Day

Time of Day	Average Savings (Seconds)
Morning	68
Noon	91
Evening	57
Night	60

3.1.2.6 Union, Connecticut

Travel times were recorded for trucks entering/exiting the weigh station on southbound I-84 near Union, Connecticut. The physical layout of the weigh station facility was similar to the configuration at Greenwich, Connecticut. As shown in Figure 3-25 all trucks exiting the highway crossed over a WIM, approached an inspection booth, and were then directed to either continue onto the highway or turn into the yard for static scale/inspection at the weigh station (shown in Figure 3-26). The distance is approximately 0.7 miles for the bypass lane and 1.2 miles for trucks entering the inspection yard to be weighed on the static scale. Most trucks were directed to proceed back onto the highway.

Figure 3-25. Trucks Crossing the WIM and Proceeding Past the Inspection Booth.

Figure 3-26. Static Scales at the Union Weigh Station.

On Monday, May 19, 2003, travel times were collected for 405 trucks entering the I-84 weigh station near Union. Of these, 391 trucks used the bypass lane past the weigh station facility. Another 14 trucks took the entrance ramp but were directed to pull onto the scales before proceeding past the downstream landmark.

Travel times for both groups of trucks were collected during two 2-hour time periods. Table 3-4 shows the number of trucks timed by time periods.

Table 3-4. Number of Timed Trucks at Union Weigh Station by Time Period

Time Period	# Bypass Trucks	# Static Scale/Inspection Yard Trucks
Morning (8:30 – 10:30 a.m.)	171	2
Noon (11:30 a.m. – 1:30 p.m.)	220	12

A graphical comparison of average travel times and 95 percent confidence intervals are shown in Figure 3-27. Trucks using the WIM and took 72 to 76 seconds on average to get through the weigh station and re-enter I-84. Trucks that were directed to the scale house and inspection yard averaged between 233 and 391 seconds. However, because of the small number of trucks that entered the inspection yard, these times are not statistically reliable.

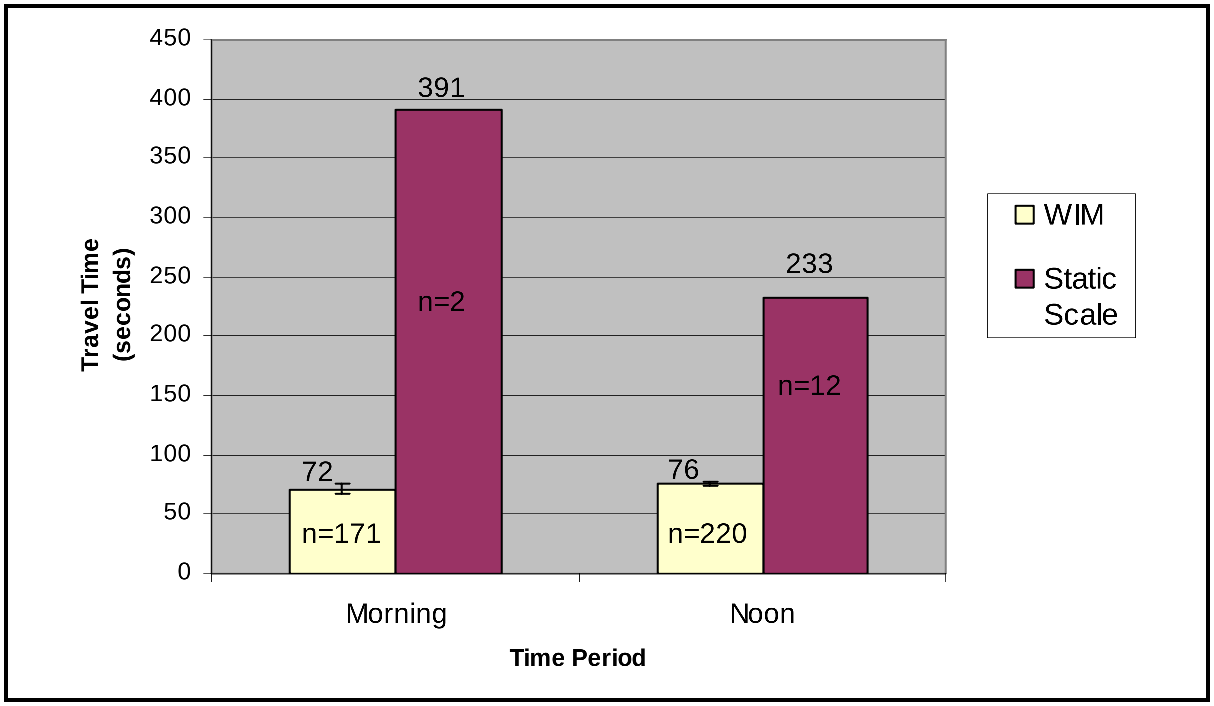

Figure 3-27. Average Travel Times by Time of Day and Weigh Station Lane.

Hypothesis Testing for Union Weigh Station Travel Time Benefit. Due to insufficient data no statistical comparisons of travel time differences were performed. Although a sufficient number of travel times were collected for WIM trucks, a very small number of travel times were available for trucks entering/leaving the inspection yard. Consequently, the calculation of the time savings between WIM and static scale times in the inspection yard should be viewed cautiously as the inspection travel times may be biased due to the small number of trucks being measured.

However, the amount of time savings WIM and mainline travel times can be can be demonstrated. Using a hypothetical truck traveling on the mainline highway the identical distance (of 0.70 miles) at a free-flow speed of 60 miles per hour, the truck would be expected to have a mainline travel time of 42 seconds. Next, by subtracting the calculated mainline travel times from the WIM times produces an average travel time savings for participating in the E-screening program. These estimated times provide some insight into achievable time savings for E-screen participants that are allowed to bypass the weigh station.

Table 3-5 shows the amount of travel time savings that could be achieved if an E-screening truck bypassed the Union weigh station at mainline speeds.

Table 3-5. Estimated Travel Time Savings between WIM and Mainline by Time of Day

Time of Day	Average Savings (Seconds)
Morning	30
Noon	34

3.1.3 Mobility Test Summary

The goal of the Mobility Test was to investigate whether ETC and E-screening would improve the mobility of commercial vehicles at weigh stations and toll collection facilities. The following two hypotheses were developed to guide the evaluation effort:

1. ETC and E-screening will improve the mobility of commercial vehicles at weigh stations and toll collection facilities.
2. Station closings due to ramp back-ups onto the mainline will be reduced.

For the first hypothesis, improve mobility, field measurements of travel times and truck counts were collected at five toll facilities and six weigh stations in New York, Maryland, and Connecticut. At the toll facilities, the data were used to compare travel times as a function of payment methods (electronic versus cash). At the weigh stations, the data was used to measure current travel times through the facilities and quantify estimated time savings, if, an electronic screening system was in place.

For the second hypothesis, station closings, the Data Collection Team was unable to obtain weigh station records to review and analyze the number of station closings per day. Consequently, the station closings portion of the evaluation was not conducted.

The following paragraphs summarize the findings of the mobility impacts found at toll facilities and weigh stations.

Summary of Travel Time Analyses at Toll Facilities. Compared to manual payment of tolls, electronic toll collection resulted in shorter delays at the toll plaza and reduced travel times for trucks at the Albany, New York, George Washington Bridge, Tappan Zee Bridge and Perryville, Maryland, toll facilities.

At Barriers 23 and 24 in Albany, New York, trucks using E-ZPass to enter and exit the Thruway experienced shorter travel times through the toll barrier during all four time periods (Morning, Noon, Evening, and Night). In general, the E-ZPass trucks had a larger time savings when exiting the Thruway (and completing the toll payment transaction). The time savings benefit was most pronounced during the Evening period. Similar results were observed at the other toll facilities. Trucks using electronic toll collection consistently had shorter travel times through the toll plaza compared to those using manual payment.

Summary of Travel Time Analyses at Weigh Stations. Travel times were examined at six locations in Maryland and Connecticut. At the four sites in Maryland (Perryville, Hyattstown, West Friendship, and New Market), travel times for trucks entering the weigh stations and crossing WIM were compared to times for trucks stopping at the static scale. At two sites in Connecticut (Union and Greenwich), the travel times for trucks entering the weigh stations and crossing the WIM were compared to free-flow mainline travel times.

In Perryville, the trucks bypassing the static scale saved on average about 75 seconds. Depending on the time of day, trucks saved between 70 to 100 seconds, with the largest time savings benefit (100 seconds) occurring during the Noon period. In Hyattstown, during the Noon and Night periods, trucks saved 85 and 70 seconds, respectively. At West Friendship, trucks saved on average about 99 seconds during the Noon period and approximately 46 seconds during the Morning, Evening, and Night periods. In New Market, trucks bypassing the static scales saved an average of 108 seconds during Morning and Noon periods.

In Greenwich, Connecticut, when comparing the travel times for trucks crossing the weigh station WIM to free-flow mainline travel times, the time savings was estimated to be between 57 and 91 seconds, with the largest time savings benefit during the Noon period. In Union, during the Morning and Noon periods, trucks saved 30 and 34 seconds, respectively.

3.1.4 Conclusions of Mobility Impacts at Toll Facilities and Weigh Stations.

In most instances, using the E-ZPass resulted in shorter travel times through the Toll Facilities and using E-ZPass generally resulted in more reliable travel times through Toll Facilities.
As would be expected with a fully integrated E-screening system, bypassing static scales resulted in significantly shorter travel times through weigh stations. If an E-screening system allowed trucks to bypass weigh stations at free-flow mainline speeds, travel times past weigh stations would enable trucks to achieve maximum travel time savings.

3.2 SAFETY TEST

Another goal of the ETC/E-screening Interoperability Pilot Project was to improve safety. As a result, the evaluation strategy included a test to assess the safety impact of the Pilot Project.

The Safety Test was based on the hypotheses that the project has the potential to provide safety improvements in the following four different ways:

1. Motor carriers with interoperable transponders will be more likely to maintain compliance with safety standards than those without transponders.
2. Enforcement personnel will be better able to identify and target non-compliant carriers using electronic screening and existing inspection selection criteria, and therefore, will not expend unnecessary resources inspecting safe carriers.
3. Crash rates involving commercial vehicles will be reduced at both weigh stations and toll collection facilities.
4. Station closings due to ramp backups onto the mainline when the station is operating at capacity will be reduced.

Table 3-6 shows each of the hypotheses along with their corresponding measures of effectiveness (MOEs) and data sources or requirements.

Table 3-6. Evaluation Goals, Hypotheses, and MOEs

Goal	Hypothesis	MOE	Data Sources or Requirements
Improve Safety	Motor carriers with transponders will maintain compliance with safety standards. Enforcement personnel will be better able to identify non-compliant or unsafe carriers. Crash rates involving trucks will be reduced at both weigh stations and toll facilities. Station closings due to ramp back-ups onto the mainline will be reduced.	Compliance rates and out-of-service rates for transponder-equipped and non-transponder-equipped vehicles. Crash rates involving trucks at weigh stations and toll facilities. Number of times that a station is closed each week due to ramp backups and duration of station closures each week due to ramp backups.	Enforcement Records/ Out-of-Service Reports and Compliance Reports Enforcement Records/ Out-of-Service Reports and Compliance Reports. Weigh Station and Toll Facility Records – Accident Reports Weigh Station Records – Station Closing Reports[1]

Each of the hypotheses are explained in further detail in the following sections along with corresponding MOEs, data requirements, data sources, and analysis methods.

To conduct the analysis using the proposed MOEs, the Evaluation Team determined that it would be necessary to have data on the number of compliant and non-compliant vehicles with and without transponders that use and/or pass a weigh station. The Evaluation Team intended to obtain data needed to test this hypothesis from records maintained by commercial vehicle enforcement personnel (i.e., MSP, MdTA Police).

However, early in the course of the evaluation it became apparent that the levels of transponder use on the part of industry for E-screening would not be sufficient to yield an adequate number of data points to support a statistically valid analysis of safety impacts. An additional concern was the fact that only one weigh station, the Perryville facility, had an operational system, thus further reducing the size of the potential sample available to conduct the safety test.

Since there was insufficient data available, the Evaluation Team recommended two alternative approaches to FHWA (Federal Highway Administration) and Federal Motor Carrier Safety Administration (FMCSA) for conducting the safety test:

- Compare Before and After safety ratings, out-of-service rates, and number of inspections for those motor carriers using transponders for E-screening. During follow-up discussions with MDOT, the Evaluation Team learned that MDOT had conducted a similar study and found that there was no significant difference in these metrics for motor carriers participating in E-screening.
- Model projected traffic volumes, projected growth in transponder market penetration, and use the Volpe model that estimates the safety impacts generated from each inspection to estimate potential safety impacts from E-screening. The hypothesis that was to be tested is

[1]The Evaluation Team had planned to use existing records currently maintained by enforcement personnel to obtain this information, if available.

that trucks using transponders are more likely to receive weigh station bypass notification, and this would enable the enforcement community to target the non-transponder using portion of the motor carrier industry.

The hypothesis was derived from anecdotal information obtained during focus groups conducted for the project shows that those carriers currently using transponders are carriers with good safety ratings eligible for green lights. However, since this approach had been used for other evaluations, it was not clear that repeating this methodology would produce meaningful results.

Based on discussions with FHWA and FMCSA, a decision was reached to not implement a formal Safety Test using either of the above methodologies. The Evaluation Team has included a recommendation for a follow-on study that would examine the safety impacts of E-screening in greater detail, once the level of transponder market penetration has reached a sufficient level to provide a statistically valid sample size. For the purposes of this evaluation activity, the Safety Test was not completed.

3.3 OPERATIONAL EFFICIENCY TEST

Given the current and projected large volumes of commercial vehicle travel through the I-95 corridor states, private-sector benefits from electronic toll collection and E-screening are and will continue to be realized primarily through travel time savings. These benefits will be realized through reduction in expected en-route delays at the toll facilities and at weigh stations along the corridor.

The benefits were estimated using an identified value of time for a commercial vehicle, defined as $71.05 per hour[2] (or equivalent to $0.0197 per second). Monetized estimates (motor carrier operational efficiency) were developed for the projected time savings by applying the value of time to the observed time savings. The result of this was then extrapolated to the larger universe of transactions at the toll facilities and weight inspections in the three target states (Connecticut, Maryland, and New York). Table 3-7 presents the per-event value of time savings, summarized as follows:

- For toll facilities, average travel time savings ranged from 13 to 55 seconds per transaction, with a simple unweighted average of 30 seconds time savings, valued at $0.59 per event.
- At the Maryland weigh stations, average travel time savings ranged from 56 to 109 seconds per transaction, with a simple unweighted average of 76 seconds time savings, valued at $1.56 per event.
- At Connecticut weigh stations, average travel time savings ranged from 32 to 68 seconds per transaction, with a simple unweighted average of 50 seconds time savings, valued at $0.99 per event.
- For all weigh stations observed, a simple unweighted average of 68 seconds time savings, valued at $1.33 per event.

[2] The 2004 Urban Mobility Report, David Schrank and Tim Lomax, Texas Transportation Institute, The Texas A&M University System, September 2004. Accessed from: http://mobility.tamu.edu.

Table 3-7. Per-Event Time Savings and Value to Motor Carriers

Facility:	E-Screening or ETC Average Time Savings	Value of Time Savings
Toll Facilities:		
George Washington Bridge	13	$0.26
Tappan Zee Bridge	38	$0.77
Albany Exit 24 Entry	16	$0.32
Albany Exit 24 Exit	55	$1.09
Perryville	25	$0.49
Weigh Stations:		
Perryville	64	$1.26
Hyattstown	77	$1.52
West Friendship	56	$1.11
New Market	109	$2.15
Union	32	$0.63
Greenwich	68	$1.34

Extrapolating these time savings to a full deployment scenario for the three subject states is proffered to illustrate potential maximum benefits to motor carriers of the ETC/E-screening programs. In terms of E-screening, based on FHWA data, the approximate average annual number of weight inspections conducted is as follows:

- Connecticut: 400,000
- Maryland: 2,900,000
- New York: 200,000

For the three states, the total is approximately 3.5 million trucks weighed per year. At an imputed value of $1.33 per bypass event, and given 100 percent enrollment and clearance at scales, the maximum estimated value to the motor carrier industry would be roughly $5 million per year.

Given these assumptions and the average commercial vehicle miles traveled in the three states of approximately 11,450 million miles per year, at best, the motor carrier industry would realize a bottom line efficiency savings of electronic screening of $0.001 per mile. This suggests that electronic screening would likely not realize overwhelming penetration into the commercial vehicle market, but remain of value to the premium carriers who have significant exposure based on routes and miles to inspection facilities.

Based on the toll facilities surveyed in this effort, the average annual commercial vehicle volumes and estimated value of the savings are presented in Table 3-8.

Table 3-8. Annual Truck Volumes at Surveyed Toll Facilities and Maximum ETC Benefits

Facility	Average Annual Truck Volume	Estimated Maximum Time Savings Value (100% Subscription)
George Washington Bridge	4.2 million	$1.1 million
Tappan Zee Bridge	0.125 million	$0.1 million
Albany Exit 24 Facilities	2.2 million	$2.4 million
Perryville	1.4 million	$1.8 million

Given the current levels of electronic toll collection deployment at the subject facilities and reduced transaction times (cash versus E-ZPass) alone, financial impacts to the industry as a whole are minimal. In terms of participation in electronic toll collection plans, again, motor carrier efficiency benefits will be directly proportional to level of exposure in terms of frequency through toll plazas. What is seen is that commercial vehicle operators, whether cash or E-ZPass customers, are already reaping significant time savings resulting from reduced congestion at toll facilities due to significant subscription rates by the general motoring public.

One key incentive for commercial vehicles operators to participate in electronic toll collection programs is the discount incentives for using electronic payment versus cash during off-peak hours when a significant proportion of commercial vehicles operate. These discounts can be as high as 33 percent off cash transaction tolls. Additionally, arguably, there are potential administrative cost savings that could be realized through the automated payment system.

3.4 ESTIMATING EMISSION IMPACTS OF ETC/E-SCREENING

Proliferation of ETC mechanisms, such as E-ZPass, has a positive effect in reducing vehicle emissions at toll-plazas due to decreased acceleration, deceleration, and idling events. Speed profiles of vehicles at ETC/E-screening facilities are significantly different for vehicles with and without transponders; vehicles without transponders are required to stop for transaction processing. On-road emission measurement with a sample fleet of instrumented vehicles is perhaps the best way to measure the impacts of ETC/E-screening on heavy-duty truck emissions. Instead, a practical alternative to this costly undertaking is to model ETC/E-screening activity. However, no such tools exist for modeling emission impacts of ETC/E-screening facilities on heavy-duty vehicle operations.

Current generation vehicle emission models MOBILE 6.2 and the Comprehensive Modal Emissions Model (CMEM) are limited with respect to their ability to model heavy-duty vehicle emissions. CMEM is incapable of modeling heavy duty vehicle emissions. Emission characteristics of vehicles transiting screening facilities cannot be accurately derived employing traditional modeling methods with MOBILE 6.2. Consequently, few studies have focused on modeling of heavy duty vehicles using ETC/E-screening facilities.

In MOBLE 6.2, modal operations of vehicles are represented as speed bins – collections of uniform speed – at 5-mph increments. Using speed bins enables employment of a speed profile discretization technique (SPD), allocating vehicle miles of travel into various speed bins. By employing an emissions influence zone (EIZ) within which the speed profiles are captured, an estimation of vehicle emissions transiting and ETC/E-Screening facility is possible. Using the

SPD technique, emission impacts of heavy-duty trucks were calculated at the toll collection plaza on George Washington Bridge, New York.

The following steps describe the methodology using the SPD techniques as previously described to estimate impacts of ETC/E-screening heavy-duty truck emissions:

1. Pre-modeling activities include collecting relevant field data to define/derive the following variables for emissions modeling:
   - Volume of light and heavy duty trucks at various facilities.
   - Processing time for cash, EZ-pass and weighing transactions.
   - VMT distribution of small and large trucks in various speed bins.
2. Develop a spreadsheet-based sketch-planning tool incorporating the SPD technique.
3. Reduce field data to develop input parameters for MOBILE 6.2.
4. Obtain emission factors from MOBILE 6.2.
5. Analyze field data in conjunction with emission factors derived from MOBILE 6.2.
6. Interpret results and report findings.

3.4.1 Truck Count and Travel Time Data Collection

Truck counts and travel times were collected New York, Maryland, and Connecticut. In New York, truck counts and travel times were collected on Interstate 90 (outside of Albany at the Barrier 23 and 24 toll facilities), and at two toll bridges in New York City (the George Washington and Tappan Zee bridges). No data were collected at weigh stations in New York. In Maryland, travel times and counts were obtained at one toll facility and four weigh stations. In Connecticut, counts and travel times were collected at two weigh stations (Union and Greenwich). Table 3-9 summarizes the State, location, type of facility, and collection dates.

Table 3-9. Data Collection Sites and Dates for Truck Counts and Travel Times

State	Location	Facility	Collection Dates
NY	Albany: I-90 at Exits 23 & 24	Toll	October 16 – 17, 2002
	NYC: I-95 George Washington Bridge	Toll	Archived data from Port Authority of NY-NJ for 2002 through 2003 inclusive; also from January – August 2004
	NYC: I-87/I-287 Tappan Zee Bridge	Toll	December 14, 2004
MD	Perryville: I-95 near Exit 93	Toll	October 23 – 24, 2002
	Perryville: I-95 near Exit 93	Weigh Station	October 22 – 23, 2002
	Hyattstown: I-270 near Exit 22	Weigh Station	December 2 – 3, 2002
	West Friendship: I-70 near Exit 80	Weigh Station	December 9 – 10, 2002
	New Market: I-70 near Exit 62	Weigh Station	January 21 – 22, 2003

State	Location	Facility	Collection Dates
CT	Union: I-84 near Exit 73	Weigh Station	May 19, 2003
	Greenwich: I-95 near Exit 2	Weigh Station	May 21, 2003

The goal of the data collection effort was to obtain a sample of truck travel times and truck counts representative of a typical work week. To minimize the effects of weekend travel, data at all sites were collected during a normal workweek (no holidays) on Monday, Tuesday, or Wednesday. With the exception of the George Washington and Tappan Zee bridges and Union weigh station, data were collected during four time periods, anticipating an ebb and flow in traffic through the course of a typical weekday. Data collection periods were: Morning (7:30 a.m. to 9:30 a.m.); Noon (11:30 a.m. to 1:30 p.m.); Evening (4:30 to 6:30 p.m.); and Night (9:30 to 11:30 p.m.).

The toll authorities in New York and Maryland provided the truck counts at tolling stations used in this analysis. At weigh stations in Maryland and Connecticut, tubes and vehicle counters were placed across the roadways to obtain counts of trucks entering the weigh stations. Additional data collection results of total truck counts by weigh facilities are presented in Section 4.

Detail regarding data collection methodology and a summary of collected data for vehicle emissions are presented in Sections 3.4.2 through 3.4.6. Recommendations for further emission-related research are presented in Section 3.4.7.

3.4.2 Assumptions and Methodology

The following assumptions and methodology were employed during the data collection activities regarding vehicle emissions:

- Only truck traffic was modeled in the determination of emissions factors.
- All observed truck traffic was segregated into two main categories – small and large trucks.
- The deceleration zone before and acceleration zone after a toll plaza or weigh station is collectively referred to as the “emission influence zone” or EIZ. Accounting for vehicle dynamics, a single EIZ representative of both facilities – toll plazas and weigh stations – was developed for each truck type. EIZ length was also altered to account for the type of transaction – cash, or two E-ZPass modes.
- The standard stopping sight-distance, deceleration, and acceleration criteria as specified in “A Manual on Geometric Design of Highways and Streets” was used in developing the EIZs. Specific parameters of interest follow:

  - Stopping distance: 325 feet for small trucks; 500 feet for large trucks.
  - Small truck acceleration: 1.3 ft/sec^2 after the transaction; to a speed of 55 mph.
  - Large truck acceleration: 1.1 ft/sec^2 after the transaction; to a speed of 55 mph.
  - The maximum length of EIZ for the research scenario was computed to be approximately 2,000 feet.

- All trucks approached the EIZ at the posted speed limit of 55 mph.

- The approach deceleration zone was divided equally into 11 speed bins ranging from 55 mph to 5 mph, at 5-mph increments. A twelfth speed bin was developed at an increment of 2.5 mph, to account for the 5 mph to 2.5 mph cash transaction case. Speed bins were distributed to EIZs based on transaction type (cash, E-ZPass 10 mph, or E-ZPass 20 mph).
- For cash transactions, vehicles came to a complete stop. However, MOBILE 6 is not capable of modeling emissions of stopped HDD vehicles (idle emissions). In the absence of an idle-speed bin, emissions were calculated from the minimum MOBILE 6 speed bin (2.5 mph) for the duration of each cash transaction. Accordingly, there were 12 deceleration speed bins (55 mph – 2.5 mph) for “full-stop” transactions.
- For E-ZPass transactions, vehicles were observed to drive at various speeds ranging from 10 to 30 mph as they passed through the toll gate. Accordingly, two E-ZPass emissions influence zones were constructed for purposes of the model, with one with a lowest speed of 10 mph (E-ZPass 10 mph) and one with a lowest speed of 20 mph (E-ZPass 20 mph). Using 5-mph increments resulted in 10 deceleration speed bins (55 mph – 10 mph) for E-ZPass 10 mph transactions, and eight deceleration speed bins (55 mph – 20 mph) for E-ZPass 20 mph transactions.
- Post-transaction acceleration was either from 2.5 mph (“full-stop” cash transactions), or from 10 mph or 20 mph (E-ZPass transactions). Consequently, there were 12 acceleration speed bins (2.5 mph – 55 mph) following cash transactions; 10 acceleration speed bins (10 mph – 55 mph) following E-ZPass 10 mph transactions; and 8 acceleration speed bins (20 mph – 55 mph) following E-ZPass 20 mph transactions. As with deceleration, beyond 5-mph acceleration speed bins were in 5-mph increments, regardless of transaction type.
- Segregated by type, the number of trucks passing through each EIZ was then multiplied by the length of the appropriate EIZ to determine truck vehicle miles traveled (VMT) – a MOBILE model input used in computing total truck emissions.
- Speed VMT inputs for small and large trucks were assumed to be constant, regardless of the hour of day. This assumption was necessary as hourly traffic counts were not available.

After examining all collected data, the authors elected to use the George Washington Bridge (New York City) toll plaza data as a representative dataset to verify and refine assumptions, and to calibrate the model. Table 3-10 provides a summary of transaction times for cash and E-ZPass operations observed at the George Washington Bridge.

Table 3-10. George Washington Bridge Transaction Time (Seconds) Staffed Lanes

George Washington Bridge Transaction Time (Seconds) Staffed Lanes								
Main	**SPC**	**SPE**	**SOC**	**SOE**	**LPC**	**LPE**	**LOC**	**LOE**
# Observed	258	43	372	--	178	20	471	--
# Obs. deleted	15	1	10	--	12	--	17	--
Mean Time	17.56	9.32	19.41	--	26.83	13.28	25.37	--
Median Time	17.80	8.18	18.43	--	25.55	12.52	24.33	--
Std Deviation	6.99	4.95	8.66	--	12.66	5.20	10.34	--
95% CI (upper)	19.54	11.38	21.07	--	31.11	15.56	27.66	--
95% CI (lower)	17.84	8.42	19.31	--	27.39	11.00	25.79	--
SPC Small Truck, Peak, Cash				LOE Large Truck, Off-Peak, E-ZPass				

George Washington Bridge Transaction Time (Seconds) Staffed Lanes								
Main	SPC	SPE	SOC	SOE	LPC	LPE	LOC	LOE
SPE Small Truck, Peak, E-ZPass				LPC Large Truck, Peak, Cash				
SOC Small Truck, Off-Peak, Cash				LPE Large Truck, Peak, E-ZPass				
SOE Small Truck, Off-Peak, E-ZPass				LOC Large Truck, Off-Peak, Cash				

3.4.3 Modeling Emission Factors with MOBILE 6.2

Using the above assumptions/parameters, the SPEED VMT input for each EIZ was computed (see Table 3-11). SPEED VMT was computed as follows:

- Emissions within each of the identified EIZ where totaled.
- This total was then multiplied by the VMT for light trucks and for heavy trucks.

Conceptually, MOBILE 6 input was modified to reflect emissions for only truck traffic (no light duty gasoline vehicles). A speed profile was built using 5-mph increments, to capture the emissions as a truck decelerated and approached the toll gate. A similar profile was built for a truck accelerating and departing the toll gate. Table 3-13, then, represents the contribution of a fleet of trucks approaching and departing a toll gate and either stopping to pay the toll, or passing through the toll gate at either 10 mph or at 20 mph (using E-ZPass in either of these later cases), for a total of three possible cases: stop/cash, pass through at 10 mph, or pass through at 20 mph. Note that VMT fraction is based on the distribution of truck types of interest in this study in the MOBILE 6 model, as applied to the number of trucks collected in the sample. The sample data as collected did not break trucks into all the MOBILE 6 truck categories. As per the original list of assumptions, these SPEED/VMT inputs to MOBILE 6 were distributed evenly over 24 hours, as the model requires data be input for a 24-hour period.

Table 3-11. Speed VMT Inputs to MOBILE 6.2

Speed Bin (mph)	Cash	E-ZPass at 10 mph	E-ZPass at 20 mph
2.5	0.1375	--	--
5	0.0784	--	--
10	0.0784	0.1225	--
15	0.0784	0.0975	--
20	0.0784	0.0975	0.2767
25	0.0784	0.0975	0.1033
30	0.0784	0.0975	0.1033
35	0.0784	0.0975	0.1033
40	0.0784	0.0975	0.1033
45	0.0784	0.0975	0.1033
50	0.0784	0.0975	0.1033
55	0.0784	0.0975	0.1033

MOBILE 6 default VMT fractions represent emissions fractions from various classes of automobiles, motorcycles, and other vehicles. However, only heavy-duty vehicles are of interest for this study. Accordingly, the default VMT fractions were adjusted as per Table 3-12 to remove seven vehicle classes not of interest in this study (represented as "0.000" in the Modified VMT Fractions portion of the table), thereby reflecting only small and large truck traffic. This preserved our initial assumption that only truck traffic would be modeled.

Table 3-12. Adjustments to MOBILE 6 Default VMT Fractions

VMT Fractions (M6 defaults)							
0.354	0.089	0.297	0.092	0.041	0.04	0.004	0.003
0.002	0.008	0.01	0.012	0.04	0.002	0.001	0.005
Modified VMT Fractions							
0.000	0.000	0.000	0.000	0.256	0.250	0.025	0.019
0.013	0.050	0.063	0.075	0.250	0.000	0.000	0.000

As used, the remaining MOBILE 6 inputs required were:

- Analysis Month: July 2004
- Minimum Temperature: 64 ºF
- Maximum Temperature: 92 ºF
- Fuel RVP (Reid vapor pressure): 7.0

In modeling the operations at toll plazas and weigh stations, it was reasonable to assume that no engine starts would occur. It was desirable to calculate only emissions resulting from a running engine (running emissions). However, MOBILE 6 does not segregate emissions for heavy-duty vehicles into engine start emissions and running emissions. Rather, MOBILE 6 generates a composite emissions bag of start and running emissions, making it unfeasible to separate only the running emissions. Consequently, composite emission factors were used in examining the research hypothesis. Table 3-13 lists the composite emission factors derived from MOBILE 6.2. Also listed in the table are the VMT fractions associated with each of the vehicles type under investigation. (Note that MOBILE 6 uses only 9 VMT fractions from Table 3.12 as input in calculating output for the 16 vehicle types in Table 3-13; there is not a one-to-one correlation of VMT fractions to vehicle type.)

Table 3-13. Composite Emission Factors Derived from MOBILE 6.2

Veh Type	VMT Fraction	Composite Emission Factors Derived from MOBILE 6.2											
		Cash			E-ZPass (10 mph)			Cash			E-ZPass (20 mph)		
		VOC	CO	NOX	VOC	CO	NOX	VOC	CO	NOX	VOC	CO	NOX
LDGT4	0.2528	2.724	18.449	1.438	1.397	13.574	1.217	2.724	18.449	1.438	1.291	13.276	1.185
HDGV2B	0.1827	2.869	23.051	3.749	1.435	14.5	3.928	2.869	23.051	3.749	1.231	11.79	4.007
HDGV3	0.0065	5.934	54.764	5.021	2.973	34.45	5.261	5.934	54.764	5.021	2.521	28.011	5.367
HDGV4	0.0057	6.378	48.861	5.117	3.358	30.736	5.361	6.378	48.861	5.117	2.918	24.991	5.469
HDGV5	0.0078	4.172	34.676	4.871	2.239	21.813	5.103	4.172	34.676	4.871	1.936	17.736	5.206
HDGV6	0.0181	4.765	42.397	4.996	2.593	26.67	5.234	4.765	42.397	4.996	2.24	21.686	5.339
HDGV7	0.0100	7.481	77.375	6.345	4.138	48.674	6.647	7.481	77.375	6.345	3.536	39.576	6.781
HDGV8A	0.0001	12.139	145.888	7.674	6.907	91.772	8.041	12.139	145.888	7.674	5.872	74.619	8.202
HDDV2B	0.0673	0.302	1.704	3.99	0.228	1.105	3.522	0.302	1.704	3.99	0.2	0.906	3.348
HDDV3	0.0185	0.331	2.019	4.434	0.249	1.309	3.914	0.331	2.019	4.434	0.218	1.073	3.721
HDDV4	0.0133	0.388	2.281	5.162	0.293	1.479	4.557	0.388	2.281	5.162	0.256	1.213	4.333
HDDV5	0.0042	0.413	2.461	5.364	0.311	1.596	4.735	0.413	2.461	5.364	0.273	1.309	4.502
HDDV6	0.0319	0.625	2.626	8.201	0.472	1.703	7.274	0.625	2.626	8.201	0.413	1.397	6.93
HDDV7	0.0530	0.792	3.362	10.417	0.598	2.181	9.242	0.792	3.362	10.417	0.523	1.788	8.807
HDDV8A	0.0749	0.831	5.617	15.056	0.627	3.643	13.623	0.831	5.617	15.056	0.549	2.987	13.091
HDDV8B	0.2500	0.987	7.259	17.767	0.745	4.708	16.127	0.987	7.259	17.767	0.652	3.86	15.518

3.4.4 Estimating Truck Emission Impacts – MOBILE 6.2 Results

Table 3-14 and Table 3-15 compare emissions totals between the observed proportion of trucks paying cash and using E-ZPass. Traffic counts for the George Washington Bridge indicated that approximately 29 percent of trucks used cash transactions, whereas 71 percent used E-ZPass. Considerable variation was observed in the E-ZPass vehicle speed (10-30 mph). Since no speed measurements of E-ZPass vehicles were taken, emission impacts of E-ZPass transaction speed at 10 mph and 20 mph were studied. The proportion of trucks using cash is the same in either E-ZPass case; Table 3-14 assumes that all E-ZPass trucks went through the toll gate at 10 mph (e.g., 29 percent of all trucks paid cash, 71 percent of all trucks used E-ZPass 10 mph). Table 3-15 assumes that all E-ZPass trucks went through the toll gate at 20 mph (e.g., 29 percent of all trucks paid cash, 71 percent of all trucks used E-ZPass 20 mph).

Table 3-14 and Table 3-15 display VOC, CO, and NOX emissions that would be expected over a 24-hour period. These emissions are based on the volume and types of trucks, and transaction preference (Cash, E-ZPass 10 mph, or E-ZPass 20 mph) captured in the collected real-world data.

Table 3-14 tallies the resulting total VOC, CO, and NOX emissions (in grams) by truck type for a 24-hour period for Cash and E-ZPass 10-mph EIZs. Similarly, Table 3-15 tallies the resulting total VOC, CO, and NOX emissions (in grams) by truck type for a 24-hour period for Cash and E-ZPass 20-mph EIZs.

The subtotal for each emission column is the MOBILE 6.2 estimate of the total emissions for that pollutant species across all truck types and the total VMT these trucks traveled in that specific EIZ during a 24-hour period. For example, the total VOC for all truck types (LDGT4 through HDDV8B) driven the calculated number of vehicles miles traveled (VMT) through the Cash EIZ over a 24-hour period is 3113.9 grams. This total was computed by calculating:

VMT Fraction = (Vehicle type) x (number of that vehicle type/hour) x (EIZ length)

Then,

Emissions (grams) = VMT Fraction x VOC emission factor for that vehicle type x 24 hours

Table 3-16 and Table 3-17 reflect emissions from all truck traffic either all paying cash, or using E-ZPass (e.g., 100 percent cash, 100 percent E-ZPass 10 mph, 100 percent E-ZPass 20 mph). Again, there are two E-ZPass cases, 10 mph and 20 mph. The intent of this portion of the analysis was to draw out the differences should an entire fleet of trucks stop at the cash lanes, vice an entire fleet of trucks passing though the toll gate at either 10 mph or at 20 mph.

Table 3-14. Emissions (Grams) by Vehicle Type in the EIZ Cash versus E-ZPass (10 mph)

Veh Type	VMT Fraction	Emissions by Vehicle Type in EIZ					
		Cash			E-ZPass (10 mph)		
		VOC	CO	NOX	VOC	CO	NOX
LDGT4	0.2528	1,136.5	7,697.2	600.0	1,409.7	13,697.4	1,228.1
HDGV2B	0.1827	865.1	6,950.4	1,130.4	1,046.5	10,574.5	2,864.6
HDGV3	0.0065	63.7	587.5	53.9	77.1	893.8	136.5
HDGV4	0.0057	60.0	459.6	48.1	76.4	699.3	122.0
HDGV5	0.0078	53.7	446.4	62.7	69.7	679.1	158.9
HDGV6	0.0181	142.3	1,266.5	149.2	187.3	1,926.9	378.2
HDGV7	0.0100	123.5	1,277.0	104.7	165.2	1,942.9	265.3
HDGV8A	0.0001	2.0	24.1	1.3	2.8	36.6	3.2
HDDV2B	0.0673	33.5	189.3	443.2	61.2	296.8	946.1
HDDV3	0.0185	10.1	61.6	135.4	18.4	96.7	289.0
HDDV4	0.0133	8.5	50.1	113.3	15.6	78.5	241.9
HDDV5	0.0042	2.9	17.1	37.2	5.2	26.8	79.4
HDDV6	0.0319	32.9	138.3	431.8	60.1	216.9	926.2
HDDV7	0.0530	69.3	294.1	911.2	126.5	461.4	1,955.2
HDDV8A	0.0749	102.7	694.3	1,861.1	187.5	1,089.2	4,072.9
HDDV8B	0.2500	407.2	2,995.0	7,330.6	743.4	4,698.2	16,093.4
Sub-totals		3,113.9	23,148.4	13,414.0	4,252.7	37,415.1	29,761.0
Total Truck Emissions (Cash + E-ZPass 10 mph)					**7,366.57**	**60,563.50**	**43,174.97**

Table 3-15. Emissions by Vehicle Type in the EIZ Cash versus E-ZPass (20 mph)

Veh Type	VMT Fraction	Emissions by Vehicle Type in EIZ					
		Cash			E-ZPass (20 mph)		
		VOC	CO	NOX	VOC	CO	NOX
LDGT4	0.2528	1,136.5	7,697.2	600.0	1,302.7	13,396.7	1,195.8
HDGV2B	0.1827	865.1	6,950.4	1,130.4	897.7	8,598.2	2,922.2
HDGV3	0.0065	63.7	587.5	53.9	65.4	726.8	139.3
HDGV4	0.0057	60.0	459.6	48.1	66.4	568.6	124.4
HDGV5	0.0078	53.7	446.4	62.7	60.3	552.2	162.1
HDGV6	0.0181	142.3	1,266.5	149.2	161.8	1,566.8	385.7
HDGV7	0.0100	123.5	1,277.0	104.7	141.1	1,579.7	270.7

Veh Type	VMT Fraction	Emissions by Vehicle Type in EIZ					
		Cash			E-ZPass (20 mph)		
		VOC	CO	NOX	VOC	CO	NOX
HDGV8A	0.0001	2.0	24.1	1.3	2.3	29.8	3.3
HDDV2B	0.0673	33.5	189.3	443.2	53.7	243.4	899.4
HDDV3	0.0185	10.1	61.6	135.4	16.1	79.2	274.8
HDDV4	0.0133	8.5	50.1	113.3	13.6	64.4	230.0
HDDV5	0.0042	2.9	17.1	37.2	4.6	21.9	75.5
HDDV6	0.0319	32.9	138.3	431.8	52.6	177.9	882.4
HDDV7	0.0530	69.3	294.1	911.2	110.6	378.3	1,863.2
HDDV8A	0.0749	102.7	694.3	1,861.1	164.1	893.0	3,913.9
HDDV8B	0.2500	407.2	2,995.0	7,330.6	650.6	3,852.0	15,485.7
Sub-totals		3,113.9	23,148.4	13,414.0	3,763.9	32,728.9	28,828.3
Total Truck Emissions (Cash + E-ZPass 20 mph)					**6,877.79**	**55,877.34**	**42,242.29**

Table 3-16 and Table 3-17 display the VOC, CO, and NOX emissions expected over a 24-hour period, based on the volume and types of trucks, assuming only a single transaction type was available (Cash, E-ZPass 10 mph, or E-ZPass 20 mph). For example, if all vehicles of all types were exclusively cash transactions for a 24-hour period, the resulting total VOC emissions would be 10,645 grams when measured at either 10 or 20 mph (see Table 3-16 and Table 3-17). The two tables include separate analyses for all cash transactions and all E-ZPass transactions. The data is shown for each type of transaction by VOC, CO, and NOX emissions.

Table 3-16. Emission (Grams): All Cash Transactions versus All E-ZPass (10 mph)

Veh Type	All Cash Transactions			All E-ZPass (10 mph)		
	VOC	CO	NOX	VOC	CO	NOX
LDGT4	3,885.3	26,314.0	2,051.0	1,992.6	19,360.7	1,735.8
HDGV2B	2,957.4	23,761.0	3,864.5	1,479.2	14,946.6	4,049.0
HDGV3	217.6	2,008.4	184.1	109.0	1,263.4	192.9
HDGV4	205.1	1,571.4	164.6	108.0	988.5	172.4
HDGV5	183.6	1,526.0	214.4	98.5	959.9	224.6
HDGV6	486.6	4,329.6	510.2	264.8	2,723.6	534.5
HDGV7	422.1	4,365.5	358.0	233.5	2,746.2	375.0
HDGV8A	6.8	82.3	4.3	3.9	51.8	4.5
HDDV2B	114.7	647.0	1,515.0	86.6	419.6	1,337.3
HDDV3	34.5	210.7	462.8	26.0	136.6	408.5
HDDV4	29.1	171.2	387.4	22.0	111.0	342.0
HDDV5	9.8	58.3	127.1	7.4	37.8	112.2

Veh Type	All Cash Transactions			All E-ZPass (10 mph)		
	VOC	CO	NOX	VOC	CO	NOX
HDDV6	112.5	472.6	1,476.0	85.0	306.5	1,309.2
HDDV7	236.8	1,005.3	3,115.0	178.8	652.2	2,763.6
HDDV8A	351.2	2,373.7	6,362.5	265.0	1,539.5	5,756.9
HDDV8B	1,392.2	10,238.9	25,060.6	1,050.8	6,640.7	22,747.3
TOTAL	10,645.3	79,136.0	45,857.5	6,011.0	52,884.6	42,065.7

Table 3-17. Emissions (Grams): All Cash Transactions versus All E-ZPass (20 mph)

Veh Type	All Cash Transactions			All E-ZPass (20 mph)		
	VOC	CO	NOX	VOC	CO	NOX
LDGT4	3,885.3	26,314.0	2,051.0	1,841.4	18,935.7	1,690.2
HDGV2B	2,957.4	23,761.0	3,864.5	1,268.9	12,153.2	4,130.4
HDGV3	217.6	2,008.4	184.1	92.5	1,027.3	196.8
HDGV4	205.1	1,571.4	164.6	93.8	803.7	175.9
HDGV5	183.6	1,526.0	214.4	85.2	780.5	229.1
HDGV6	486.6	4,329.6	510.2	228.8	2,214.6	545.2
HDGV7	422.1	4,365.5	358.0	199.5	2,232.9	382.6
HDGV8A	6.8	82.3	4.3	3.3	42.1	4.6
HDDV2B	114.7	647.0	1,515.0	75.9	344.0	1,271.3
HDDV3	34.5	210.7	462.8	22.8	112.0	388.4
HDDV4	29.1	171.2	387.4	19.2	91.0	325.1
HDDV5	9.8	58.3	127.1	6.5	31.0	106.7
HDDV6	112.5	472.6	1,476.0	74.3	251.4	1,247.3
HDDV7	236.8	1,005.3	3,115.0	156.4	534.7	2,633.5
HDDV8A	351.2	2,373.7	6,362.5	232.0	1,262.3	5,532.1
HDDV8B	1,392.2	10,238.9	25,060.6	919.7	5,444.6	21,888.3
TOTAL	10,645.3	79,136.0	45,857.5	5,320.1	46,260.9	40,747.6

3.4.5 Study Limitations

The SPD technique and the study methodology employ several simplifications and assumptions concerning modal activity and other parameter inputs. Therefore, the applying the SPD technique should be limited to sketch planning, where a rough estimate of emission impacts due to ETC/E-screening are sufficient. The degree of reduction is dependent on the speed with which E-ZPass vehicles are processed (smallest speed bin, either 10mph or 20mph) and the level of penetration of E-ZPass use.

Emissions during cash transactions are likely somewhat overstated, as both start and running emissions (combined emissions) were used for this factor MOBILE did not provide actual idle emissions, which may vary significantly from the emissions at 2.5 mph. The Evaluation Team did not collect incremental data breaking down stop and start times during a truck's passing through a toll facility. Instead, the data collected measured only the total time spent passing through a toll facility.

Uniform vehicle distribution throughout a 24-hour period was assumed. While simplifying the model, this assumption does not match the ebbs and flows normally seen in truck traffic at a facility during a normal 24-hour period. Attention to this is important, as traffic peaks can result in delays (hence, idling) at facilities that would be free-flowing under less-congested conditions.

3.4.6 Conclusions

Table 3-18 summarizes estimated VOC, HC, and NOX emissions reduction (in the EIZ) attributable to E-ZPass operations for heavy-duty diesel vehicles using the George Washington Bridge. With the number of vehicles of interest held constant, the degree of reduction in emissions was dependent on the speed with which vehicles using E-ZPass were processed and the level of penetration of E-ZPass use. For example, if vehicles using E-ZPass were processed at 10 mph, reductions in VOC, CO, and NOX, are estimated to be 30.8, 23.5, and 5.8 percent, respectively. E-ZPass processing at 20 mph yielded greater emissions reductions; a 50 percent reduction in VOC from emissions during cash transactions was estimated. In a hypothetical scenario – if all vehicles were processed with E-ZPass (no cash transactions) – the model estimates that even greater emission reductions are possible.

Table 3-18. Summary: Percent Reduction in EIZ Emissions by Employing E-ZPass

Pollutant Species	All Cash Transaction	Observed Cash-E-ZPass Split		All E-ZPass Transactions	
		E-ZPass at 10 mph	E-ZPass at 20 mph	at 10 mph	at 20 mph
VOC	10645.30	7366.6	6877.8	6011.0	5320.1
% Reduction		30.8%	35.4%	43.5%	50.0%
CO	79136.00	60563.5	55877.3	52884.6	46260.9
% Reduction		23.5%	29.4%	33.2%	41.5%
NOX	45857.46	43175.0	42242.3	42065.9	40747.6
% Reduction		5.8%	7.9%	8.3%	11.1%

In the absence of a modeling tool or methodology to model emissions of heavy-duty vehicles at ETC/E-screening facilities, the SPD technique presents a workable solution. The approach is easy to implement as a sketch-planning tool in a spreadsheet environment. The SPD technique and the study methodology presented in this research may be used for modeling heavy duty vehicle emissions attributable to any traffic flow improvement project. This sketch-planning technique should not be used when more robust models are available or field emission measurements are feasible.

As demonstrated by the analysis at the toll plaza on George Washington Bridge, New York, the degree of reduction is dependent on the speed with which E-ZPass vehicles are processed and the level of penetration of E-ZPass use.

The percent reductions within the EIZ appear rather dramatic. However, the impact of ETC/ E-screening on regional emissions could be marginal, given the small contribution to total VMT these facilities represent. A multitude of such facilities in a region, however, might help make a dent in region-wide emissions.

3.4.7 Areas for Further Research

Further refinement of the MOBILE emission factors for low-speed operation and idle of heavy-duty diesel trucks is important to research efforts such as this, and offers a better understanding to estimate the problem that truck idling presents to the public. With the development and fielding of portable emission monitoring sensors, emissions can now be collected on-road from vehicles operating under real-world conditions.

Collecting data from a designated representative fleet of trucks would permit development of emissions factors for idle operations, and permit researchers to split idle emissions from start emissions in the MOBILE model's lower speed bins. This effort would also greatly enhance the validity of research problems such as this one, and more accurately project emissions savings made possible by ETC/E-screening and other traffic improvement schemes.

Steps should also be undertaken to estimate particulate emissions (PM10 and PM2.5) that would be generated by trucks under the three study scenarios. Additionally, investigation into the toxics generated by these vehicles would round out the total emissions picture, and more nearly estimate the total benefits that may be possible by applying traffic flow improvement measures such as ETC/E-screening.

3.5 CUSTOMER SATISFACTION

This section details the evaluation approach, preliminary findings, survey development, results, and conclusions of the customer satisfaction evaluation of the ETC/E-Screening Interoperability Pilot Project.

3.5.1 Baseline Focus Groups

One goal of the ETC/E-Screening Interoperability Pilot Project is to improve customer satisfaction. The customers considered for this evaluation are trucking industry representatives, which include: enforcement officials, motor carriers, and commercial vehicle operators.

The approach, as described in the Detailed Test Plans,[3] was to conduct a series of focus groups to develop an understanding of the enforcement and operational challenges associated with ETC/E-screening that could impact customer satisfaction. The information gained through the focus groups was then to be used to develop comprehensive and quantitative customer satisfaction "After" surveys, the results of which could be used to make conclusions and recommendations with regard to the technology's impacts on customer satisfaction.

3.5.2 Evaluation Approach

It was hypothesized that the ETC/E-screening Interoperability Pilot Project had the potential to improve customer satisfaction in four different ways. Table 3-19 presents the specific hypotheses related to improved customer satisfaction for each of the customer groups, as well as industry as a whole. The table also shows the goals, MOEs, and data sources for testing each hypothesis.

[3] Electronic Toll Collection/Electronic Screening Interoperability Pilot Project: Detailed Test Plans, submitted to Federal Highway Administration, July 31, 2002.

Table 3-19. Evaluation Goals, Hypotheses, and MOEs

Goal	Hypothesis	MOE	Data Sources or Requirements
Improve customer satisfaction.	Enforcement officials will perceive benefits in their operations from the carriers' use of the transponder technology.	Enforcement officials' assessment of technology and perceptions of benefits.	Focus groups/ interviews with enforcement officials.
	Motor carriers will perceive a time and cost savings benefit with the use of the transponder technology.	Motor carriers' perceived time and cost savings.	Focus groups/surveys of motor carriers.
	Drivers will perceive time savings and other benefits associated with the use of the transponder technology.	Drivers' perceived time savings (and other benefits).	Focus groups/surveys of drivers.
	The use of one transponder for both ETC and E-screening will promote industry acceptance and use of the transponder technology.	Industry acceptance/ endorsement of technology. Perception of benefits of incentives offered by state agencies.	Focus groups/ interviews with industry representatives (enforcement officials, motor carriers, and truck drivers).

3.5.3 Preliminary Findings

The focus groups are identified as follows:

- Maryland Motor Carrier Focus Group
- New York Motor Carrier Focus Group
- Truck Driver Focus Group in Baltimore, Maryland and Albany, New York
- Maryland Enforcement Focus Group
- Connecticut Enforcement Survey

The preliminary findings of each focus group and the Connecticut enforcement survey are summarized in Sections 3.5.3.1 through 3.5.3.5.

3.5.3.1 Maryland Motor Carrier Focus Group

A total of seven representatives from six carriers participated in the Maryland motor carrier focus group, as well as a representative of MMTA. In general, the participants were responsible for overseeing operations within their company, and they had a wide range of experience levels, with an average of 23 years in their current positions. The participating companies, who well represented the Maryland motor carrier industry, included:

- Intermodal carriers (3)
- Moving company (1)
- HAZMAT carriers (2)

The companies represented ranged from small to medium in size, with the smallest company operating only 16 power units, and the largest company operating 210 power units. A number of the companies represented reported that they frequently used owner-operators. Each of the companies was based in Maryland, but operated on a regional basis (e.g., Maryland, Virginia, Washington, D.C.), and on a broader interstate basis (e.g., Eastern Seaboard). Accordingly, the participants reported that their drivers spent between 50 and 90 percent of their time on interstate highways. Four of the six companies represented reported that they issued transponders to their drivers.

3.5.3.1.1 Perceptions of ETC

Cost. In general, the focus group participants stated that the switch to ETC has increased costs due to the following reasons:

- Opening an ETC account
- Maintaining an ETC account

All participants indicated that these costs were absorbed in their companies' bottom line and that they were not able to pass this cost along to customers, given the trucking industry's competitive nature and tight margins.

Reduction in Toll Discounts. Prior to implementing ETC, companies were able to purchase ticket books that provided a maximum 33.3 percent toll discount. Companies were able to provide these ticket books both to their own drivers and to owner-operators working for them. However, ticket books are no longer being issued, and companies have the option of either paying cash or obtaining a transponder for ETC. Therefore, if a trucking company does not participate in the transponder program, its drivers must carry and pay cash at the toll location.

While the use of ETC still enables companies to obtain a discount, the discount has been reduced to a maximum of 20 percent, and the discount a company receives is based on a graduated scale linked to ETC use. Therefore, companies that do not use ETC on a regular basis (e.g., owner-operators and smaller companies) will not meet volume thresholds and will receive a lower discount.

Opening an ETC Account. Owner-operators may not use a transponder issued to a different company in the way they were formerly able to use ticket books. Transponders are assigned to a single account and may not be passed between accounts. Owner-operators must now open their own accounts to obtain transponders, a significant change from receiving the ticket books provided by the company using their services. This represents the additional cost of purchasing a transponder and submitting a pre-payment deposit.

Maintaining an ETC Account. Before ETC, trucking companies received time-stamped receipts from their drivers from toll facilities. These receipts enabled the companies to track where their drivers were and when. While ETC account data are available for companies, only a list of the most recent 50 transactions in chronological order is provided, and these data cannot be sorted by facility, vehicle type, etc. Companies do receive monthly account statements, but information is presented in summary form only.

To obtain a detailed daily report, companies must access the Web on a continual basis. To obtain more detailed information that is sorted on a per transaction basis or daily basis, for example, companies are required to pay an additional fee. As a result, trucking companies are no longer able to track individual driver performance, and are no longer able to track driver compliance with safety requirements, such as hours of service. Companies would like to be able to receive detailed account information on a more frequent basis to help with internal operations management and compliance.[4]

System Design and Implementation. The most significant concern expressed by participants of the Maryland motor carrier focus group was that the ETC system initially was not designed to meet industry needs, rather, the system was designed for passenger cars and had certain features that were not "truck friendly". For example, transponders are programmed for a fixed number of axles for the tractor and trailer. However, companies often shift tractor and trailer combinations (in particular, for intermodal hauls) and frequently have a situation where the axle information contained in the transponder in the tractor does not correlate to the number of axles in the tractor-trailer combination. Companies do not have the ability to change the information on axle configuration contained in the transponder.

As a result, the companies are either 1) overcharged when they pass through a facility (e.g., a 3-axle combination using a 5-axle transponder will be charged the 5-axle toll), or 2) they undercharged (e.g., a 5-axle combination using a 3-axle transponder). In the latter instance, this may result in a stop by authorities whereby drivers are required to sign a "pledge" or promissory note to pay the fee difference.

Typically, if a company is asked to sign a pledge to pay, it is not charged an administrative fee. A pledge is normally incurred only if the transponder does not read. In Maryland, if a carrier has a transponder programmed for three axles and goes through with five axles, the MdTA receives a discrepancy report and will automatically adjust the toll rate and charge the higher toll. The MdTA will not automatically reduce the rate if the carrier has a 5-axle transponder and goes through with three axles. In that instance, the carrier must contact the MdTA to get a credit for the toll difference.

This fixed number of axles design results in an increased administrative burden on companies and additional costs associated with maintaining an ETC account. Companies find it difficult to keep track of all of the promissory notes, and are also concerned that their drivers may be subject to arrest and other enforcement actions if these fees are not paid, even if the driver is not at fault. Companies also expressed concern about the delays experienced by their drivers due to these toll enforcement stops.

Another concern related to the design and implementation of ETC expressed by participants was that must use "truck only" lanes. With this restriction, a transponder-equipped truck may still have to wait in a queue at a toll booth (behind other trucks paying tolls without transponders), thus losing any travel time savings that would have otherwise resulted from the use of ETC.

A related concern involving the video cameras used for enforcement purposes[5] was brought up by participants. The video cameras are positioned to take photographs of the rear license plate of a vehicle, which in the case of a commercial vehicle, would be the trailer license. Trucking companies, in particular, intermodal companies, may haul many different trailers over the course of a work week. As a result, if an enforcement action is initiated, there is not a correlation between the transponder linked to a tractor and the photograph of a trailer license plate.

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[4] The implementation of the Super Accounts has enabled owner-operators and smaller companies to obtain transponders and through the Super Accounts obtain the volume discounts.

[5] Under Maryland law, a photograph is taken of the rear license plate for any vehicle using an ETC lane. In the event of an infraction, the license plate is used to identify the vehicle owner.

Companies face the administrative burden of tracking down the driver and tractor involved in the enforcement action, if possible, to determine what happened and why. Companies may also be cited for the inconsistency between the transponder information and the license plate identified through the photograph.[6]

Customer Service. A few of the trucking company representatives at the focus group commented that they have not been very successful in using the phone to contact E-ZPass customer service. A specific comment was that it was more efficient to send a person directly to the E-ZPass office to resolve an issue rather than try to call – an approach that is not cost effective.

Other trucking company representatives expressed frustration with the quality of customer service that they had experienced when attempting to pay fees. A specific complaint was that companies were “bounced” back and forth between the toll authority and the E-ZPass office in an attempt to solve a problem, and that there did not seem to be significant concern about the problems encountered by the customer. Many of the representatives felt that there was no cooperation between the private E-ZPass vendor and the public toll facilities.

3.5.3.1.2 Perceptions of E-Screening

In general, participants in the Maryland enforcement focus group expressed fewer concerns about the E-screening program, possibly because the program is newer than the ETC program and they have had less exposure to it. The most significant concern expressed was with the reliability of the on-line registration for the E-screening program. One company registered six trucks online 2 months prior to the focus group, and none of the drivers had received a green light (the representatives reported that each truck drove through the Perryville facility one to two times a week). Participants also indicated that the availability of E-screening only on I-95 at the Perryville weigh station was not a strong incentive to participate in the program.

One trucking company representative said that he would definitely consider registering his trucks if there was E-screening on I-70.
Another representative said, *“There’s no incentive unless you use I-95 a lot.”*

A representative of an intermodal carrier said that he was somewhat discouraged from joining the E-screening program because he felt that intermodal carriers had less control over the equipment maintenance portion of their DOT score (i.e., they pick up steamship equipment, etc., that is not well maintained). Therefore, they would have a more difficult time getting green lights with E-screening as compared to other trucking companies.

The most significant benefit mentioned by the participants was related to the use of E-screening. A representative of a HAZMAT company that operated with a good safety rating indicated that using the transponder for screening had reduced the number of times his trucks were being pulled in for inspection. He also stated that the ability to obtain the bypass had produced travel savings and had improved operations.

This experience, however, contrasted with the experience of another carrier who stated that his HAZMAT vehicles were always subject to more in-depth scrutiny whenever his trucks entered a weigh station even though his company maintained a satisfactory safety rating, and he was skeptical that E-screening would change this situation.

[6] The Maryland Transportation Authority has, or is in the process, of addressing these issues. This is discussed in more detail in the Institutional and Technical Issues section of the report.

3.5.3.1.3 Incentives to Help Promote Program Participation

Focus group participants noted several potential incentives that would encourage more participation in ETC and E-screening:

- Detailed account data showing transactions by transponder should be presented electronically and in a timely manner, ideally on a daily basis. This information would allow the trucking companies to track expenses, monitor operations, and monitor regulatory compliance (such as hours of service).
- Owner-operators (and smaller carriers) should receive a benefit, in the form of a larger discount, for enrolling. This would address the current market situation where this industry segment has lost the benefit of discounted tickets without obtaining any compensating benefit from the ETC program.
- There should be more locations with E-screening – this would help expand the demand for services.
- Trucks should be able to do a “rolling pass” through toll facilities, that is, be able to use E-ZPass lanes instead of truck-only lanes to obtain the time saving benefit.

The carriers indicated that they knew ETC was here to stay, but several stated, *“We’d gladly go back to tickets instead of transponders!”*

In general, the carriers stated that customer service needs to be improved for ETC and E-screening to work. The carriers also stated the system design and implementation issues needed to be addressed. The carriers further stated that improving customer service would provide a strong incentive for other carriers to participate.

An additional comment related to the need for nationwide interoperability to make the program a true success. As stated previously, the carriers indicated that if E-screening were available on other routes that the carriers ran frequently (e.g., I-70), they would apply for it, an indication that trucking companies see a potential benefit from E-screening.

3.5.3.2 New York Motor Carrier Focus Group

The New York motor carrier focus group was conducted in Albany, New York at the New York State Motor Truck Association on September 19, 2003. Focus group participants were recruited through the State motor carrier association.

The participating motor carriers included for hire, LTL, HAZMAT, and leasing companies. The number of power units operated ranged from 2 to 3,500. Three carriers operated under 100 power units (85, 13, and 2), while three operated significantly larger numbers of power units (3,500, 435, and 210). Participants representing the motor carriers included terminal mangers, operations managers, and safety directors. The average length of experience on the job was 16 years. All participating companies operated extensively in New York, Maryland, and Connecticut.

All focus group participants used the E-ZPass transponder. Most of the carriers enrolled through the New York State Motor Truck Association’s Master Account with the New York State Thruway Association, and all participants stated that they had been using E-ZPass since the program was first implemented. Very few participants were familiar with E-screening. None of the carriers was using a Mark IV Fusion Transponder for travel in the Coalition region.

3.5.3.2.1 Perceptions of ETC

The participants generally found E-ZPass difficult to deal with administratively. For example, one company was overcharged by about $3,000 due to bookkeeping errors with travel between toll-free exits on the Thruway. As a result, they had spent the equivalent of 3 full work weeks dealing with the mistake, which had not yet been resolved. Other issues mentioned were the difficulties in reaching E-ZPass customer service when calling with a question or problem and in getting transponders back when transponders were removed due to “insufficient funds” in an account. (The current process requires companies to mail in the ticket issued at the time a transponder is confiscated and then having to wait while the transponder is mailed back to them.) The company representatives expressed a need for an easier way to resolve the issue of insufficient funds.

The participants were generally happy with the technical performance of E-ZPass. The only problem mentioned was that of where to locate the transponder on the windshield of the power unit. For example, one company initially placed its transponders high on the windshield but then had to lower them because they were not functioning properly.

The participants did raise a number of safety issues related to toll collection:

- Most representatives felt that inconsistencies in speed limits at toll plaza approaches are a problem – they felt that consistent speed limits on the approaches would improve safety.
- Some companies mentioned that they are unsure that the cameras/technology are obtaining accurate information about speeds because they are getting speed violations that do not seem realistic (e.g., doubles getting speed violations of 17mph 30 feet before the toll plaza).
- Company representatives expressed that there should be more “E-ZPass Only” lanes at the toll plazas, and that the location of the “E-ZPass Only” lanes should be consistent (inconsistent use of the lanes violates driver expectation and leads to weaving/merging to get in the appropriate lane).

The motor carrier companies felt that it would be helpful if they were notified as additional states joined the E-ZPass program – when Delaware joined, the companies had to cover their transponders until they were able to use all the pre-purchased Delaware tickets.

All of the participants agreed that they did not feel that there is a general concern about “big brother”.

The companies were concerned about the price of the technology and most felt that it would eventually hit their bottom line somehow – the companies were also interested to know if the Commercial Vehicle Safety Alliance (CVSA) was involved in the project. The companies did not really note a problem with losing discounts as a result of joining the E-ZPass program. The only exception was that some thought Massachusetts did away with the discount it used to provide when the State implemented ETC.

3.5.3.2.2 Perceptions of E-Screening

When asked how often their drivers got pulled in for inspection, some participants reported approximately 20 percent of the time while others reported closer to 40 percent of the time. Most agreed that out-of-state trucks tended to get checked more often and that HAZMAT vehicles are almost always checked. In general, most of the issues related to E-screening related to program operations:

- One participant was concerned because many of his drivers had overweight permits, and he wanted to know if they would still qualify for E-screening.
- One participant said that his drivers frequently ran empty (empty refrigerated trailers, empty flatbeds) and asked if they would be eligible for E-screening when running empty.
- Several company representatives were interested in knowing if E-screening would be used on county roads as they felt that local inspections were “more of a hassle” than passing through a weigh station.

All participants agreed that there was currently a significant problem with truck queues spilling onto the mainline at weigh stations, which poses potential crash risks and near misses.

3.5.3.3 Truck Driver Focus Group in Baltimore, Maryland and Albany, New York

Driver focus groups were conducted in Baltimore, Maryland (MMTA) on September 17, 2003 and in Albany, New York (NYSMTA) on September 18, 2003. Focus group participants were recruited from the motor truck association members in each state.

Participating drivers averaged 20 years of experience, with 60 percent of the participants having more than 20 years of experience. At least 80 percent of the participants drove along I-95 on a regular basis. All participating drivers were company employees (none were owner-operators). Commodities hauled included containers, general freight, frozen food, heavy freight, and food goods.

All participants were using E-ZPass transponders for ETC. Two of the Maryland participants were using the Mark IV Fusion transponder and had participated in the E-screening Pilot Project at the Perryville, Maryland weigh station. Up to 60 percent of participants reported that they operate primarily intrastate, with only one driver reporting that he had no interstate operations.

All participating drivers reported that they passed E-ZPass toll plazas on a routine basis during their routes, and 8 percent reported passing weigh stations. All reported being pulled in for safety inspections, with only one driver reporting a frequency of more than one to two times per year.

3.5.3.3.1 Perceptions of ETC

The drivers reported that they had been very happy with the results of ETC, although they did identify several issues that had a negative impact on the program:

- Signs advising that trucks may not use the dedicated E-ZPass lanes, which are limited to 2-axle vehicles in Maryland, are not placed far enough out to give trucks time to change lanes. The drivers said they are often so close to the toll plaza by the time they see the sign, they have difficulty changing lanes safely.
- Speed limits at toll booths for trucks should be capped at no more than 15 mph. The drivers expressed concerns about the safety of moving large rigs through narrow toll lanes at the toll booths – several drivers relayed stories of having seen or been told by toll collectors about seeing trucks sideswiping toll booths with their mirrors or coming extremely close to hitting the toll booths.
- Drivers specifically mentioned safety concerns at the toll plazas at Exit 23 and 24 on the New York Thruway. Doubles are required to enter into the parking areas at both plazas. The concern raised by the drivers is that trucks at Exit 23 are required to cross eight lanes of traffic (all lanes leading eastbound as vehicles exit the toll plaza) and across four lanes at

Exit 24 as trucks exit the Thruway. All drivers stated that crossing this many lanes of traffic, frequently heavily traveled, is extremely dangerous.

- New York's E-ZPass Only lanes are often adjusted based on traffic volumes – the signage above the lanes at the toll booths can be adjusted to make lanes E-ZPass only, E-ZPass and cash, or are dark indicating that E-ZPass is not being used in that particular lane. The issue raised by drivers was that the changes in E-ZPass lane designation were not consistent and that as a result, drivers are not able to plan for moving into the proper lane prior to reaching the toll plaza.

3.5.3.3.2 Perceptions of E-Screening

In general, the drivers did not have a good understanding of electronic screening, including the two drivers using Mark IV Fusion transponders for electronic screening. All participants emphasized the need for safe operations, and all emphasized that safety is ultimately the responsibility of the driver. Most stated that being stopped for a safety inspection is not a bad thing, and that a certain number of trucks should be stopped and inspected. Both Maryland and New York drivers stated that inspections gave them a way to check to make sure that their maintenance and safety crews were doing their job.

The drivers were very positive about the use of transponders for E-screening in terms of safety – they felt that this would allow enforcement officials to inspect the right trucks (by allowing the trucks with good safety ratings to bypass). Several drivers in each state expressed the opinion that transponders should be mandatory for all trucks. Drivers felt that transponder technology is good – one had been using E-ZPass for 3 years and had only experienced problems with it working on three occasions.

3.5.3.4 Maryland Enforcement Focus Group

A Maryland Enforcement Focus Group was held on April 2, 2003 at the Maryland DOT headquarters building at Baltimore – Washington Airport. The group consisted of seven participants representing the two state agencies involved with commercial vehicle enforcement and weigh station operations – Maryland State Police (MSP) (with statewide jurisdiction) and MdTA Police (toll facilities jurisdiction).
Attendees included the following:

- Civilian inspectors (2)
- Uniformed officers (2)
- Supervisory personnel (1 from MdTA; 2 from MSP)

All seven participants were familiar with how E-screening works, and five of the seven had direct experience with the E-screening process. Four of the seven participants were familiar with how ETC works, while only one of the seven had direct experience with ETC.

3.5.3.4.1 Perceptions of E-Screening

The participants understood the purposes of E-screening, but did not have much practical experience with it. The MdTA Perryville weigh station was the only facility in Maryland equipped for E-screening at the time, and the number of transponder-equipped trucks using the system was minimal.

The MdTA Police commented that only six trucks with transponders regularly passed through or by the station. They noted that inspection selection was based on random selections (as one participant stated, *"It depends on who's working the board that day."*); visual inspections of trucks (i.e., the detection of an obvious defect); and/or visual inspections of drivers (i.e., detection of signs of fatigue, actions/odors that raise concerns about drug or alcohol use); or by existing knowledge of carriers and drivers.

One enforcement officer commented that,

> *"You get to know the drivers by name. You get to know which companies operate overweight."*

Participants noted that it is less expensive for companies to pay a $500 overweight ticket than to put another driver on the road (it's the price of doing business). With E-screening, the participants felt that they would be bypassing these overweight trucks, which would damage the roads in the long run.

Both enforcement agencies also used the existing carrier rating systems to select carriers for inspection (Inspection Selection System [ISS] and the Motor Carrier Safety Status Measurement System [SafeSTAT]), as well as the Safety and Fitness Electronic Records (SAFER) snapshot information. They also noted that sometimes they will target certain types of vehicles (e.g., years, make, models, etc) based on information they have received.

Both MSP and MdTA police stated that the most significant problem they faced during the screening process was the volume of traffic. Truck traffic, in particular at peak periods, is too heavy to bring all trucks across the static scales at weigh stations. Weigh stations also experience lane back-ups that require the temporary closing of weigh stations until the queue has been cleared.

In general, the participants did not seem to feel that E-screening offered the potential for much benefit. The primary benefit identified by the participants was the use of the transponder number to identify stolen trucks, trucks jumping out of service orders, or other enforcement activities. For example, the participants stated that they could enter the transponder number of a stolen vehicle into the E-screening system and flag the number for a red light as a means of identifying the vehicle. At present, this is done by radio and telephone communication between weigh stations and between states.

On the other hand, the participants cited a number of concerns about E-screening. The major concern expressed was the fact that trucks would be bypassed without any visual check and that obvious defects would go undetected. The participants all stated that requiring trucks to pass through the weigh station helps enforcement personnel identify and flag obvious violators, and that relying on a computer to make this decision would cause them to lose control of the truck. As one participant stated,

> *"We want total control of the truck. That is the best way to protect the public."*

Other specific problems with the current operation of E-screening noted by participants included:

- Lack of driver information/contact – the participants stated that the E-screening system was based on carrier ratings, not driver ratings, and that more information was needed on the driver. They felt that it might even encourage drivers to drink (or engage in other illegal activity) because they know they will get a green light most of the time. The participants also expressed concern about not being able to "look the driver in the eye" to identify signs of fatigue, substance abuse, or other issues that would lead to selecting the particular truck/driver for further inspection. As one participant stated,

> *"We already have the ability to look at the company. But the [safety history of the] driver in front of you and the company [safety rating] are not always correlated."*

- Lack of information on the trailer – the participants stated that many violations were found on the trailers as well as on the power units. However, the snapshot and other data used for E-screening do not include the trailer, only the carrier. The participants expressed concern that not being able to visually examine trailers on the scales (e.g., giving carriers a green light for bypass) would allow many trailers with safety defects to remain on the road.
- Data are not always up to date. In some cases, the data can be up to 6 years old. Bypassing trucks today should not be based on data there are out of date.
- Ability of carriers to change tags in trucks – participants expressed concern that carriers would be able to move the transponders from truck to truck and that they would not have any way of identifying when this happened. An additional comment raised was what would happen if an owner-operator leased by a company and using a transponder assigned by the company – the company may have a good rating while the owner operator may have a poor rating, but under this scenario would receive a green light.

3.5.3.4.2 Perceptions of E-Screening

Participants also noted some general concerns about E-screening. One concern was that they had not had enough involvement in requirements definition and provided input only into the design of the print out. A second general concern dealt with the actual placement of the ROC in the weigh station. Participants noted that the weigh station already had several monitors used for reporting information, and the ROC was not readily accessible to those personnel who were manning the scale operations inside the facility.

As one participant stated,

> *"We've got so much stuff to look at and these guys are not computer people. The computer is across the room and gets ignored. We don't have the personnel to handle it. Across the room – out of sight, out of mind."*

Participants were also concerned about if E-screening supports the increased emphasis on security. For example:

- Increased levels of security require that all trucks be pulled in and more cargo checks be done. This completely offsets E-screening.
- A terrorist will have the ability to obtain a transponder-equipped truck and bypass weigh stations. As one participant stated,

  "All you need is a truck with a good safety rating and a transponder and he (the terrorist) can go up and down the highway."

A final general comment was that the true effectiveness of E-screening would not be fully measured at this point in time. The participants stated that the level of penetration was so low at present it was difficult to tell how the system might actually work.

3.5.3.5 Connecticut Enforcement Survey

During May 2003, a survey of the Connecticut Department of Motor Vehicles motor carrier enforcement personnel was conducted. As previously stated, the Evaluation Team had requested that a focus group be assembled, as in New York and Maryland, to discuss the issues related to E-screening with enforcement officials. The Connecticut Department of Motor Vehicles, however, preferred to participate in a survey rather than a focus group.

Surveys were distributed to each of the 35 inspectors in the State of Connecticut, and 15 (43 percent) completed surveys were returned. The surveys included general questions on length of experience and familiarity with E-screening, as well as a series of statements that participants responded to according to their level of agreement. For example,

> *"E-screening encourages trucking companies to improve safety and compliance in order to enroll."*

Enforcement officials rated their level of agreement used a rating scale of 1 to 5 with 1 being "strongly agree" and 5 being "strongly disagree". The surveys also included open-ended questions about motor carriers' opinions on the advantages and disadvantages of E-screening. Of the 15 personnel who returned completed surveys, one-third had less than 5 years of experience in commercial vehicle safety and weight enforcement, one-third had 5 to 10 years of experience, and one-third had more than 10 years of experience. Ten (67 percent) of the enforcement officials understood how E-screening works, but only two (13 percent) reported having direct experience with E-screening.

The quantitative data (i.e., responses rating statements) were examined in a number of ways and discussed in detail as follows:

- The average of the responses.
- The mode of the responses.
- The standard deviation of the responses.
- The distribution of responses by level of experience.

<u>The Average of the Responses</u>. The statements with the highest and lowest overall average responses are shown in Table 3-20. In general, responses to these questions were consistent with the focus group discussions. The exception was the issue related to the identification of stolen trucks; enforcement officials from Maryland identified this issue as one of the only benefits they saw with E-screening, while the survey results show that the enforcement officials from Connecticut disagree.

Table 3-20. Statements with Highest and Lowest Overall Average Responses

Statement	Average	Tend to Agree or Disagree	Consistency with Focus Group Discussions
E-screening reduces driver delays at weigh stations.	1.7	Agree	Consistent
E-screening allows trailers with defects to remain on the road.	2.0	Agree	Consistent

Statement	Average	Tend to Agree or Disagree	Consistency with Focus Group Discussions
E-screening is consistent with the increasing emphasis on national security efforts.	3.7	Disagree	Consistent
E-screening allows me to do my job better.	3.7	Disagree	Consistent
E-screening helps identify stolen trucks.	4.0	Disagree	Inconsistent

The Mode of the Responses. In about half of the statements, the mode response was “3” or “neither agree nor disagree”. This result is most likely due to the fact that the majority of the motor carriers did not have direct experience with E-screening (rather than the fact that they actually did not have an opinion). In fact, six motor carriers added a comment at the end of the survey that they did not know enough about E-screening to form an “educated” opinion. This result is not surprising, as the focus groups and surveys were done prior to implementation of E-screening at all sites, with the exception of Perryville in Maryland.

While this issue should be less evident in the “After” survey, an additional response option, “don’t know” will be added to any opinion scale questions to account for those who, even though they may be using the technology, do not have sufficient experience to respond to a particular question.

The standard deviation of the responses and the distribution of responses by level of experience. In examining the data, the variability in the responses was primarily due to the following:

- Conflicting perceptions between enforcement officials based on experience level (e.g., those with less than 5 years experience tend to agree, while those with more than 10 years experience tend to disagree), and/or
- Similar distributions of responses across experience levels, but conflicting perceptions across motor carriers within the same experience level.

An example of conflicting perceptions between enforcement officials based on experience level is the following statement:

> *“E-screening can lead to a decrease in the effectiveness of trucking company safety programs.”*

Table 3-21 shows while all of the motor carriers with 5 to 10 years experience agreed with the statement, the majority of motor carriers (3 out of 5) with less than 5 years of experience disagreed with the statement. Those motor carriers with more than 10 years of experience were split in their opinions (2 agreed, 2 disagreed, and 1 was neutral).

Table 3-21. Distribution of Responses Across Experience Levels for Statement 10

Response	Number of Motor Carriers		
	< 5 years	5 – 10 years	> 10 years
Strongly agree.	1		
Somewhat agree.		5	2
Neither agree nor disagree.	1		1
Somewhat disagree.	1		1
Strongly disagree.	2		1

An example of similar distributions of responses across experience levels, but conflicting perceptions across motor carriers within the same experience level is the following statement:

"E-screening is an improvement over existing screening processes."

Table 3-22 shows while the motor carriers are similarly distributed for the three experience levels, there tends to be disagreement within each of the groups.

Table 3-22. Distribution of Responses Across Experience Levels for Statement 2

Response	Number of Motor Carriers		
	< 5 years	5 – 10 years	> 10 years
Strongly agree.		1	
Somewhat agree.	3	1	2
Neither agree nor disagree.	1	1	2
Somewhat disagree.		2	1
Strongly disagree.	1		

The highest standard deviations of responses were generally due to both of the above factors. For example, there was disagreement in the responses to the following statement:

"E-screening should be implemented at all sites in this state."

The standard deviation of responses to this statement was 1.4, one of the highest standard deviations of the responses to the statements. The overall response distribution to this statement is shown in Table 3-23, where it can be seen that there was at least one response in each of the five categories.

Table 3-23. Distribution of Responses with High Standard Deviation

Response	Number of Motor Carriers
Strongly agree.	1
Somewhat agree.	4
Neither agree nor disagree.	4
Somewhat disagree.	1
Strongly disagree.	5

In examining the responses by experience level (shown in Table 3-24), it can be seen that there was not only disagreement across motor carriers with different experience levels, but there was also disagreement between motor carriers within the same experience level.

Table 3-24. Distribution of Responses Across Experience Levels for Statement 16

Response	Number of Motor Carriers		
	< 5 years	5 – 10 years	> 10 years
Strongly agree.		1	
Somewhat agree.	3	1	
Neither agree nor disagree.	1		3
Somewhat disagree.		1	
Strongly disagree.	1	2	2

A number of general observations were made with respect to the responses:

- The mid-level experience motor carriers (5 – 10 years) tended to be more negative about the promise of the technology than those with less (less than 5 years) and more (more than 10 years) experience, and they tended to agree with each other more than the other two groups.
- There were only two statements where there was strong agreement across all experience levels:
- E-screening reduces driver delays at weigh stations.
- E-screening allows truck drivers to abuse alcohol/drugs because they have “green light” clearance.
- The three statements with the highest disagreement in responses were:
- E-screening should be implemented at all sites in this state.
- E-screening should use transponders that are interoperable with those used for electronic toll payment, such as E-ZPass.
- E-screening encourages trucking companies to improve safety and compliance in order to enroll.

Particular attention will be paid to the statements with large variability in the responses, as the variability may be due in part to the wording of the statement. Where appropriate, statements may be re-worded or refined for clarification on the “After” survey.

3.6 SUMMARY OF PRELIMINARY FINDINGS

Figure 3-28 through Figure 3-34 show the synthesized perception findings of the focus groups and Connecticut enforcement survey in terms of the following seven issues related to ETC and E-screening:

- Safety Perceptions (Figure 3-28)
- Mobility Perceptions (Figure 3-29)
- Perceptions of Operational Efficiency (Figure 3-30)
- Cost Perceptions (Figure 3-31)
- Perceptions of Industry Acceptance and Use (Figure 3-32)
- Perceptions of System Design, Implementation, and Operation (Figure 3-33)
- Perceptions of Registration and Customer Service (Figure 3-34)

Safety Perceptions

ETC

Motor Carriers

- The way in which the ETC accounts are charged and tracked, companies are no longer able to track individual driver performance, and in turn, driver compliance with safety requirements such as hours of service.

Truck Drivers

- Signs indicating E-ZPass Only lanes should be placed far enough in advance of the toll plaza to allow drivers to change lanes safely.
- The location of the E-ZPass Only lanes should be consistent. When the lanes are moved, the drivers cannot anticipate which lane to be in and have to make last minutes lane changes in congestion, creating a safety hazard.

E-Screening

Enforcement Officials

- Obvious defects (visible on truck or trailer, visible driver impairments) would go undetected by providing bypasses.
- Not being able to see the driver “face-to-face” when bypassed combined with a lack of driver information in the system is a problem with current E-screening operation.
- Not being able to examine the trailer when bypassed combined with a lack of driver information in the system is a problem with current E-screening operation.
- Data on carriers are not necessarily current.
- E-screening concept not consistent with emphasis on national security.

Motor Carriers

- Motor carrier perception of the safety impacts has been identified as an information gap. This issue will be explored further in the “After” survey.

Truck Drivers

- While most of the drivers did not have experience with E-screening, they were positive about the potential safety benefits of the program (in terms of enforcement officials being able to identify and target non-compliant carriers).

Figure 3-28. Perceptions of Safety Impacts of ETC and E-Screening.

Mobility Perceptions

ETC

Motor Carriers

- Discrepancies in the number of axles programmed in the transponder and the number of axles on the tractor-trailer combination can cause delays if drivers are stopped for toll enforcements.
- Trucks with transponders confined to "truck only" lanes negate the travel time savings benefit of ETC because they are in lanes with vehicles without transponders (Maryland only).
- Should be more "E-ZPass Only" lanes at the toll plazas.

Truck Drivers

- Truck driver perception of the mobility impacts has been identified as an information gap. This issue will be explored further in the "After" survey.

E-Screening

Enforcement Officials

- Survey results suggest that enforcement officials agree that there are mobility benefits in terms of reducing queues at weigh stations; however, this topic was not discussed in the Maryland enforcement focus group. Therefore, enforcement official perception of the mobility impacts has been identified as an information gap. This issue will be explored further in the "After" survey.

Motor Carriers

- As stated by a HAZMAT company representative participating in E-screening, a decrease has been seen in the number of times trucks had been pulled in for inspection. This decrease has produced noticeable travel time savings.

Truck Drivers

- Truck driver perception of the mobility impacts has been identified as an information gap. This issue will be explored further in the "After" survey.

Figure 3-29. Perceptions of Mobility Impacts of ETC and E-Screening.

Perceptions of Operational Efficiency

ETC

Motor Carriers

- Because of the way in which the accounts are charged, companies are no longer able to track individual driver performance, which negatively impacts internal operations management.

E-Screening

Enforcement Officials

- The use of transponders and E-screening cannot replace the human interaction and therefore takes control away from the inspectors.
- There was mixed feedback about whether E-screening would help identify stolen trucks (focus group participants provided positive feedback, while survey responses were more negative).

Motor Carriers

- As per a HAZMAT company representative participating in E-screening, have seen a decrease in the number of times trucks had been pulled in for inspection. This decrease had improved operations.

Figure 3-30. Perceptions of the Operational Efficiency Impacts of ETC and E-Screening.

Cost Perceptions

ETC

Motor Carriers

The switch from ticket books to ETC has increased costs on several levels (e.g., decreased overall discounts, volume requirements for discounts raised, owner-operators may not qualify based on volume requirements).

Those who had not yet seen the bottom line cost impacts expressed concerns that they eventually would.

E-Screening

Enforcement Officials

- Resources would be better spent on additional personnel and supplies.

Motor Carriers

- Motor carrier perception of cost implications has been identified as an information gap. This issue will be explored further in the "After" survey.

Figure 3-31. Perceptions of Cost Impacts of ETC and E-Screening.

Perceptions of Industry Acceptance and Use

ETC

Motor Carriers

- All motor carriers represented in the focus groups were enrolled in ETC.
- There should be more "E-ZPass Only" lanes at the toll plazas

Truck Drivers

- All truck drivers participating in the focus groups were using E-ZPass transponders.
- Drivers expressed satisfaction with ETC.

E-Screening

Enforcement Officials

- In general, does not offer the potential for much benefit in terms of enforcement.
- No benefits with current market penetration. Benefits will only be recognized with increased market penetration.

Motor Carriers

- Availability of E-screening at only one location along I-95 is not a strong incentive to participate in the program.
- Intermodal carriers' lack of control over the equipment maintenance is a deterrent to participation in the program (they feel they would have a difficult time getting green lights as compared to other trucking companies).

Truck Drivers

- Two of the Maryland participants were using the Mark IV Fusion transponder and were participating in the E-Screening Pilot Project at the Perryville weigh station.
- Drivers expressed an interest in E-screening and its potential benefits, but did not have a good understanding of how it worked.

Figure 3-32. Perceptions of Industry Use and Acceptance of ETC and E-Screening.

Perceptions of System Design, Implementation, and Operation

ETC

Motor Carriers

- Certain aspects of the system were designed for passenger cars, and as a result, these features are not "truck friendly" (e.g., transponders are programmed for a fixed number of axles). The result is an increased administrative burden on companies.
- Trucks still confined to "truck only" lanes negates the travel time savings benefit of ETC (Maryland only).

Truck Drivers

- The location of the "E-ZPass Only" lanes should be consistent.

E-Screening

Enforcement Officials

- Did not have enough input into E-screening system design.
- Placement of the roadside operations computer (ROC) in the weigh station not done from an ergonomic perspective (MD).

Motor Carriers

- If E-screening were available on other routes that the carriers ran frequently (e.g., I-70), they would participate.
- Need nationwide interoperability to make the program a true success.

Truck Drivers

- Drivers did not have a good understanding of the operation of E-screening (including those who were participating in the Pilot Project at Perryville).
- Truck driver perception of system design, implementation, and operation has been identified as an information gap. This issue will be explored further in the "After" survey; however, the lack of exposure that many drivers have had to an E-screening program may limit the information gained in this category.

Figure 3-33. Perceptions of System Design, Implementation, and Operation of ETC and E-Screening.

Perceptions of Registration and Customer Service

ETC

Motor Carriers

- Have not had much success contacting E-ZPass customer service via the phone.
- Quality of customer service is lacking.
- No cooperation between E-ZPass vendor and public toll facilities.

Truck Drivers

- Truck driver perception of registration and customer service has been identified as an information gap. This issue will be explored further in the "After" survey.

E-Screening

Motor Carriers

- Questionable reliability of the on-line E-screening registration.

Figure 3-34. Perceptions of ETC and E-Screening Registration and Customer Service After Project Enforcement Focus Group After Project Industry Survey.

Table 3-25 shows the survey response rates by association. Overall the response rate was just slightly above 10 percent, with a slightly higher rate from the members of the NYSMTA (11 percent) and a slightly lower response rate from the members of the MMTA (10 percent).

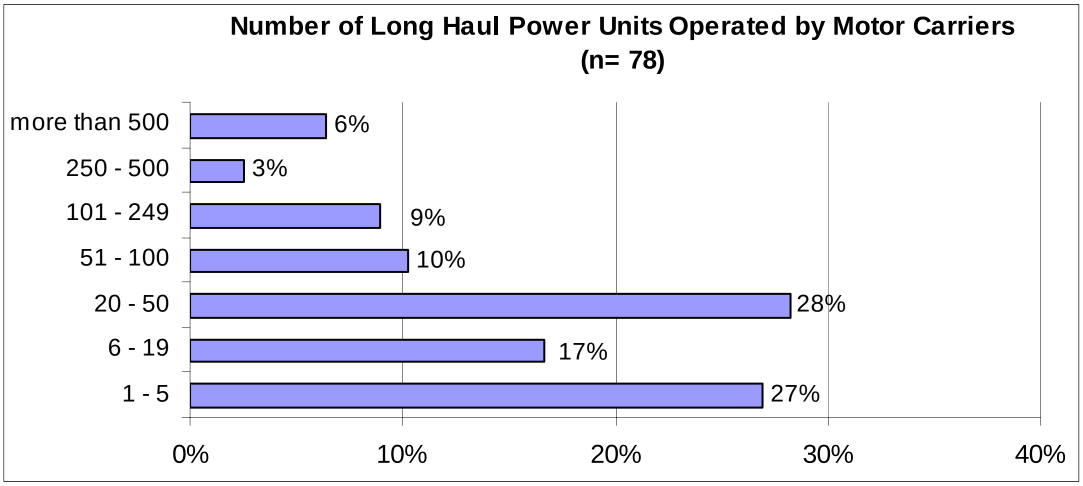
Table 3-25. Survey Response Rates by Association

State Trucking Association	Membership	Total Surveys Returned	Response Rate
Maryland	910	91	10%
New York	441	49	11%

3.6.1 Motor Carrier Profiles

Motor carriers were asked a series of questions about their company, including: number of power units operated, percent of drivers that are owner-operators, geographic range of operations, percent time spent on Interstate highways, and type of commodities hauled.

Figure 3-35 shows the number of long haul and short haul power units operated by each motor carrier. Of those motor carriers responding to the survey, 56 percent operate long-haul power units, 77 percent operate short-haul power units, and 49 percent operate both.



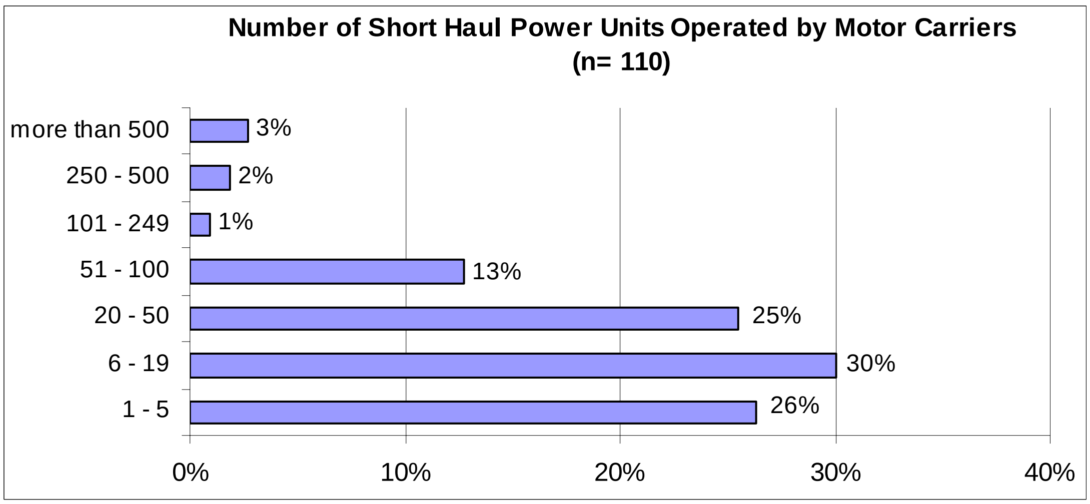


Figure 3-35. Number of Power Units Operator by Motor Carriers.

Table 3-26 shows the percentage of drivers for the motor carriers that are owner-operators. The majority of motor carriers (61 percent) do not have any owner-operators. Of the 55 motor carriers that do use owner-operators, the majority (55 percent) has less than 25 percent owner-operators.

Table 3-26. Percentage of Drivers Who are Owner-Operators

Percentage of Drivers Who Are Owner-Operators	Percentage of Motor Carriers
Less than 25%	55%
26 – 50%	11%
51 – 75%	16%
More than 75%	18%
TOTAL	100%

Figure 3-36 shows the geographic range of the motor carriers' operations. Of the responding motor carriers, 22 percent operate on an intra-state basis, 60 percent operate on a regional basis, and 18 percent operate on a national basis.

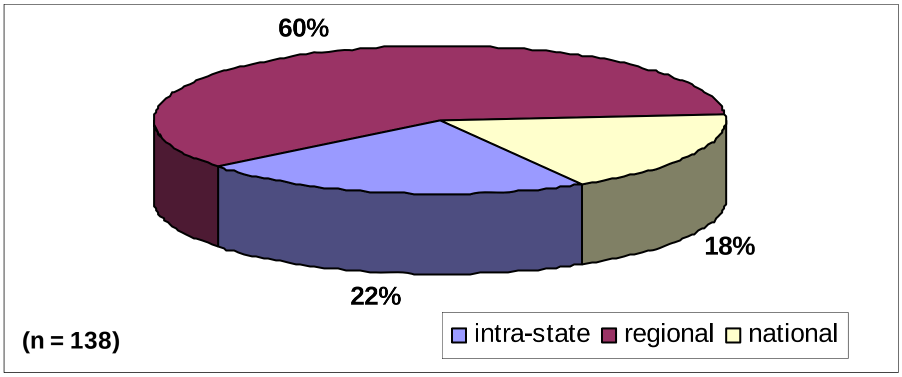


Figure 3-36. Geographic Range of Motor Carrier Operations.

Figure 3-37 shows the percentage of the time that the motor carriers spend on interstate highways. The distribution of motor carriers is fairly even across the four categories. Of the responding motor carriers, 22 percent spend less than 25 percent of their time on interstate highways, and 32 percent spend 26 – 50 percent of their time on interstate highways. The responding motor carriers reported that 31 percent spend 51 – 75 percent of their time on interstate highways, while 15 percent spend over 75 percent of their time on interstate highways.

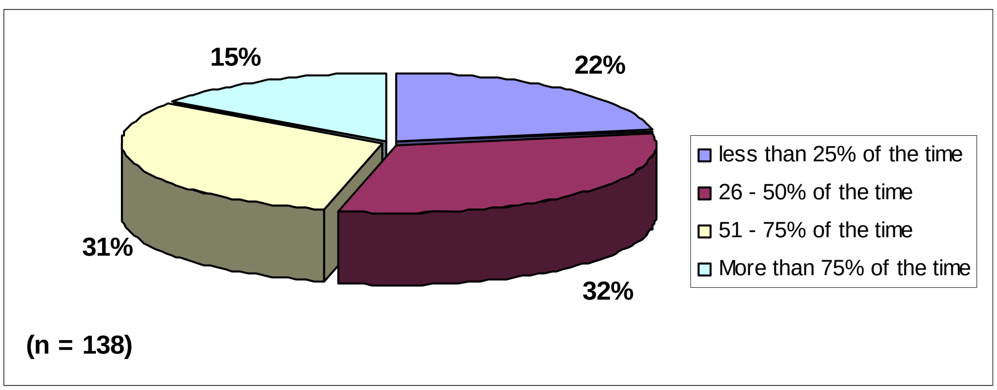


Figure 3-37. Percentage of the Time the Motor Carriers Spend on Interstate Highways.

Table 3-27 shows the types of commodities hauled by the motor carriers. Motor carriers could choose more that one category. For the responding motor carriers, 32 percent reported that they hauled *general freight – truckload*, 17 percent haul *hazardous materials*, and 15 percent each haul *general freight – less-than-truckload* (LTL) and *bulk – dump loading*. Additionally, 37 percent reported multiple types of commodities hauled.

Table 3-27. Type of Commodities Hauled by the Motor Carriers

Commodities	Number of Motor Carriers
General freight – truckload	32%
Hazardous materials	17%
Bulk – dump loading	15%
General freight – less than truckload	15%
Intermodal	6%
Automotive parts	5%
Household goods –movers	4%
Other	28%

3.6.2 Survey Results for ETC

Sections 3.6.2.1 through 3.6.2.5 present the ETC survey results regarding related use and acceptance, mobility benefits, cost benefits, and E-ZPass customer service.

3.6.2.1 Questions Related to Use and Acceptance

Of the 140 motor carriers responding to the survey, 73 percent reported that they were enrolled in ETC. Table 3-28 shows the number of years that the motor carriers have been enrolled in ETC. From the table, it can be seen that only 34 percent of the motor carriers were enrolled in ETC prior to the year 2000. In fact, nearly half (45 percent) have been enrolled for only about 2 years.

Table 3-28. Years Enrolled in ETC

Enrolled Since	Percentage
Prior to 1995	12%
1995 – 1 999	22%
2000	10%
2001	8%
2002	14%
2003	23%
2004	8%
Not sure	3%
TOTAL	100%

Of the 37 percent of motor carriers who responded that they were *not* enrolled in ETC, the most commonly reported reason for not being enrolled was that they do not use toll facilities often enough to justify participating. Table 3-29 shows the other reasons that motor carriers reported for not enrolling in ETC. The two other commonly reported reasons for not participating were that there are not enough incentives to participate and that it costs too much to participate.

Table 3-29. Reasons Motor Carriers Do Not Participate in ETC

Reason Not Enrolled in ETC	Percentage
Don't use toll roads enough (no need).	34%
There are not enough incentives.	23%
Costs too much.	15%
Use owner-operators or subcontractors who are responsible for own tolls.	8%
Too difficult to register.	5%
Concerned with driver abuse of system.	5%
Don't believe in concept/no interest.	5%
Security of transponders in trucks a concern.	3%
Tracking truck tolls is too time consuming.	3%

Those motor carriers who participate in ETC were asked to indicate if they had used any method of toll payment, other than cash, prior to using E-ZPass. Methods used other than cash include ticket books, toll cards, etc., with the results shown in Table 3-30. For the responding motor carriers, 55 percent participating in ETC reported that they did use some form of payment other than cash before enrolling in ETC.

Table 3-30. Motor Carriers' Use of Methods Other Than Cash Prior to ETC

Did your company use any method other than cash for toll collection (e.g., ticket books, toll cards) prior to E-ZPass Deployment? (n=101)	
Yes	55%
No	43%
Not enrolled in E-ZPass	2%

These 55 percent motor carriers were then asked to compare ETC to their previous method of toll payment. Specifically, motor carriers were asked to rate their level of agreement with the statement, *"We prefer our old method of paying tolls to electronic toll collection."*

Respondents were asked to rate their level of agreement on a scale of 1 to 5, with 1 being "strongly disagree" and 5 being "strongly agree". The results are shown in Figure 3-38, which shows that the majority of the motor carriers (68 percent) disagreed with the statement and 41percent strongly disagreed. Only 21 percent strongly agreed with the statement. These results indicate that the large majority of motor carriers surveyed are happy with ETC.

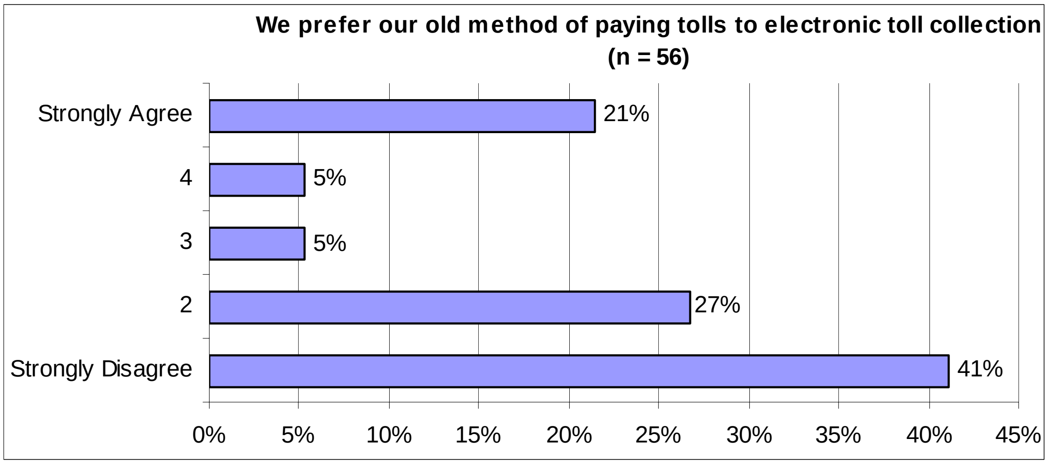


Figure 3-38. Motor Carriers' Perceptions of ETC as Compared to Their Old Method of Toll Payment.

Regarding their acceptance of ETC, motor carriers were asked to rate their satisfaction of the service with 1 being "extremely satisfied" and 5 being "extremely dissatisfied". Figure 3-39 shows that the majority of motor carriers (63 percent) reported that they were satisfied with ETC to this point, that 25 percent were neutral, and 12 percent were dissatisfied.

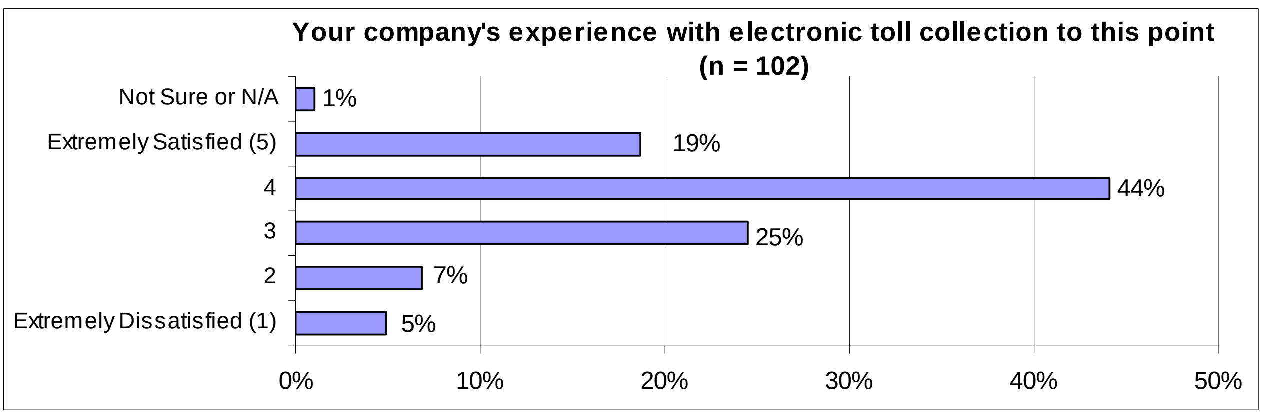


Figure 3-39. Motor Carriers' Satisfaction with ETC.

3.6.2.2 Questions Related to Mobility Benefits

First, motor carriers were asked to indicate whether they thought there should be ETC lanes dedicated to trucks. Table 3-31 shows that 79 percent of the motor carriers thought that there should be dedicated ETC truck lanes, while 21 percent did not. Those who said "yes" were asked to report how many designated truck lanes they would like to see. The responses to this question were as follows:

- 16 percent reported *1 lane out of 10*
- 55 percent reported *2 lanes out of 10*
- 30 percent reported *3 or more lanes out of 10*

Therefore, 68 percent of all motor carriers surveyed think that at least 20 percent of the total number of toll lanes should be dedicated ETC truck lanes.

Table 3-31. Motor Carriers' Responses to Whether There Should be ETC Lanes Dedicated to Trucks

From your company's perspective, should there be lanes for electronic toll collection dedicated to trucks? (n = 139)	
Yes	79%
No	21%

Motor carriers were then asked to indicate how the use of ETC has impacted their drivers' travel times through toll facilities. The responses are shown in Figure 3-40, which shows that the majority of motor carriers reported at least some travel time savings as a result of using ETC (only 12 percent reported *no travel time savings whatsoever*). For the motor carrier respondents, 47 percent reported that their drivers have experienced *less than a 10-percent reduction in travel times* through toll facilities; 32 percent reported a travel time savings of *11 – 20 percent*; and 10 percent reported more than a *20 percent reduction in travel times*.

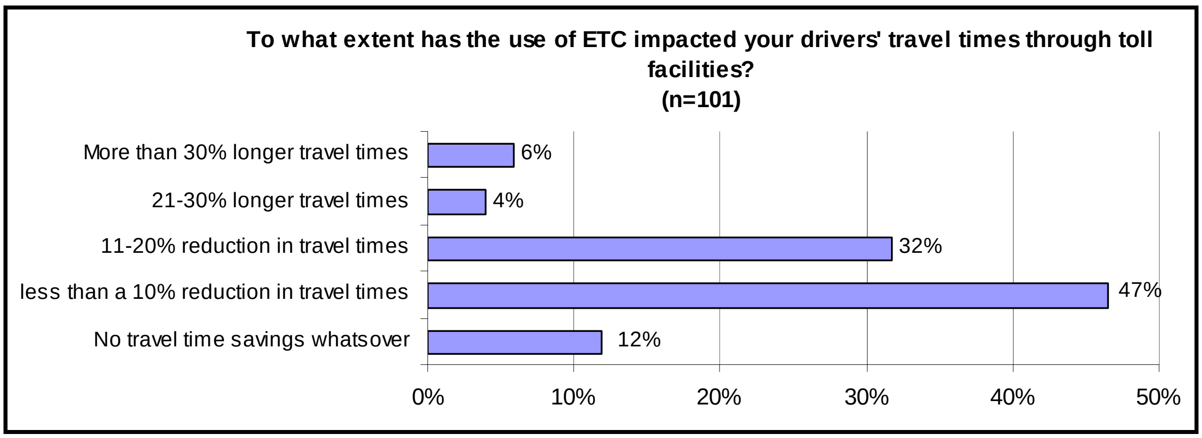


Figure 3-40. Impact of ETC on Travel Time Through Toll Facilities

Motor carriers were also asked to indicate the extent to which confinement to "truck only" lanes at ETC facilities in Maryland impact their drivers' travel times through these facilities. The responses are shown in Figure 3-41, which shows 31percent of motor carriers who travel through toll facilities in Maryland (n = 87) reported that the "truck only" lanes have no impact on their drivers' travel times through these facilities (*doesn't take any longer*). However, 40 percent reported that it took 10 percent longer to get through these lanes, and 21 percent reported that it took 11 – 20 percent longer. Surprisingly, 8 percent of motor carriers reported a 30-percent increase in travel time in the "truck only" lanes.

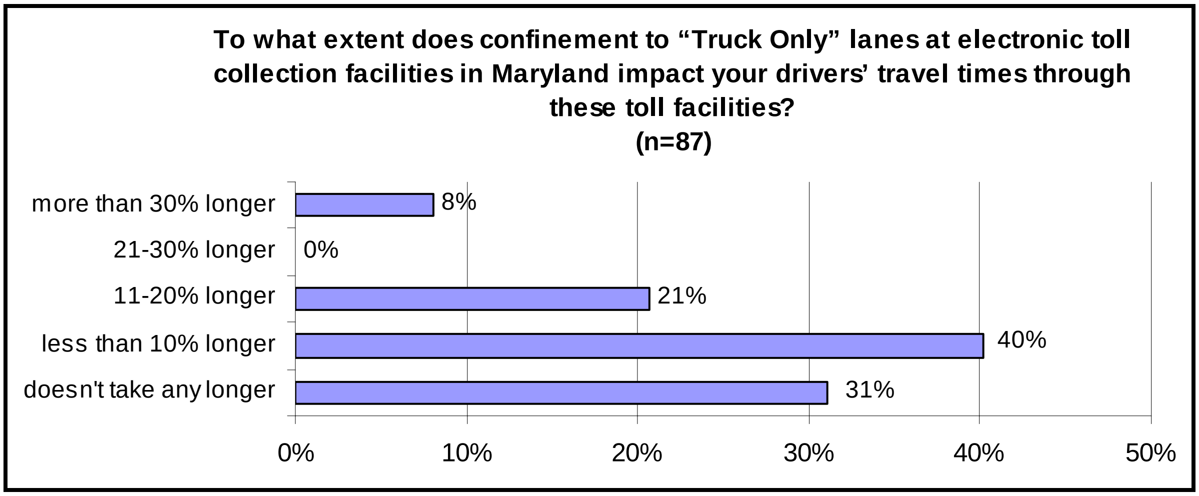


Figure 3-41. Impact of Truck Only Lanes on Travel Time Through Toll Facilities.

Motor carriers were asked to rate their level of satisfaction with the travel time savings benefit of ETC. The results are shown in Figure 3-42, which shows that the majority (59 percent) reported that they were satisfied (ratings of 4 or 5) with the travel time savings benefit of ETC (23 percent were *extremely satisfied*). For the responding motor carriers, 27 percent were neutral (rating of 3), and only 9 percent of the motor carriers reported that they were dissatisfied with the travel time savings benefit.

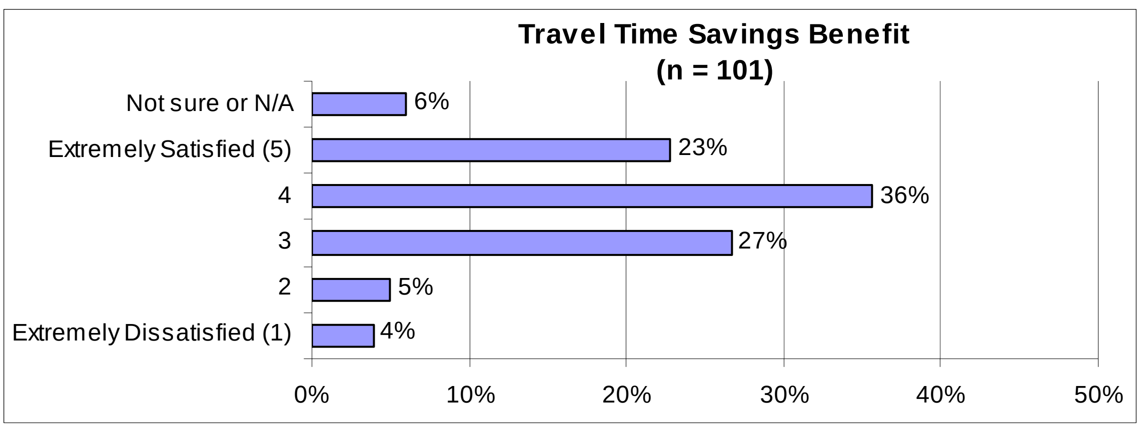


Figure 3-42. Motor Carriers' Satisfaction with Travel Time Savings of ETC.

3.6.2.3 Questions Related to Operational Benefits

With regard to the impact of ETC on operations, motor carriers were asked to indicate which of the following sentences best represented their company's opinion of the general design and implementation of ETC. They were asked to choose their response based on how the design and implementation of ETC related to their company's operations. The response choices were as follows:

- Good – ETC has had positive impacts on our operations.
- OK – but ETC could benefit from modifications that could further improve operations.
- Poor – ETC was designed to improve passenger car operations, not truck operations.
- I'm not sure.

The results are shown in Figure 3-43, which shows that the majority (58 percent) reported that ETC had positive impacts on their operations. Additionally, 23 percent thought that ETC was *OK*, but that it could benefit from modifications. Only 13 percent reported that *ETC was designed to improve passenger car operations, not truck operations*.

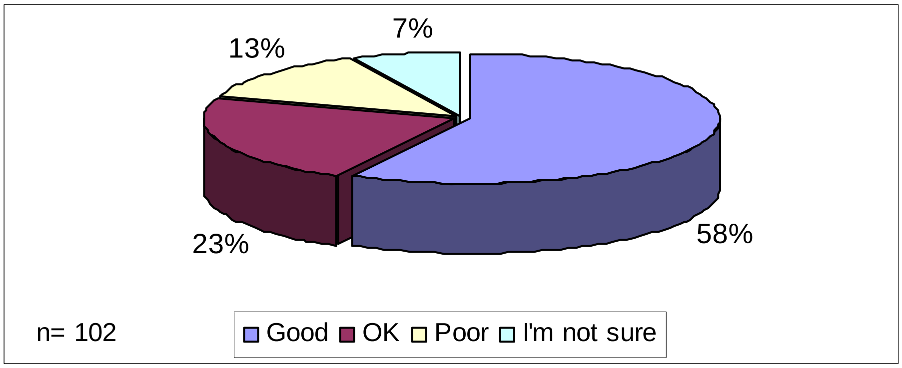


Figure 3-43. Motor Carriers' Perceptions of the Impact of ETC on Their Operations.

Motor carriers were also asked to rate their satisfaction with the impacts of ETC on their operational efficiency. The results are shown in Figure 3-44, which shows that the majority reported (60 percent) that they were satisfied with the impact ETC has had on their operational efficiency – 22 percent were *extremely satisfied*. From the responding motor carriers, 26 percent reported that they were neither satisfied nor dissatisfied (rating of "3"). Only 9 percent reported that they were dissatisfied with the impact ETC has had on their operational efficiency.

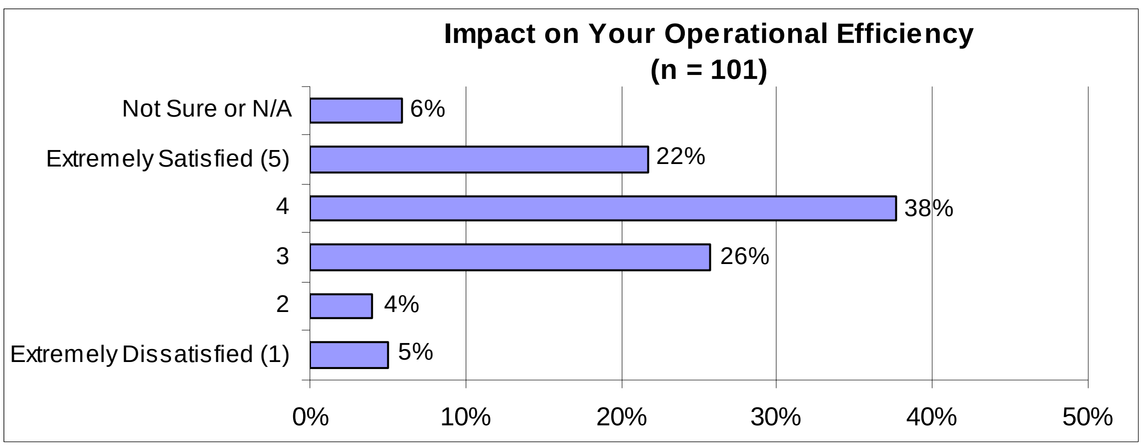


Figure 3-44. Motor Carriers' Satisfaction with Impacts of ETC on Operational Efficiency.

3.6.2.4 Questions Related to Cost Benefits

Motor carriers who used some form of toll payment, other than cash, were asked to compare the cost impacts of switching to ETC. They were first asked if the switch to ETC had impacted their company's costs. Table 3-32 shows that 69 percent reported that it had impacted costs, while 14 percent reported that they expected to see cost impacts in the future.

Table 3-32. Impact of ETC on Motor Carriers' Costs

Has the switch from your old method of paying tolls to ETC impacted your company's costs (either positively or negatively?) (n=56)	
Yes	66%
Not yet, but we expect to see impacts in the future.	9%
No, and we don't expect to see any impacts.	25%

Figure 3-45 shows more specifically how the motor carriers rated the impacts of ETC on different factors, including:

- Fuel usage
- Time/cost of enrolling owner-operators (in ETC)
- Time/cost of maintaining accounts
- Time/cost of record keeping
- Time/cost of auditing drivers' log books

Figure 3-45 also shows that few motor carriers reported decreases in costs of more than 10 percent; however, between 25 to 33 percent of the motor carriers did report up to 10 percent decreases in three of the four areas.

While 28 percent of the motor carriers reported decreases in fuel usage of 1 – 10 percent, the majority (53 percent) reported *no impact*, and another 19 percent reported that they were not sure.

From the responding motor carriers, 42 percent reported some level of decrease in the time/cost of maintaining their accounts as a result of the switch to ETC. However, 41 percent reported some level of increase in the time/cost of maintaining their accounts. Only 8 percent reported *no impact*.

While 35 percent of motor carriers reported decreases in the time/cost of record keeping as a result of ETC, 43 percent reported some level of increase in time/cost. Only 14 percent reported *no impact*.

Only 20 percent of motor carriers reported decreases in the time/cost of auditing drivers' log books, while 36 percent reported *no impact*, and 22 percent reported some level of increase in time/cost, and 22 percent were unsure.

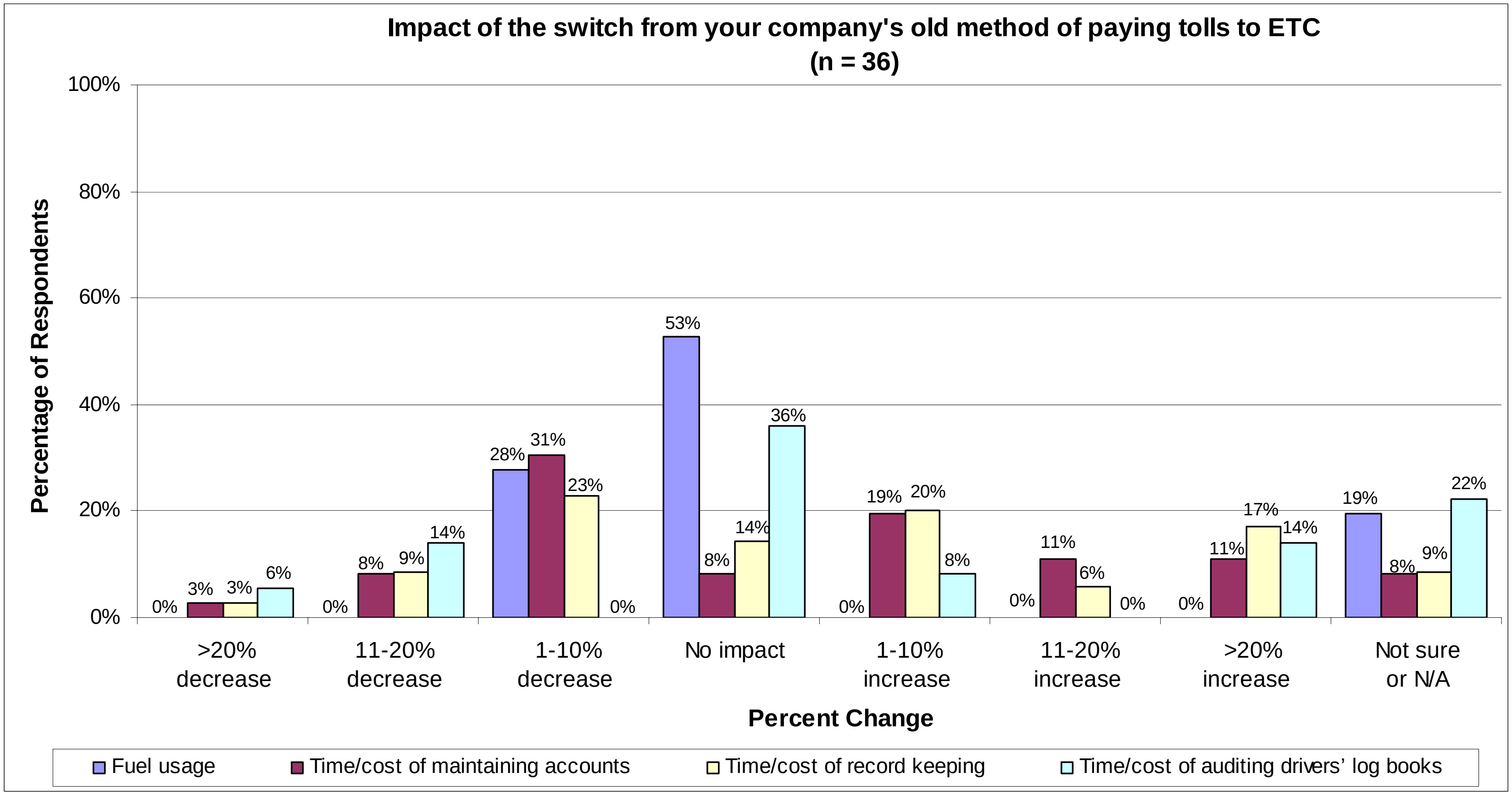


Figure 3-45. Impact of ETC on Motor Carriers' Costs.

Motor carriers were then asked to rate their agreement with the statement, “The cost associated with our participation in ETC outweigh any savings”. The responses are shown in Figure 3-46, which shows that 47 percent disagreed with this statement – 29 percent strongly disagreed. Additionally, 27 percent agreed, and 20 percent were neutral.

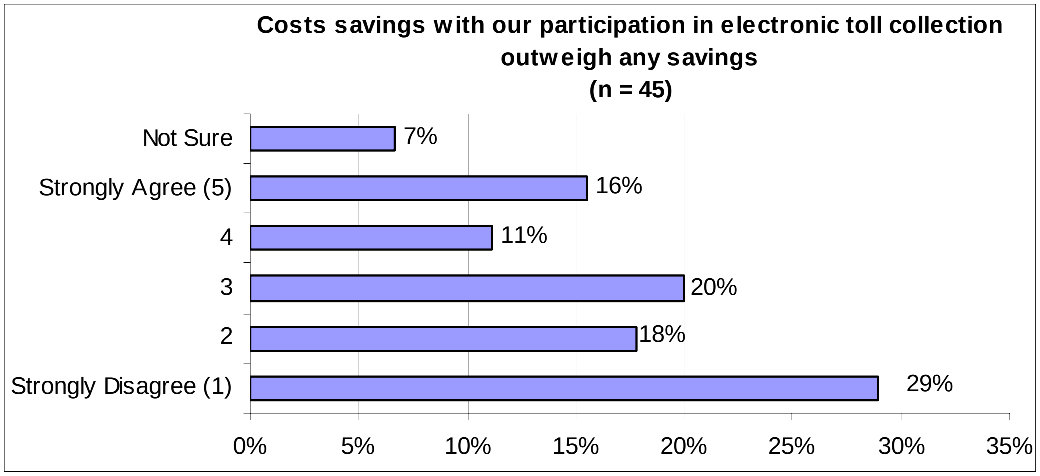


Figure 3-46. Motor Carriers’ Perception of Cost Savings Versus Benefits of ETC.

With the introduction of ETC in Maryland, came the reduction in toll discounts, as well as more stringent criteria for obtaining the discounts. Motor carriers were asked to indicate how these changes had impacted their company’s costs. The results are shown in Table 3-33, with the majority (70 percent) reporting that, while they still qualify for toll discounts, their discounts are lower – 39 percent reported that their discounts are much lower than before. Additionally, 6 percent reported that they no longer qualify for discounts, and 4 percent reported that they *don’t travel on toll roads enough to qualify for discounts now*. Just 19 percent reported that the changes had no impacted their costs.

Table 3-33. Impact of Reduction in Toll Discounts on Motor Carriers’ Costs

In what ways has the reduction in toll discounts with E-ZPass impacted your company’s costs? (n=54)	
Our maximum discount is now a little lower.	31%
Our maximum discount is now much lower.	39%
We’re a small company and no longer quality for discounts.	6%
We don’t travel on tolls roads enough to qualify for discounts now.	4%
Other.	9%
It has not impacted costs.	19%

Motor carriers were also asked to rate how these changes had impacted their level of satisfaction with ETC. The results are shown in Figure 3-47, which shows that 28 percent of motor carriers reported that they were dissatisfied with the new eligibility criteria for obtaining toll discounts. Additionally, 28 percent were neutral, and 38 percent were satisfied.

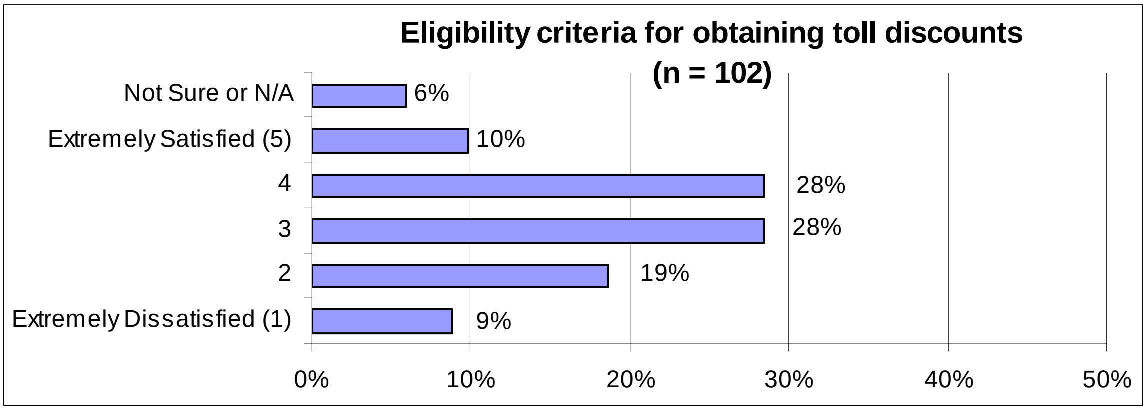


Figure 3-47. Motor Carriers' Satisfaction with Eligibility Criteria for Obtaining Toll Discounts Under E-ZPass.

Motor carriers were asked to rate their level of satisfaction with the cost of using ETC. Figure 3-48 shows that 44 percent of motor carriers were satisfied with the cost of using ETC, and 31 percent were neutral. For the responding motor carriers, 20 percent reported that they were dissatisfied with the cost of using ETC.

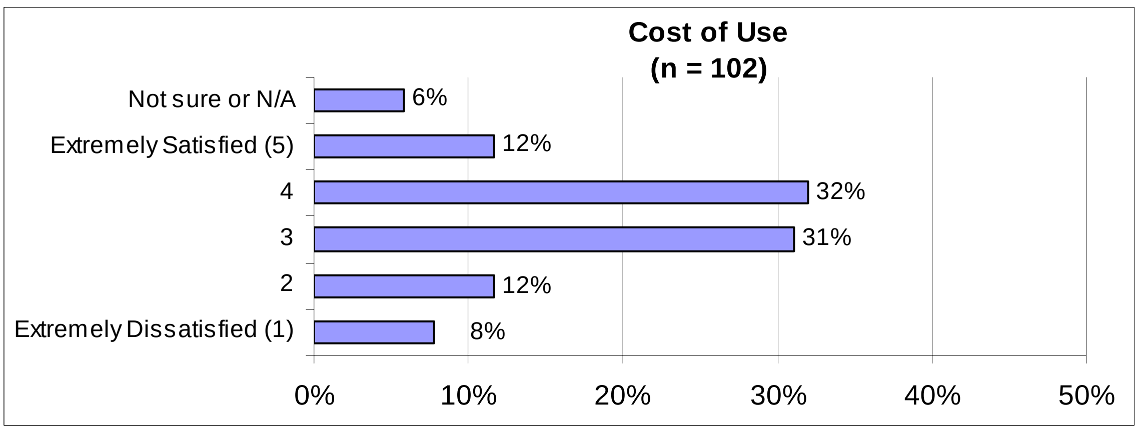


Figure 3-48. Motor Carriers' Satisfaction with Cost of ETC.

3.6.2.5 Questions Related to E-ZPass Customer Service

Of the 102 motor carriers enrolled in E-ZPass, 59 percent reported that they had contacted E-ZPass customer service. Figure 3-49 shows the frequency with which the motor carriers reported that they contacted E-ZPass customer service. The majority (66 percent) reported that they contacted E-ZPass' customer service a few times a year or less.

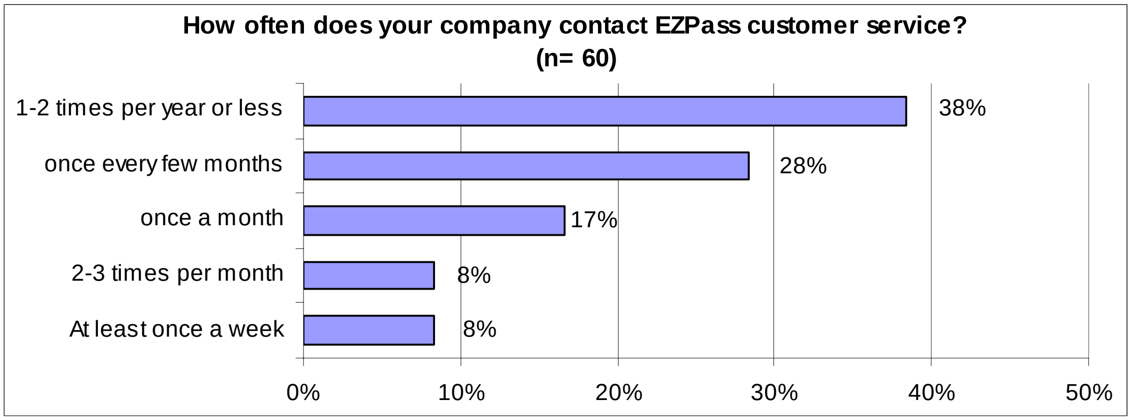


Figure 3-49. Frequency with Which Motor Carriers Contact E-ZPass Customer Service.

Motor carriers were then asked to rate their level of agreement with two questions related to E-ZPass customer service:

> "*We have success contacting E-ZPass customer service.*"
>
> *"The quality of the information received from E-ZPass customer service is good."*

Motor carriers' responses are shown in Figure 3-50. The majority of those who had used E-ZPass customer service agreed with the statements, and about 22 percent were neutral. About 20 percent of those motor carriers who had experience with E-ZPass customer service disagreed that they had been successful contacting the service or that the information received was good.

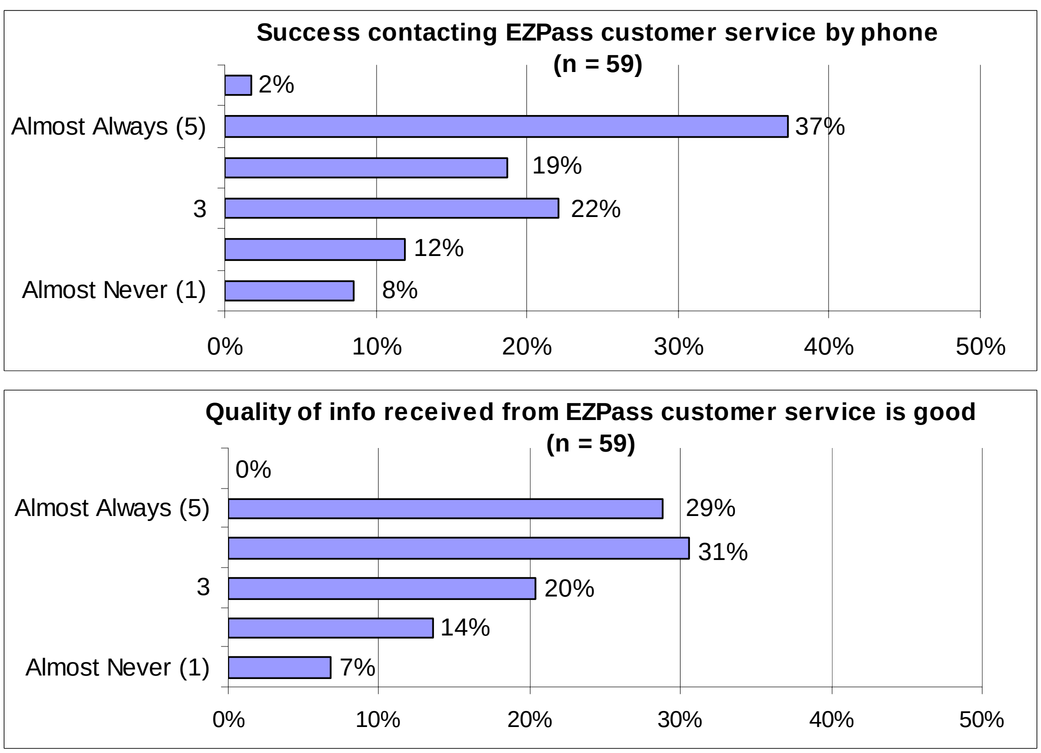


Figure 3-50. Motor Carriers' Ratings of E-ZPass Customer Service.

Motor carriers were asked to rate their level of satisfaction with their ability to reach E-ZPass customer service and the information received from customer service. The satisfaction ratings are shown in Figure 3-51, which shows that 45 percent were satisfied with their ability to reach customer service, 53 percent were satisfied with the information received, and 37 percent were neutral. Overall, 19 percent were dissatisfied with their ability to reach customer service, and 20 percent were dissatisfied with the information received.

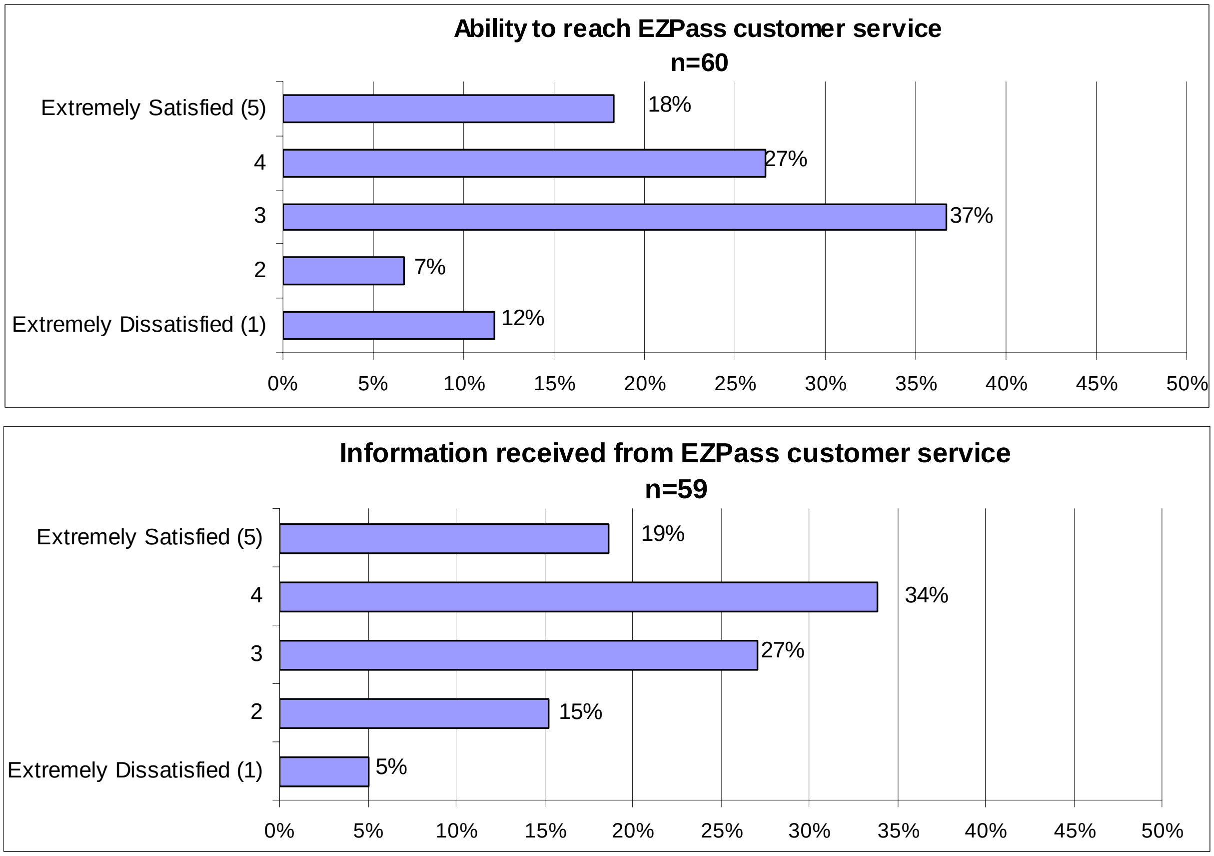


Figure 3-51. Motor Carriers' Satisfaction with E-ZPass Customer Service.

3.6.3 Survey Results for E-Screening

Sections 3.6.3.1 through 3.6.3.7 present E-screening survey results regarding related use and acceptance, promotion and registration, mobility benefits, safety benefits, operational benefits, cost benefits, and interoperability.

3.6.3.1 Questions Related to Use and Acceptance

Of the 140 motor carriers responding to the survey, 15 (11 percent) reported that they were enrolled in E-screening in Maryland. These 15 motor carriers were asked to indicate how they learned about the Maryland E-Screening Program, and the responses are shown in Figure 3-52. The majority of the motor carriers (10) learned about the Maryland E-Screening Program through the state trucking association.

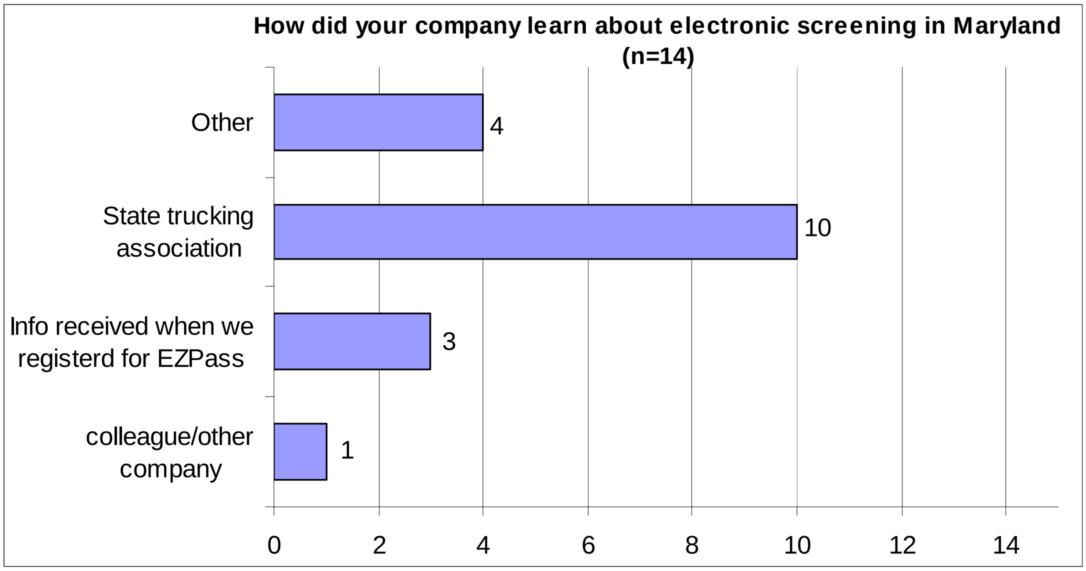


Figure 3-52. How Motor Carriers Learned about E-Screening.

Next, the motor carriers were asked to rate the level of influence a number of factors had on their decision to participate in E-screening. The results are shown in Figure 3-53. The two most influential factors in deciding to participate were that participation could improve operational efficiency and that participation could decrease stops/delays at weigh stations. It appears that increasing overall safety compliance was an influential factor for fewer of the motor carriers than were the operational factors.

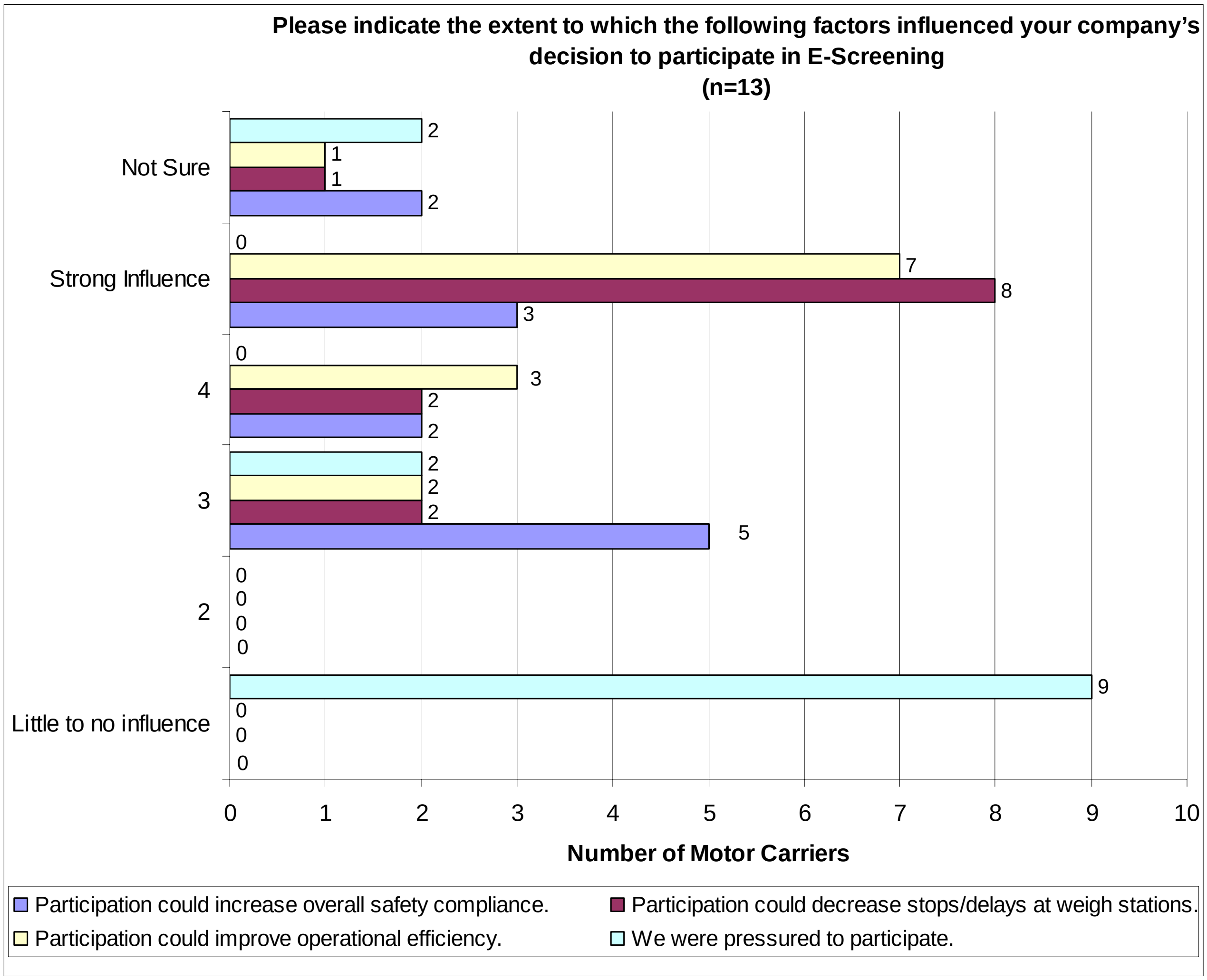


Figure 3-53. Factors That Influenced the Decision to Participate in E-Screening.

Motor carriers were asked to rate their level of satisfaction with their use of E-screening to this point. The results, shown in Figure 3-54, are varied. Three of the motor carriers reported they were satisfied (rating of 4) (none were *extremely satisfied*). Likewise, three of the motor carriers reported that they were dissatisfied (ratings of 1 or 2). Two of the motor carriers were neutral, and three were unsure.

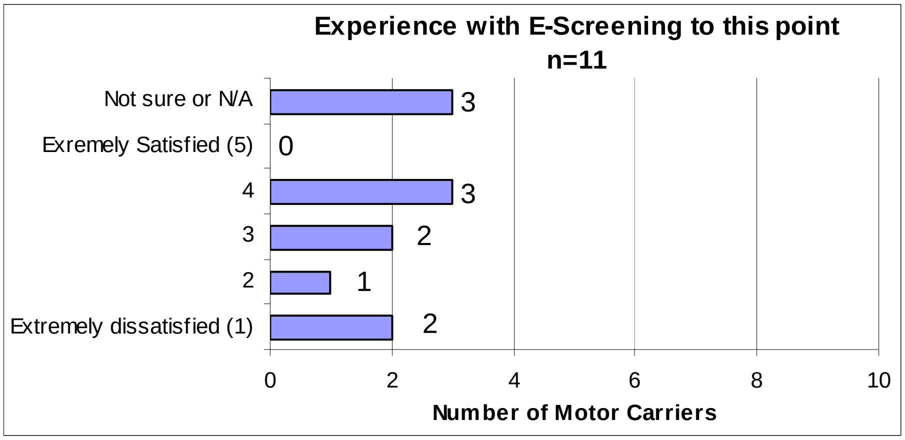


Figure 3-54. Motor Carriers' Satisfaction with E-Screening.

Those motor carriers that reported that they were not enrolled in E-screening were asked to indicate why they were not enrolled. Of the 85 percent of motor carriers who responded that they were not enrolled in E-screening, the most commonly reported reason for not being enrolled was that they were not familiar with the technology. Table 3-34 shows the other reasons that motor carriers reported for not being enrolled in E-screening. The other commonly reported reason for not participating was that they *did not pass inspection facilities in Maryland often enough to enroll*.

Table 3-34. Reasons Motor Carriers Do Not Participate in ETC

Reason Motor Carriers Are Not Enrolled in ETC	Percentage (n=123)
We aren't familiar with E-screening.	50%
We are familiar with it, but we weren't aware of the program in Maryland.	10%
We are aware of the Maryland program, but don't know how/where to register.	2%
It's too difficult to register.	2%
We don't pass inspection facilities in Maryland often enough to enroll.	28%
We would not receive as many bypasses as other carriers due to the loads we haul.	6%
Availability at few locations along I-95 is not a strong incentive to enroll.	7%
E-screening simply does not offer enough benefits.	7%
Other.	5%

These motor carriers not enrolled in Maryland E-screening were asked to rate their level of agreement with the statement, "If E-screening were available on more routes that we frequently run, we would participate". The results are shown in Figure 3-55. The most common response was *not sure*. Of the respondents, 38 percent did agree with the statement – 23 percent reported that they *strongly agree*. Only 16 percent reported that the disagreed that they would participation if E-screening were available on more routes.

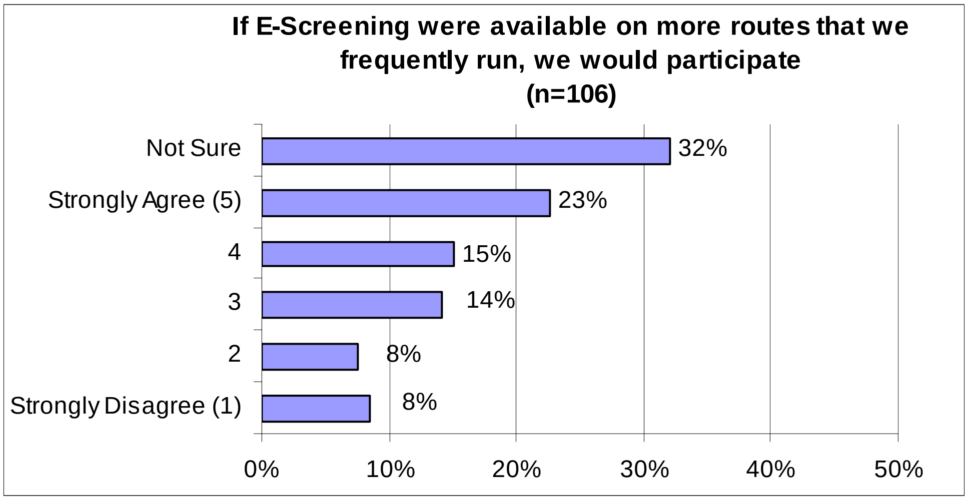


Figure 3-55. Motor Carriers' Perceptions About Use of E-Screening.

Motor carriers were also asked to indicate other E-screening programs in which they are enrolled. Table 3-35 shows that of the motor carriers enrolled in Maryland E-screening, five were also registered in other E-screening programs such as PrePass and NORPASS. In addition, 14 of the motor carriers not enrolled in Maryland E-screening were enrolled in other programs. This result shows that E-screening has not yet achieved much market penetration.

Table 3-35. Other E-Screening Programs of Motor Carriers Not Registered in Maryland

Other E-screening Programs	Number of Motor Carriers Registered in Maryland that are Registered in Other Programs	Number of Motor Carriers Not Registered in Maryland that are Registered in Other Programs
PrePass	1	4
NORPASS	2	0
Other	1	6
PrePass & NORPASS	1	2
PrePass & Other	0	1
PrePass, NORPASS, & Other	0	1
Not registered in any other program	9	101
TOTAL	14	115

3.6.3.2 Questions Related to Promotion and Registration

Those motor carriers enrolled in Maryland E-screening were asked to rate their satisfaction with the following:

- Public promotion of the program.
- Ease of determining how to register.
- User friendliness of online registration.
- Reliability of online registration.

The results are shown in Figure 3-56 through Figure 3-59. Motor carriers' satisfaction ratings with the public promotion of the program varied (see Figure 3-56); however, none was *extremely dissatisfied*. Motor carriers tended to be neutral (rating of 3) or *not sure*. These results may be because the motor carriers were not aware of any promotion other than what they had learned from the state trucking association.

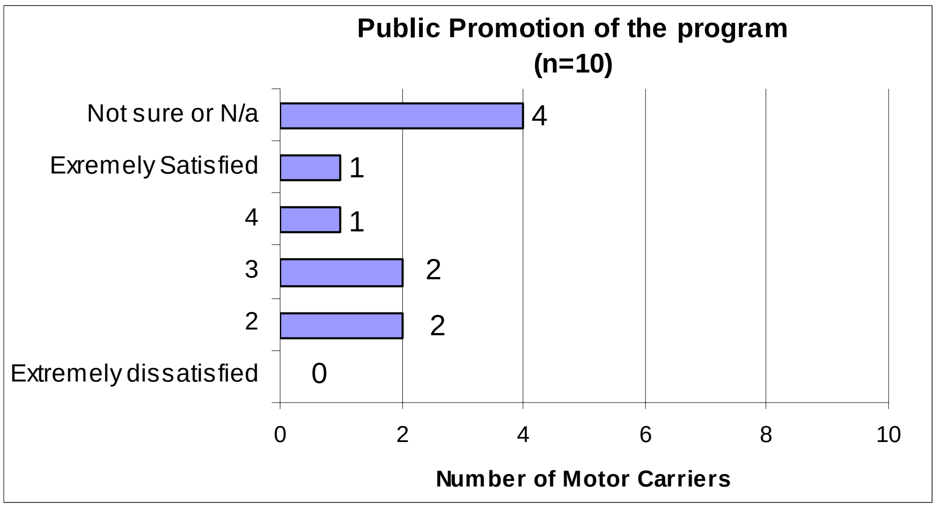


Figure 3-56. Motor Carriers' Satisfaction with Public Promotion of Maryland E-Screening.

Regarding satisfaction with registration, the majority of the motor carriers were *not sure* of their satisfaction with the ease of determining how to register, the user friendliness of the online registration, and the reliability of the online registration (see Figure 3-57, Figure 3-58, and Figure 3-59. The remaining motor carriers' satisfaction ratings varied from *extremely satisfied* to *extremely dissatisfied*.

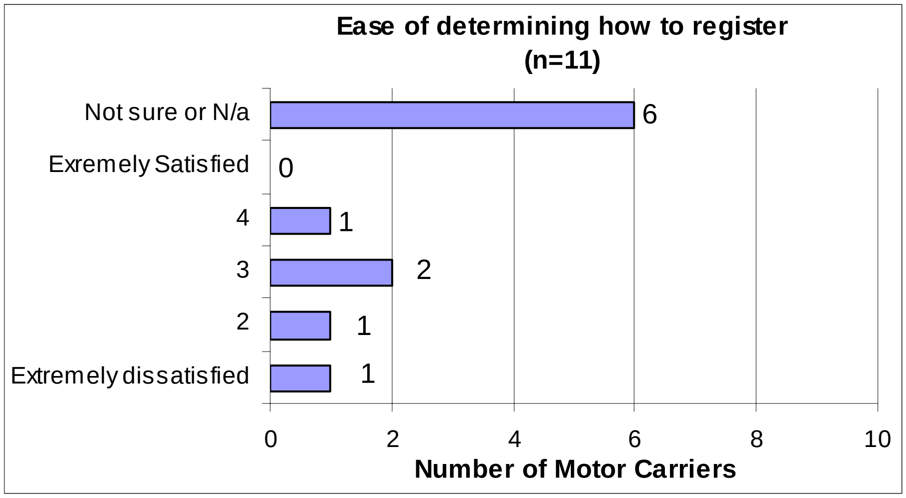


Figure 3-57. Motor Carriers' Satisfaction with the Ease of Determining How to Register for E-Screening in Maryland.

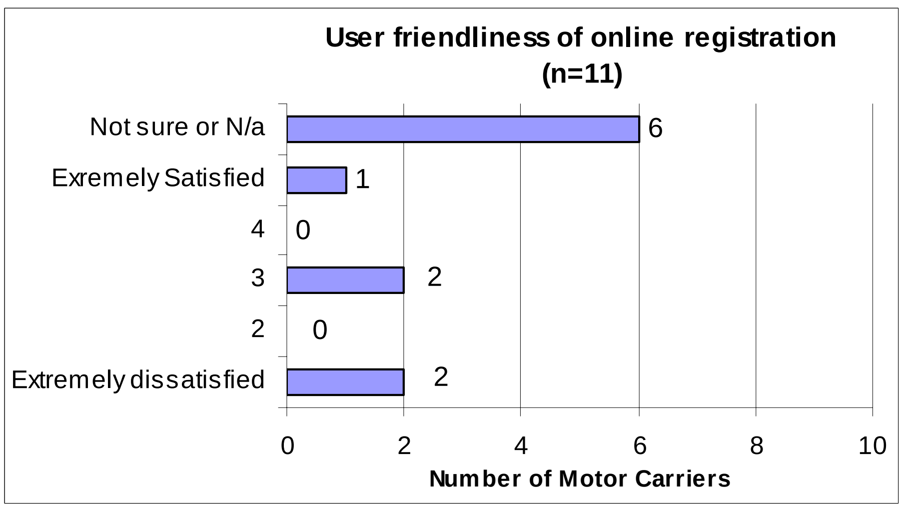


Figure 3-58. Motor Carriers' Satisfaction with User Friendliness of Online Registration.

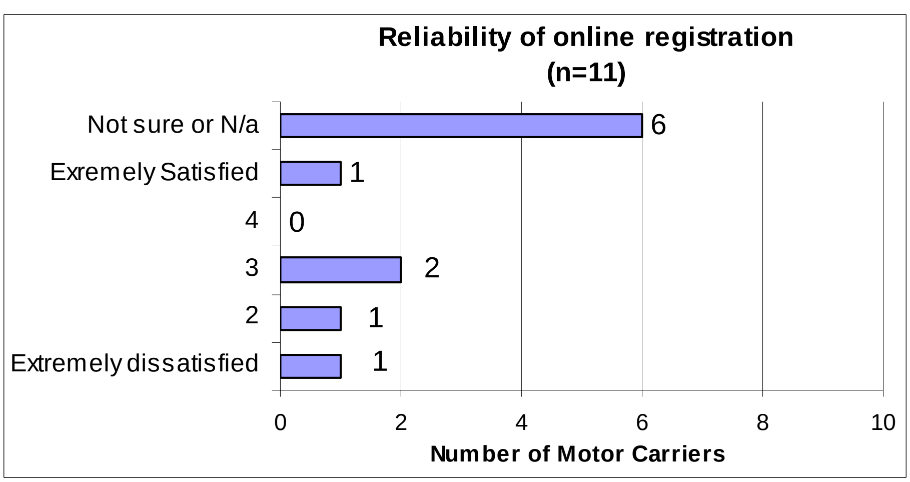


Figure 3-59. Motor Carriers' Satisfaction with Online Registration.

3.6.3.3 Questions Related to Mobility Benefits

Motor carriers participating in Maryland E-screening were asked a few of questions about the mobility benefits of participation. First, they were asked to indicate how often each of their drivers received green light bypasses at the weigh stations with E-screening. These results are shown in Figure 3-60. The majority of the motor carriers (8 out of 13) were unsure of this statistic. Of the remaining five motor carriers, most (three) reported that *they've never received a bypass*. One motor carrier reported that their drivers received a bypass *4 – 6 times out of 10,* and one motor carrier reported that their drivers received a bypass *7 or more times out of 10*. Next, the motor carriers who had received a bypass were asked to indicate the impacts of the bypasses on travel times. Of the two motor carriers who reported that their drivers had received bypasses, both reported that it had reduced their travel times by *11 to 20 percent*.

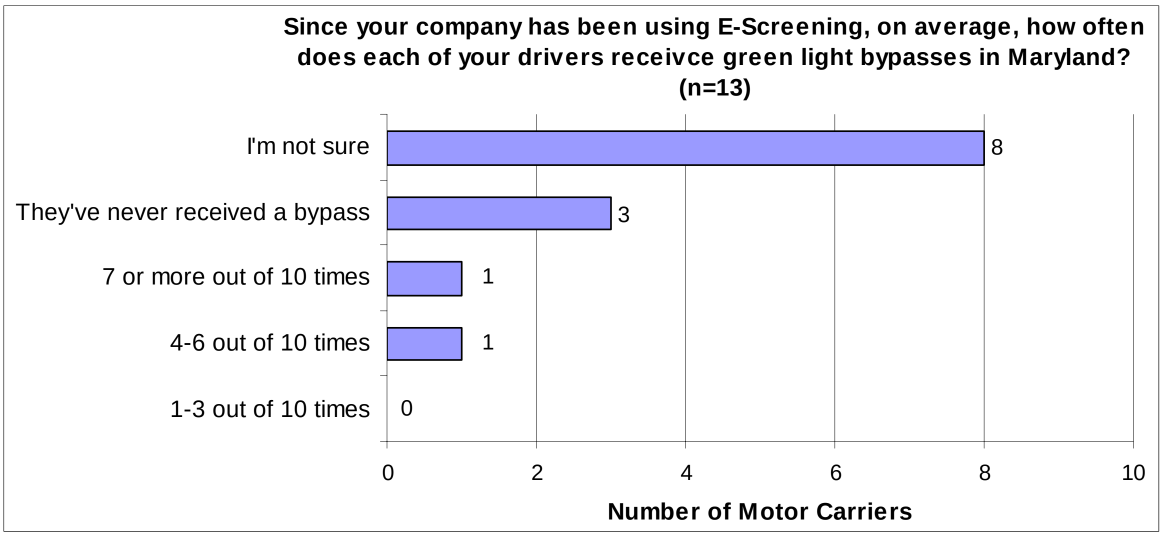


Figure 3-60. Frequency With Which Drivers Receive E-Screening Bypasses.

Finally, motor carriers were asked to rate their level of satisfaction with the travel time savings benefit of E-screening. Figure 3-61 shows the responses, where half of the motor carriers reported as neutral (rating of 3), two were satisfied, and one was extremely dissatisfied. Two of the motor carriers reported that they were *not sure*.

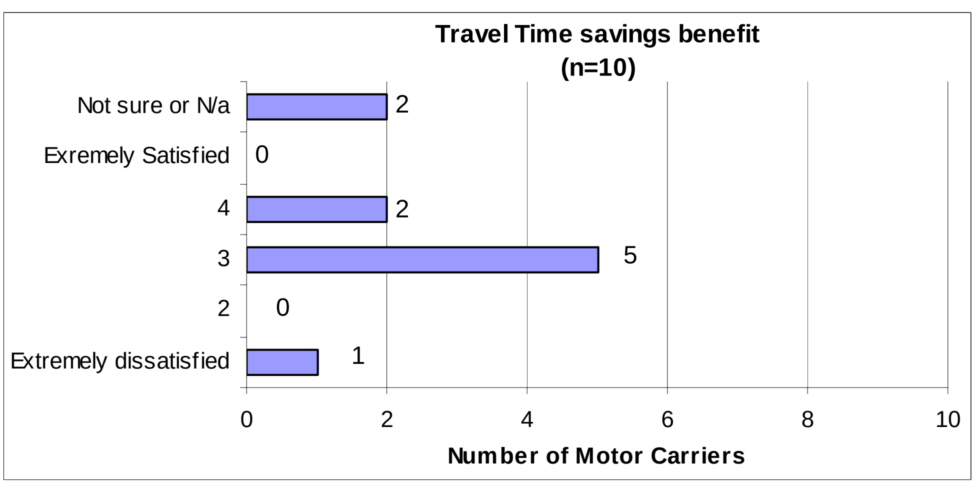


Figure 3-61. Motor Carriers' Satisfaction with the Travel Time Savings of E-Screening.

3.6.3.4 Questions Related to Safety Benefits

Next, motor carriers were asked to rate their level of agreement with a series of statements related to the safety benefits of E-screening. The ratings are shown in Figure 3-62, which shows that the majority of the motor carriers (seven) agreed that *“electronic screening will improve overall motor carrier safety by focusing enforcement of trucking companies that aren’t compliant”.* Only three motor carriers disagreed with this statement.

While more motor carriers agreed than disagreed that the benefits that E-screening offers encourage their company to maintain compliance in order to participate, the most common response (by four motor carriers) was neutral. Likewise, while more motor carriers agreed than disagreed that one drawback to E-screening is that unsafe drivers, who work for reputable companies, will not be adequately identified, the most common response (by five motor carriers) was neutral. This was a concern identified by enforcement officials in the focus groups. Finally, half of the motor carriers disagreed that *“there are no safety benefits of E-screening”* – four reported that they *strongly disagreed*.

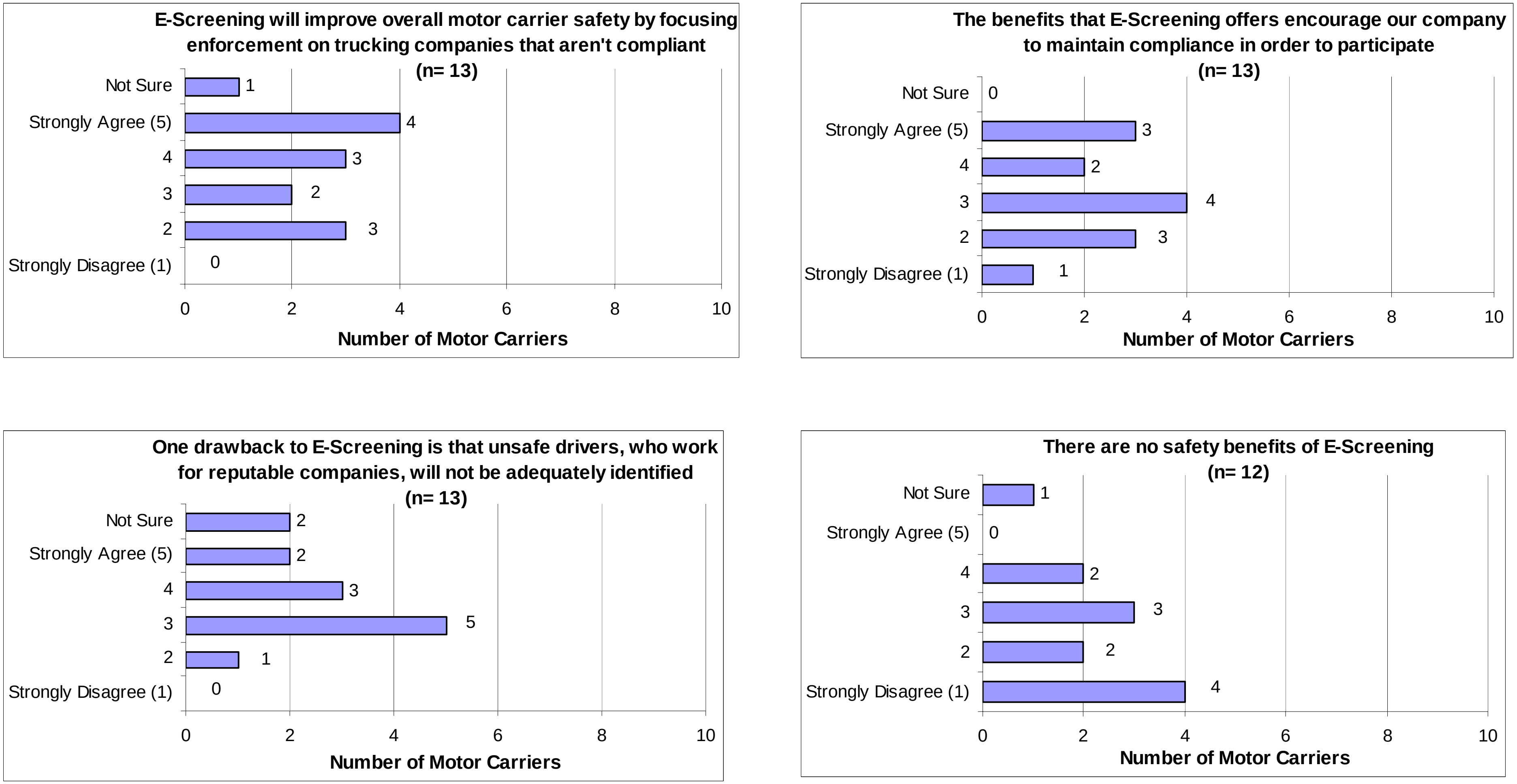


Figure 3-62. Motor Carriers' Perceptions of the Safety Benefits of E-Screening.

3.6.3.5 Questions Related to Operational Benefits

Motor carriers participating in Maryland E-screening were asked their perceptions of the concept and operation of E-screening and to indicate what impacts it had on their operational efficiency. Figure 3-63 illustrates that five of the motor carriers reported that *both the concept and operation of E-screening are* good. Six of the motor carriers reported that *the concept of E-screening is good, but the current operation needs improvement*. None of the motor carriers reported that *neither the concept nor the current operation of E-screening is good.* Three of the motor carriers were *not sure*.

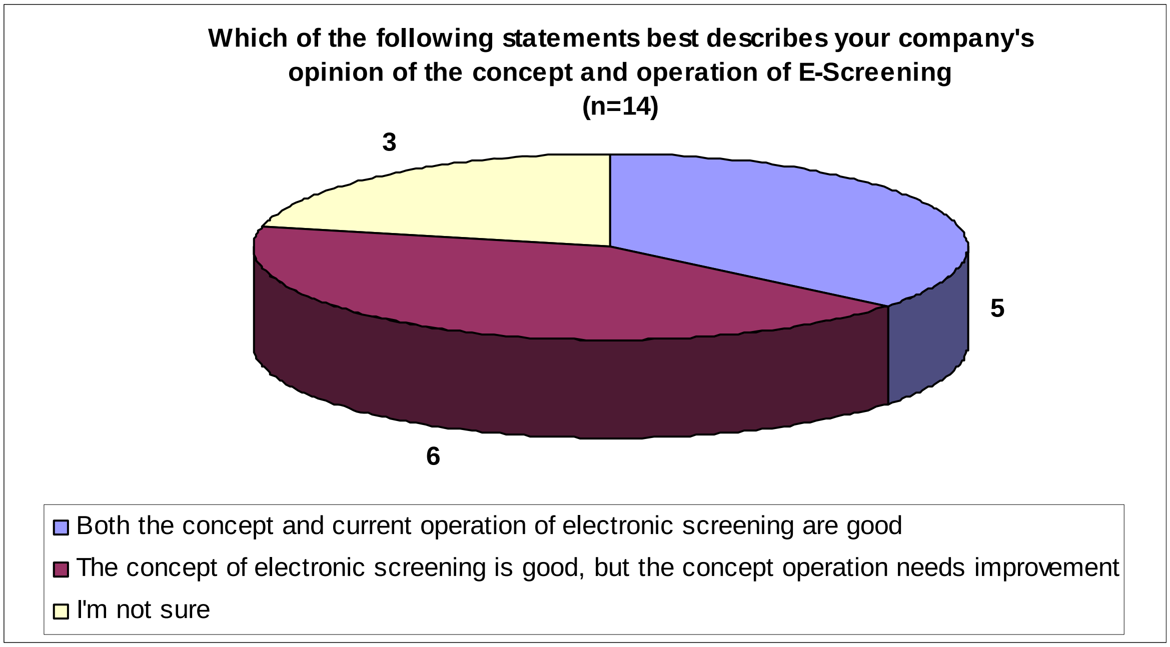


Figure 3-63. Motor Carriers' Perceptions of the Concept and Operation of E-Screening.

When asked what impacts E-screening had had on their operational efficiency, seven of the motor carriers reported that it had somewhat improved their operational efficiency (see Figure 3-64). Two motor carriers reported that E-screening had significantly improved their operational efficiency, and four reported that E-screening had in no way impacted their operational efficiency.

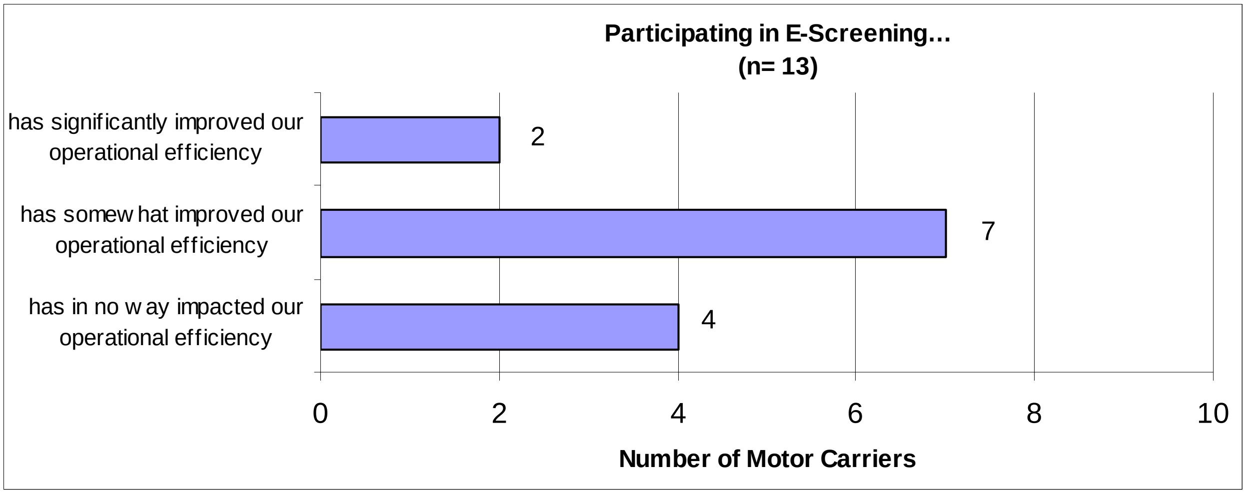


Figure 3-64. Motor Carriers' Perceptions of the Impacts of E-Screening on Operational Efficiency.

A few of the motor carriers offered ways in which their operational efficiency had improved as a result of E-screening. Their responses were as follows:

- Less time on the side of the road.
- Accounting.
- Less stops at weigh stations.
- Fuel and time savings in an overall situation has been a great benefit to our company.

3.6.3.6 Questions Related to Cost Benefits

Finally, motor carriers were asked about the impact of E-screening on their costs. Only six of the motor carriers participating in the Maryland E-Screening Program indicated that the program had impacted their costs, either positively or negatively. The reported impacts are shown in Figure 3-65. Three motor carriers each reported a *1 – 10 percent decrease* in travel times and fuel usage. One motor carrier reported an *11 – 20 percent decrease* in travel times, while two others reported a *1 – 10 percent increase* in travel times as a result of E-screening. Two motor carriers reported *no impact* of E-screening on fuel usage, and one other reported a *1 – 10 percent increase*. One other motor carrier reported that their accounting costs had been *decreased by 1 – 10 percent*.

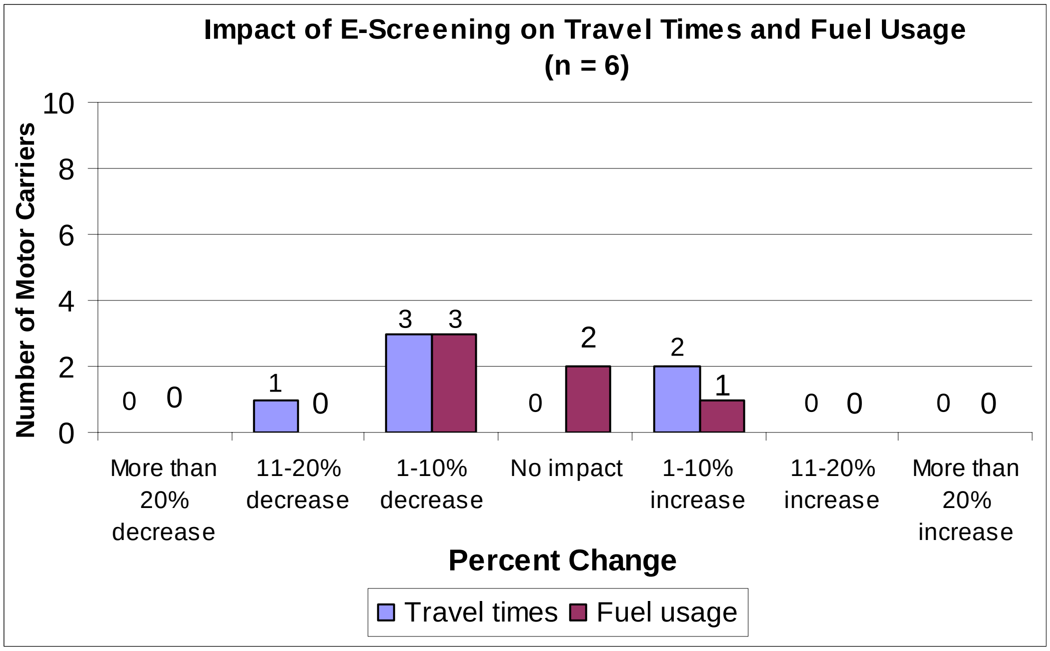


Figure 3-65. Impacts of E-Screening on Costs.

The six motor carriers who indicated an impact of E-screening on costs were asked to indicate how strongly they agreed with the following statement, "The costs associated with our participation in E-screening outweigh the savings/benefits."

The results are shown in Figure 3-66. Five of the six motor carriers disagreed with this statement, indicating that the savings/benefits did outweigh the cost of their participation in E-screening. Only one of the motor carriers reported that they agreed with the statement.

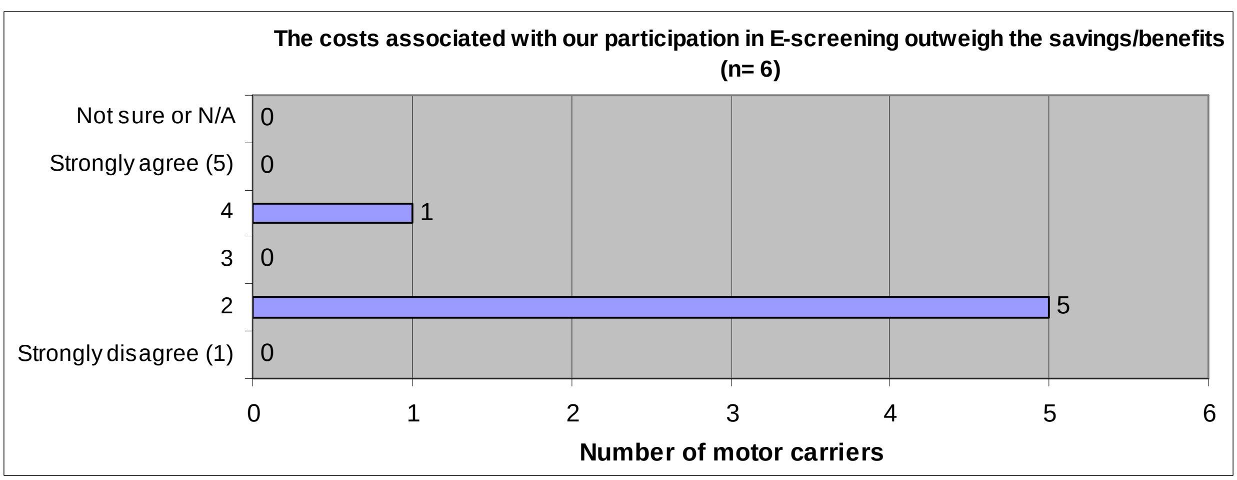


Figure 3-66. Motor Carriers' Perceptions of the Costs Versus the Savings/Benefits of Participating in E-Screening.

Motor carriers were asked to rate their level of satisfaction with the cost of using E-screening. The satisfaction ratings are shown in Figure 3-67. Half of the motor carriers were neutral about their satisfaction with the cost of using E-screening, two were satisfied (rating of 4), one was extremely dissatisfied, and two were not sure.

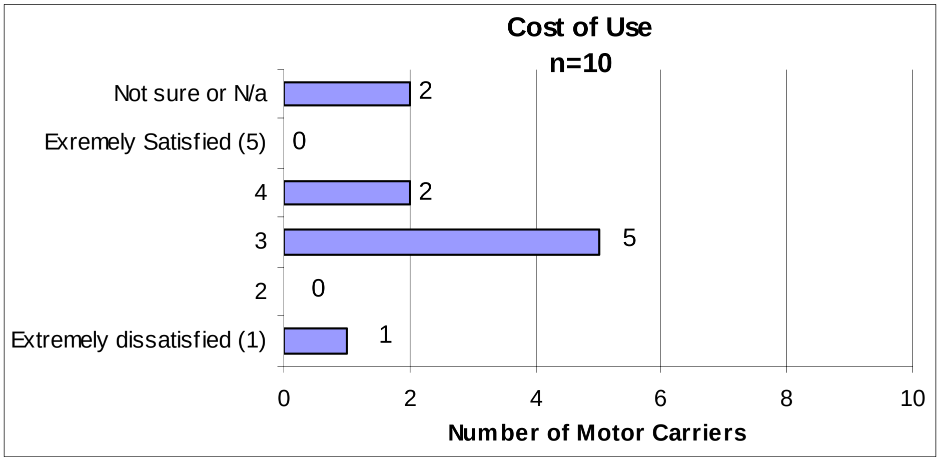


Figure 3-67. Motor Carriers' Satisfaction with Cost of Using E-Screening.

3.6.3.7 Questions Related to Interoperability

Motor carriers were asked a question about the interoperability of E-screening programs. They were asked to rate their level of agreement with the statement, "E-screening would be a success if we had one transponder for all weigh stations nationwide". The responses are shown in Figure 3-68, which shows that majority (55 percent) agreed with this statement – 41 percent *strongly agreed*. In fact, only 5 percent of the motor carriers disagreed with it, 8 percent were neutral, and 33 percent reported that they were *not sure*.

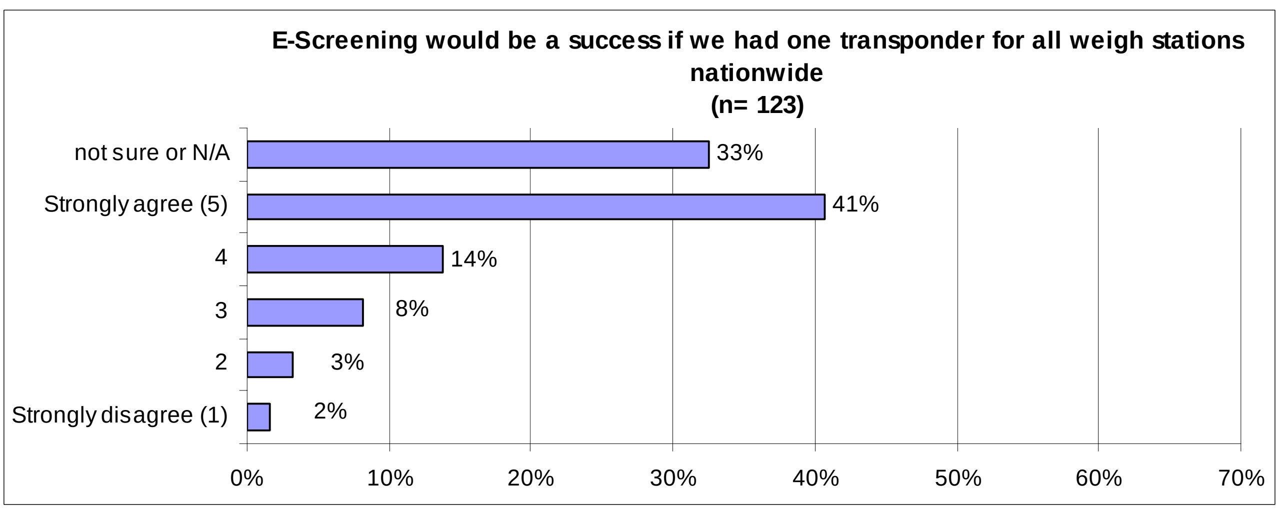


Figure 3-68. Motor Carriers' Perceptions About One E-Screening Transponder Nationwide.

Motor carriers were also asked a question about the interoperability transponders for ETC and E-screening. They were asked to rate their level of agreement with the statement, "The concept of a transponder for ETC and E-screening is good". The responses are shown in Figure 3-68 and are very similar to the results of the previous question about the interoperability of E-screening programs. Figure 3-69 shows that the majority (54 percent) agreed with this statement – 34 percent *strongly agreed*. Only 5 percent of the motor carriers disagreed with it, 8 percent were neutral, and 32 percent reported that they were *not sure*. These results indicate that, while about a third of the motor carriers are unsure of the prospects of interoperability, over half agree that interoperability of transponders and E-screening programs could be beneficial.

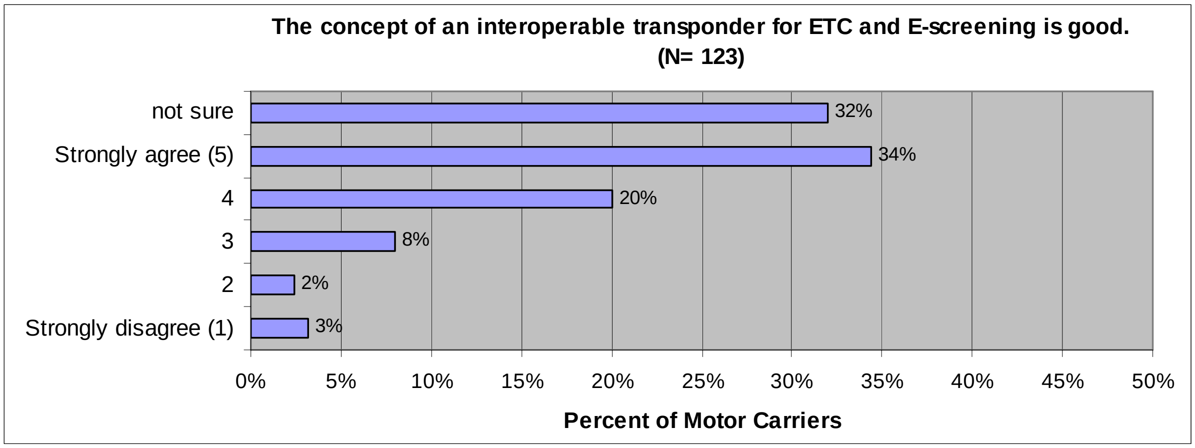


Figure 3-69. Motor Carriers' Perceptions of the Costs Versus the Savings/Benefits of Participating in E-Screening.

3.7 POST-DEPLOYMENT ENFORCEMENT FOCUS GROUP

A post-deployment focus group was conducted with the MdTA Police on October 14, 2004, to obtain their views on the performance of the ETC/E-Screening Interoperability Pilot Project. Participants included uniformed police, commercial vehicle inspectors, a representative from the Information Technology (IT) Department, and a representative from the technical staff responsible for system maintenance and operation.

A baseline focus group that included the MSP was conducted in April 2003. The MSP were not included in the post-deployment focus group due to the fact no MSP-operated weigh station has yet deployed electronic screening.

The focus group was conducted by first having participants discuss a series of questions. Following this, the results of the baseline focus group were distributed for review and comment. All comments offered by participants were recorded on a flipchart and electronically using a laptop computer.

The discussion questions posed to the focus group participants were developed to gather input on the key evaluation test areas, as follows:

- **Safety** – From their experience using the technology for over a year now, are the impacts of E-screening consistent with the goals of maintaining/increasing highway safety? Why or why not?
- **Mobility** – Has E-screening helped reduce queues/delays/congestion at the weigh station (Do they have to close the facility less frequently now than before they had the technology)?
- **Operational Efficiency** – How has E-screening impacted their ability to do their job/duties? Has it made their job/operations easier or has it complicated things?
- **Cost** – Have the costs of procuring/maintaining the technology impacted operations, staffing, etc? (For example, have they had to cut back in other areas to make room for the technology? if so, what impact might this have on safety?)
- **Industry Acceptance and Use** – Do they use/have they accepted the technology as part of their job/duties (or do they continue to fight it?).

- **System Design, Implementation, and Operation** – What could be changed about the technology (in terms of design, implementation, and/or operation) to better integrate it into their duties/processes?

The focus group participants identified two key findings:

- The E-screening system deployed for the Pilot Project demonstrated that electronic screening is technically feasible. The system did generate electronic bypasses (green lights) and random pull-in messages (red lights) to carriers participating in the Maryland electronic screening program.
- The system, however, has not proven reliable. MdTA staff had problems keeping the system operational and at present are not conducting electronic screening.

The focus group participants identified a number of issues related to system reliability and operations:

- The electronic screening system was not integrated into the daily work activities of the MdTA staff at the Perryville weigh station. This raised the following operational and maintenance challenges:
  - The system was not integrated with other weigh station IT systems, and operated as a stand-alone system. As a result, operations and maintenance support was not included in the MdTA budget, and support was provided at the expense of support to other IT systems. No funds and staff resources have been allocated specifically for the support of the electronic screening system.
  - Since the E-screening system was deployed as a stand-alone system, no one agency was assigned responsibility for system operations and maintenance. As a result, many operational issues were not addressed proactively until a determination was made as to who was responsible for providing support, the vendor supporting the project or the MdTA staff.
- The focus group participants also identified additional technical challenges associated with the project:
  - The E-screening hardware has not worked to specification. The ramp AVI system and the mainline WIM were both not operational at the time of the focus group, and the focus group participants stated that the WIM computer had been down since July 2004 and would now need to be replaced.
  - The hardware used to support the electronic screening system is aging, and obtaining spare parts is a problem, as several components are no longer being manufactured.
  - There is no software and data backup. This lack of system redundancy has caused problems when the system has crashed.
  - The Perryville facility is subject to frequent electricity voltage fluctuations, which cause problems for the system. Protection and safeguards against such fluctuations need to be built into the system.
  - The software supporting the system does not work consistently. The ramp screening software, which is designed to send information to the ROC, has a tendency to generate error statements and close itself out.
  - The ROC installed with the initial screening system lacked adequate security protection. Data exchange was being done via modem and did not have adequate firewall

protection. A virtual private network (VPN) client has since been installed to address this issue.

Additional issues raised by focus group participants included:

- A key problem has been the location of the computers supporting the system in the scale house. At present, these are located on a table that is not adjacent to the work stations used by weigh station personnel to monitor the sorter ramp and the static scales. As a result, the staff does not use the system, as it is neither supports nor is integrated into their existing work activities.
- The Maryland Commercial Vehicle Information Exchange Window (CVIEW) appears to be working, as information is downloaded in snapshot format and provides the necessary information on a motor carrier. However, at present, the fields providing information on the International Registration Form (IRP) and International Fuel Tax Agreement (IFTA) are not being populated, and it is not possible to check for credentials and fuel tax.
- The scale house staff is not able to determine if a red light has been issued, as no alarm or other warning is provided. This information is posted on the computers supporting electronic screening, and unless the staff visually checks the computers, there is no way to determine if a red light has been issued.
- At present, the screening software and the sign directions at the weigh station are not coordinated. A truck may receive a red light, pull into the weigh station and pass over the WIM on the sorter ramp, and then be directed back onto I-95 by the overhead signs on the sorter ramp even though the truck received a red light. There is no sign indicating that a truck receiving a red light should continue to the static scale, and the screening system is not integrated into the message generating software so that the overhead sign messages can be overridden for trucks operating with transponders.
- All transponder-equipped trucks are being read, even trucks with transponders not enrolled in the Maryland system.
- Weigh station personnel do not have any way to identify a truck that receives a red light but does not pull into the weigh station in compliance with the red light. The system does not enable personnel to track if the truck in question enters the weigh station or continues on the mainline.

The MdTA personnel did offer a number of recommendations for consideration by any agency or state considering the deployment of electronic screening:

- All maintenance and operations requirements, both funding and staff, need to be identified and included in agency budgets.
- Screening systems should not be developed as site-specific systems. The core software needed to support screening systems should be developed as a module that could be used to support electronic screening at multiple locations.
- The system hardware should be designed so that equipment maintenance upgrades incorporating technology improvements can be done without causing major problems with system operation.
- The system reliability problems were such that the focus group participants were not able to provide significant input to the six discussion questions posed to start the focus group. The participants also noted that many of the issues identified in the April 2003 focus group had not yet been addressed.

3.8 CONCLUSIONS

Based on the focus groups and surveys conducted as part of this customer satisfaction evaluation, the following conclusions were compiled for ETC and E-screening, respectively.

3.8.1 ETC Conclusions:

- Motor carriers tend to like ETC.
- 73 percent are enrolled.
- 68 percent disagreed that they preferred their old system of payment.
- 63 percent were satisfied with their experience with ETC.
- ETC has positive impacts on travel times through toll facilities.
- 47 percent reported decreases in travel times of 1 – 10 percent.
- 42 percent reported decreases in travel times of more than 10 percent.
- 59 percent of motor carriers are satisfied with the travel time benefits associated with ETC.
- ETC has positive impacts on operations.
- 58 percent indicated that ETC has had positive impacts on their operations.
- 60 percent were satisfied with the impacts of ETC on operational efficiency.
- ETC, as compared to previous non-cash methods of toll payment (e.g., ticket books) has had both positive and negative impacts on costs.
- 28 percent of motor carriers reported decreases in fuel usage, while 53 percent reported no impact on fuel usage.
- 42 percent of motor carriers reported decreases in time/cost of maintaining accounts, while 41 percent reported increases.
- 35 percent of motor carriers reported decreases in time/cost of record keeping, while 43 percent reported increases.
- 47 percent of motor carriers disagreed that the costs of participating in ETC outweighed any savings (27 percent agreed).
- Perceptions of overall impact on costs are divided.
- 38 percent of motor carriers were satisfied with the eligibility criteria for obtaining toll discounts, and 28 percent are dissatisfied.
- 44 percent of motor carriers were satisfied with the costs of using ETC, and 20 percent are dissatisfied (31 percent are neutral).

3.8.2 E-Screening Conclusions:

NOTE

> There is not enough market penetration of E-screening in Maryland to assess motor carriers' perceptions of the technology.

- The general trend of those that use the technology tend to be divided on their perceptions of the benefits of it.
- Those that do not use it tend to agree that they would enroll if E-screening were available on more routes that they run frequently.
- Enforcement officials in Maryland are not accepting of the E-screening technology:
  - They feel it will have adverse long-term impacts on safety.

- It has not been well introduced into their work environment.
- It has not functioned well.

3.9 INSTITUTIONAL AND TECHNICAL EFFECTIVENESS LESSONS LEARNED

This section of the report presents the institutional and technical challenges identified during the evaluation and lessons learned. This section is intended to present only those issues not previously discussed in the Customer Satisfaction test. Institutional challenges were identified and documented via the following methods:

- **Stakeholder Interviews** – The primary information source for identifying issues and the processes by which they were resolved was accomplished through interviews with project stakeholders on a “Before” and “After” basis.
- **Document Review** – Interviews were supplemented by reviewing selected documents (meeting minutes, correspondence, and project reports) generated through project activities. Document reviews, in particular meeting minutes, were used to document the processes by which institutional challenges were resolved.
- **Stakeholder Surveys** – To the extent feasible, information was obtained through stakeholder surveys. The primary objective of obtaining information through surveys was to gauge stakeholder satisfaction with how a particular challenge was or was not resolved. In addition, surveys were used to gauge how well the stakeholders felt their views or concerns were incorporated into the process by which an issue was addressed.

Overall, the pilot project has successfully demonstrated that interoperability is both technical and institutionally feasible. The project management team has shown a highly flexible and adaptive approach to project management and made a number of mid-project adjustments to reflect changes in the business environment for ETC and E-screening. The project management team has also worked extremely well with the motor carrier industry and has demonstrated that partnerships with industry can be effectively established. Particular examples of this flexible management approach and the working relationship established with the industry include:

- **Mid-Term Project Scope Adjustments** – The mid-term project assessment and the revision to the Phase 2 and 3 scopes of work made by the Evaluation Team addressed several significant issues identified during project implementation. Based on changes in the business environment, the project team determined that the continued subsidy of the cost of the Mark IV Fusion transponders was not necessary. Rather, the most significant constraint facing the project was the lack of a single registration portal for both ETC and E-screening for motor carriers. Many motor carriers did not understand that enrolling in ETC and obtaining a Mark IV Fusion transponder did not automatically enroll them in E-screening and as a result did not enroll in the Maryland E-Screening Program.

  Recognizing this, the project management team made a decision to modify the original project scope and reallocate funds to develop an on-line E-screening enrollment process and explore the feasibility of developing a single enrollment portal that would include both ETC and E-screening.

  The decision to improve the E-screening enrollment process and to enable the ability of the program to accept enrollment from other programs represent major accomplishments for enhancing interoperability and encouraging motor carriers to enroll in the program. This type of flexible project management, and the willingness to make mid-project adjustments, is a management approach that is critical for the successful deployment of Intelligent Transportation Systems/Commercial Vehicle Operations (ITS/CVO technologies and systems.

- **NYSMTA and MMTA Super Accounts –** A policy change by the Inter-Agency Group (IAG) agencies that took place during the project allowed third party organizations to establish large scale or super accounts and serve a transponder administrator function. Both the NYSMTA and MMTA established Super Accounts, which have been highly successful in recruiting motor carriers to participate in ETC, and in creating a potential market for E-screening. Using these accounts has also helped smaller carriers and owner-operators who may not qualify for any discount under the ETC system to still obtain a discount by enrolling through each state association's Super Account, thus offsetting the potential elimination of a significant benefit (toll discounts) of the ETC program, as perceived by the motor carrier industry. In addition, these smaller carriers and owner-operators receive administrative support from each association for enrollment and accounting functions, a significant additional benefit to this segment of the motor carrier industry.
- **Working Relationship with NORPASS –** The establishment of a working relationship with the NORPASS program further expanded the reach of the pilot project and also demonstrated interoperability between E-screening programs.
- **Motor Carrier Outreach –** Initially, when motor carriers applied for E-ZPass accounts they were not provided with adequate information about the Maryland E-Screening Program and the option of obtaining a Mark IV Fusion transponder. Vendor representatives have since been provided with training and informational materials, and a more comprehensive marketing and outreach program has been established. To this end, the inclusion of the motor carrier industry, in particular the state trucking associations, in promoting the project has been of significant benefit. Outreach efforts have been targeted to association members as well as to E-ZPass account holders, and the industry has played an active role in promoting the program.

3.9.1 Connecticut E-Screening – Implementation Issues

Connecticut has not yet deployed an operational E-screening program, due to a number of challenges beyond the control of the Connecticut evaluation team. These have included state-wide budget reductions, which delayed the project startup, and technical challenges such as the State needing to replace all mast arms used on the highway system. The latter included the mast arms being used for the AVI readers at the Union weigh station. The institutional and technical challenges related to E-screening are from the Maryland deployment.

As was noted in the Customer Satisfaction section of the report, a policy change made by the IAG, while not directly related to the project, has had an impact on the project. The IAG agencies discontinued the use of the ticket books that motor carriers purchased in bulk to obtain a toll discount, thus requiring motor carriers to either enroll in ETC or pay cash. Motor carriers were also required to register for ETC in one state, a base state system similar to that used for IRP and IFTA. Previously, motor carriers would purchase ticket books in each state in which they operated and would obtain the issuing state's discount. Concurrent with this, the IAG also reduced the overall discount available to motor carriers and made discounts contingent on transaction volume. Thus, from the perspective of the motor carrier industry, the implementation of ETC resulted in a reduced discount and a higher threshold needed to obtain a discount.

3.9.2 Maryland E-Screening – Implementation Issues

The two key issues that have impacted the Maryland E-Screening Program are the lack of operational capability of the E-screening system at Perryville and the lack of other weigh stations deploying E-screening systems throughout the northeast:

- The E-screening system deployed has not proven reliable. MdTA personnel encountered hardware and software problems that have adversely impacted system performance:
  - A primary problem for the Perryville site is that the facility is subject to electrical power surges and periodic outages, frequently caused by lightening strikes. Eventually the problem was diagnosed and surge protectors were installed, but this problem caused significant disruption to the E-screening system.
  - The sorter ramp WIM (Cardinal Load Cell Scale) and the static scale located at the Perryville facility are installed separately from the E-screening project. Although these were integrated into the E-screening system, they experienced a number of operational problems that disrupted the overall E-screening system operations. MdTA has contracted with a vendor for maintenance of the ramp WIM and this has helped address the operational problems.
  - The mainline WIM (quartz Piezzo) failed prematurely and was eventually determined by the manufacturer to have been defective. While the WIM has been replaced, the failure of the original system and the wait for a replacement system resulted in several weeks of downtime.
  - The E-screening software was designed to be deployed throughout Maryland weigh stations, with the Perryville site being the initial deployment and test. While project plans included the transition of software maintenance and support from the developers to a commercial vendor, this has not yet happened. However, the fact that other weigh stations in Maryland have not yet deployed e-screening capability has resulted in the E-screening software operating as a custom application at one site. This has caused difficulties in finding a vendor and has created a scenario where MdTA IT staff are continuing to support the application beyond the time when the project plan called for operations and maintenance activities to be shifted to a private vendor.
  - Initially, the E-screening system lacked a configuration management process as the project was intended only as a Proof-of Concept project. As a result, adjustments to the system were not adequately documented. As the project evolved to a prototype project, a formal change management process has since been implemented.
- The E-screening system was not fully integrated into the ongoing work flow of weigh station operations:
  - The MdTA appointed a project manager and assigned technical staff to support the project and these personnel were available to support deployment. However, the resources needed for ongoing system operation and maintenance, including assignment and training of support staff; identification and procurement of spare parts; and integration of the system into MdTA information technology operations, have not been incorporated into the MdTA planning and budget process. This fact, coupled with the fact that the system has not yet been deployed on a state-wide basis, has resulted in operations and maintenance support being provided on more of an ad-hoc basis rather than as a regular IT support activity.
  - The physical location of the E-screening and ROC were not integrated into either the regular work processes of MdTA personnel or into their existing work space. As a result, MdTA personnel frequently faced the choice of either addressing regular work responsibilities at their normal work stations, or leaving both to use the E-screening system. Figure 3-70 demonstrates physical access problem faced by these personnel

due to actual system component locations for the static scale and ramp versus the existing work station and location of ROC and E-screening computers.

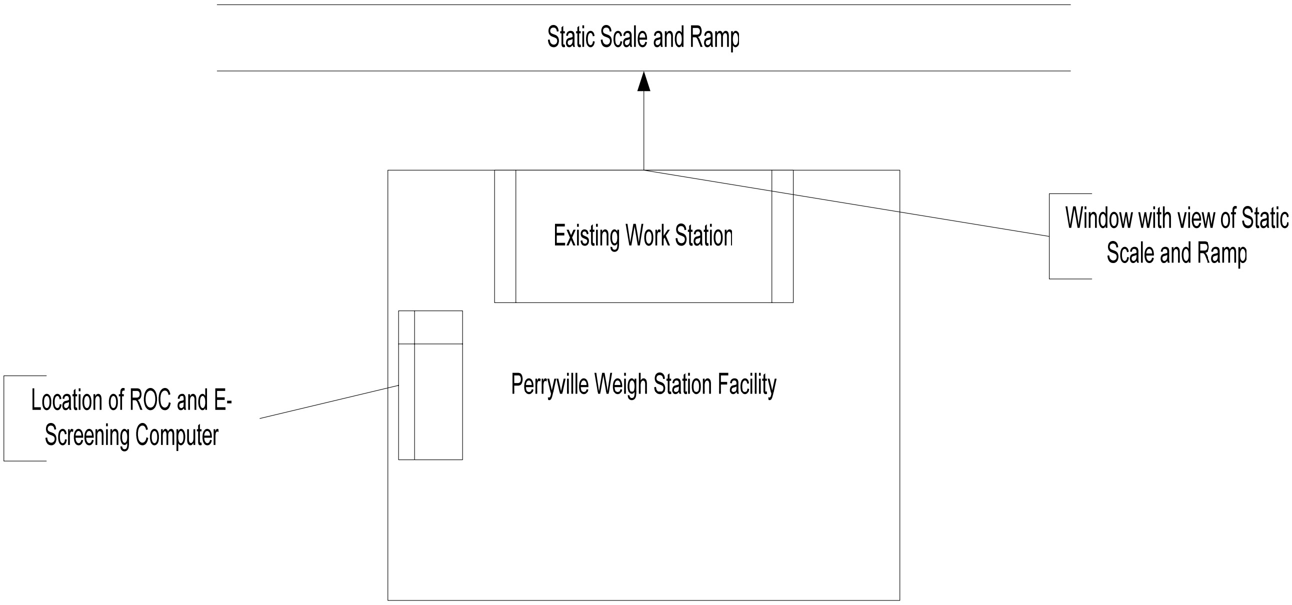


Figure 3-70. Perryville Weigh Station – Existing Work Station.

An additional consideration is that the State's Systems Development Life Cycle methodology and MDOT's project management processes were not utilized for the project. Using these methodologies and management processes would help ensure that the project is incorporated into Maryland's motor carrier program as a regular component of program operations.

The project has also identified the importance of supporting transponder administrator functions within a state. At present, enrollment in the Maryland E-Screening Program is handled by one staff person. Applications are received electronically through the Maryland Motor Carrier Web page, but an end-to-end interface that will enable the E-screening system to electronically receive this data is still under development. Application information is then manually entered into the E-screening system. Data entry in the Maryland E-Screening Program is presently being handled by one staff person at MDOT who has other duties in addition to supporting E-screening enrollment. The State is working to develop an interface that will link the Maryland Motor Carrier Web page and the electronic screening system, but this has not yet been deployed. In addition, this staff person is responsible for following-up on transponder administration.

4 TOTAL TRUCK COUNTS BY WEIGH FACILITIES

This section contains the truck counts obtained from the various data collection sites. The counts are provided as reference only.

4.1 PERRYVILLE WEIGH STATION TRUCK COUNTS

Figure 4-1 through Figure 4-7 shows the counts obtained from the Perryville Weigh Station during the week of October 20 – 26, 2002.

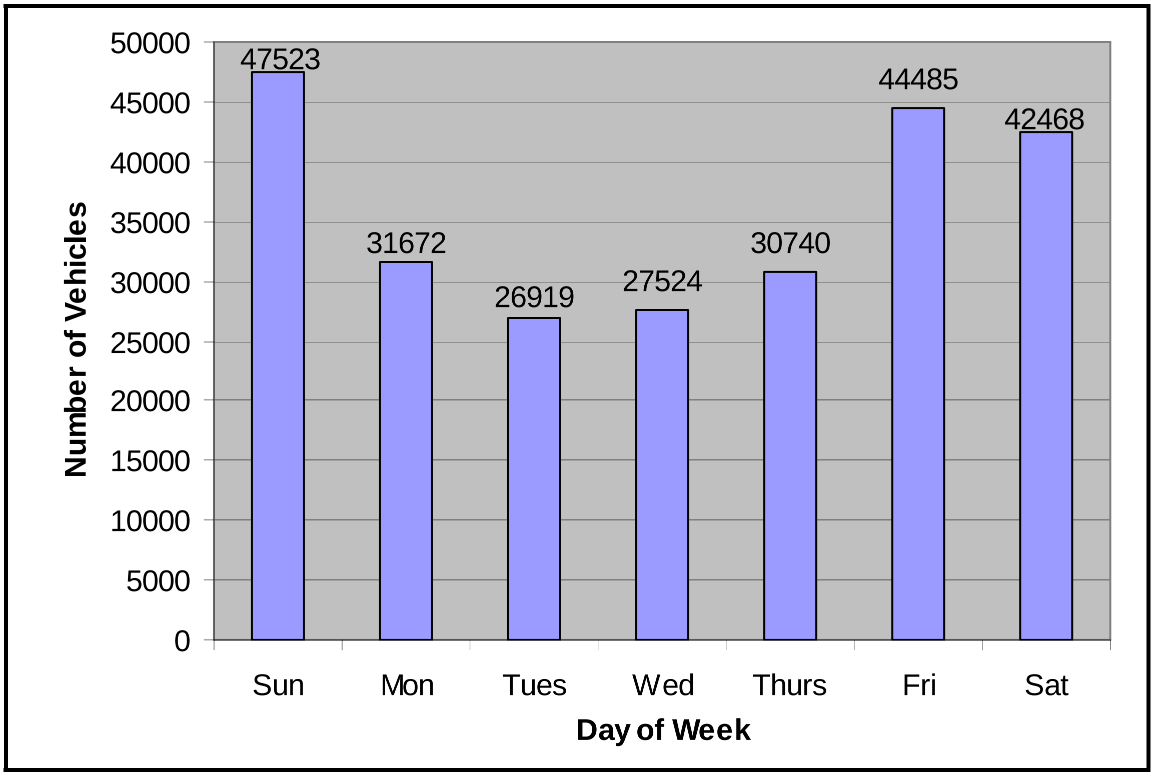


Figure 4-1. Overall Traffic Count by Day of Week for the Period of October 20 – 26, 2002.

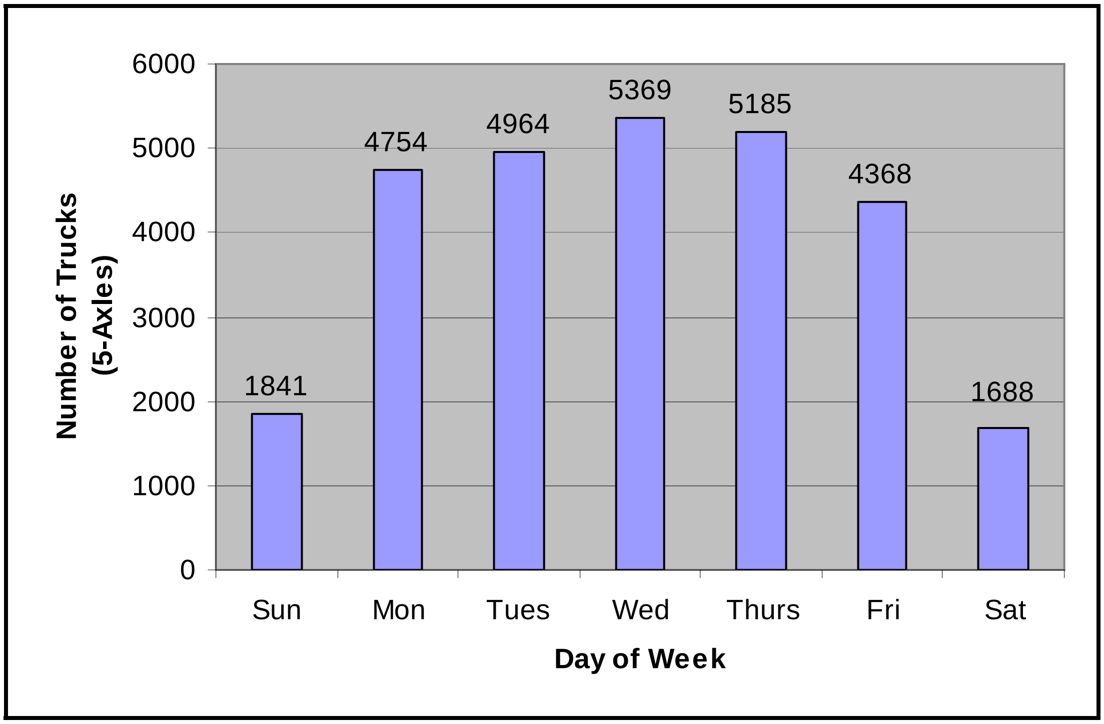
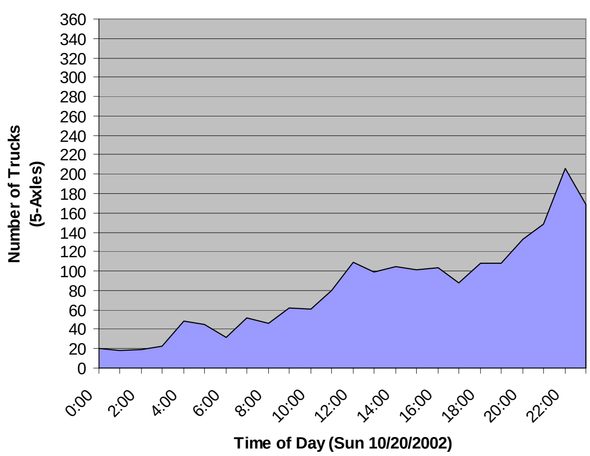
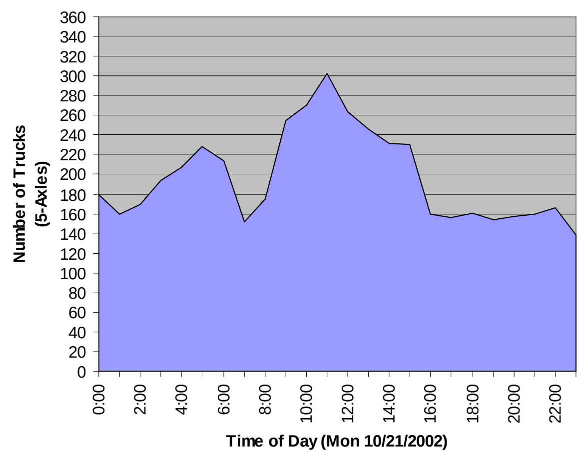


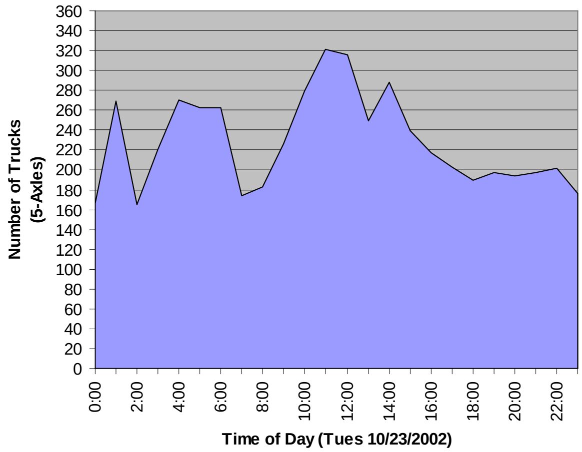
Figure 4-2. Five-Axle Truck Count by Day of Week for the Period of October 20 – 26, 2002.

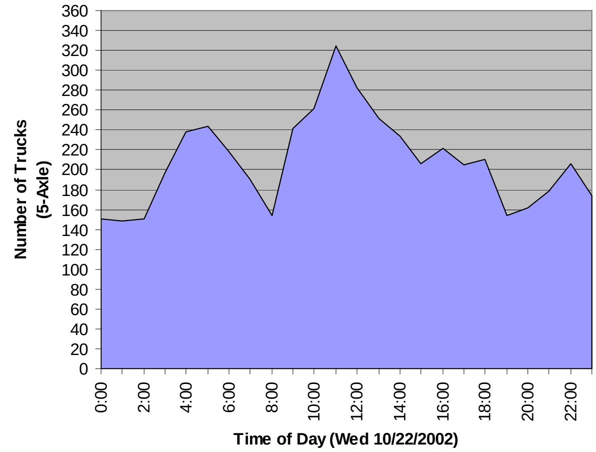
Sunday & Monday



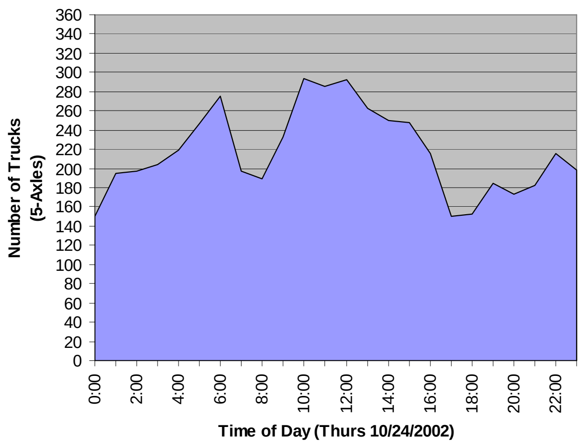


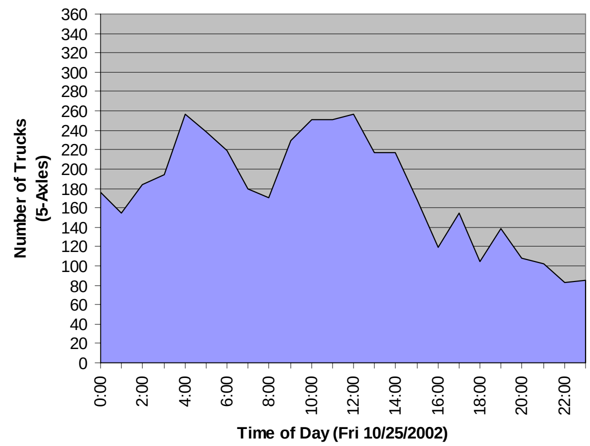
Tuesday and Wednesday





Thursday and Friday





Saturday

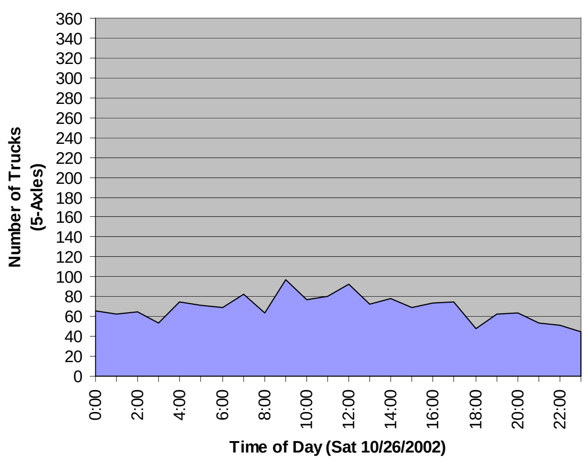


Figure 4-3. Five-Axle Truck Count by Time of Day for the Period of October 20 – 26, 2002.

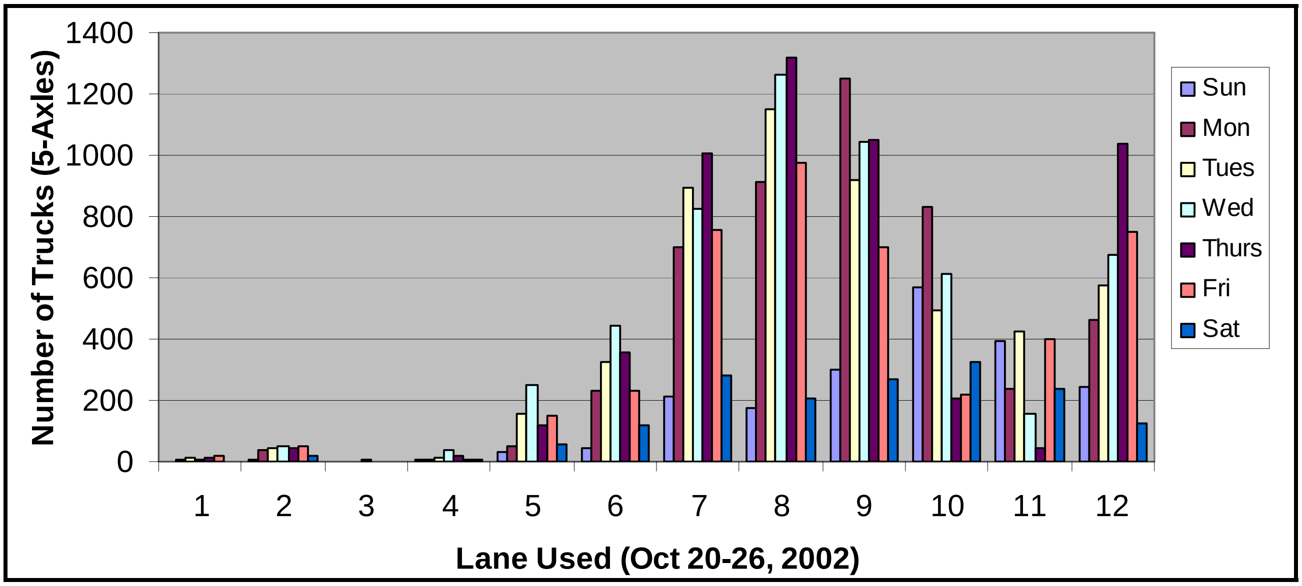


Figure 4-4. Lane Utilization for Trucks at Perryville Toll Facility.

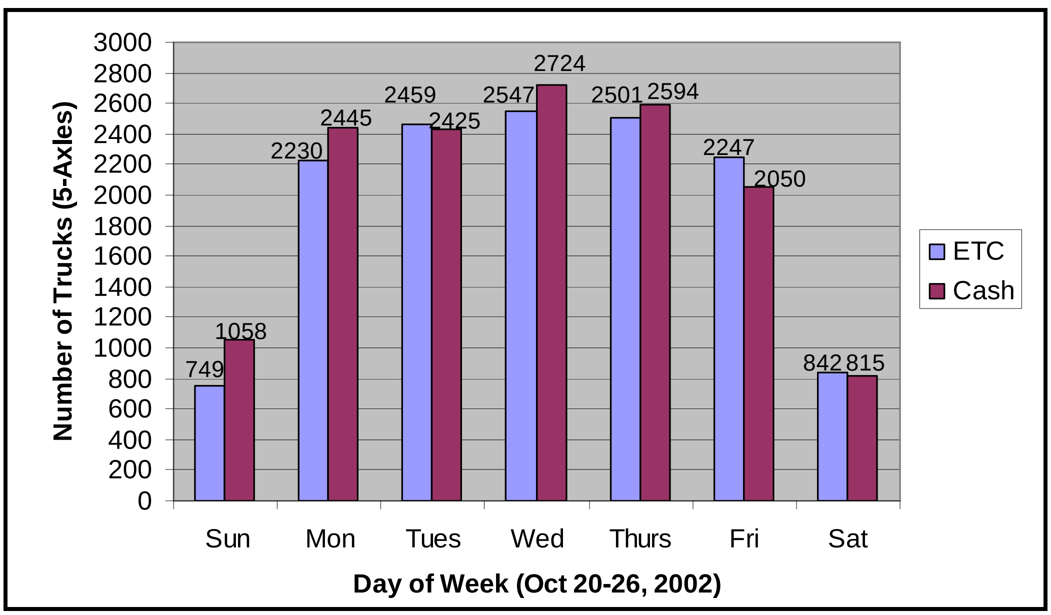


Figure 4-5. Payment Method for Trucks.

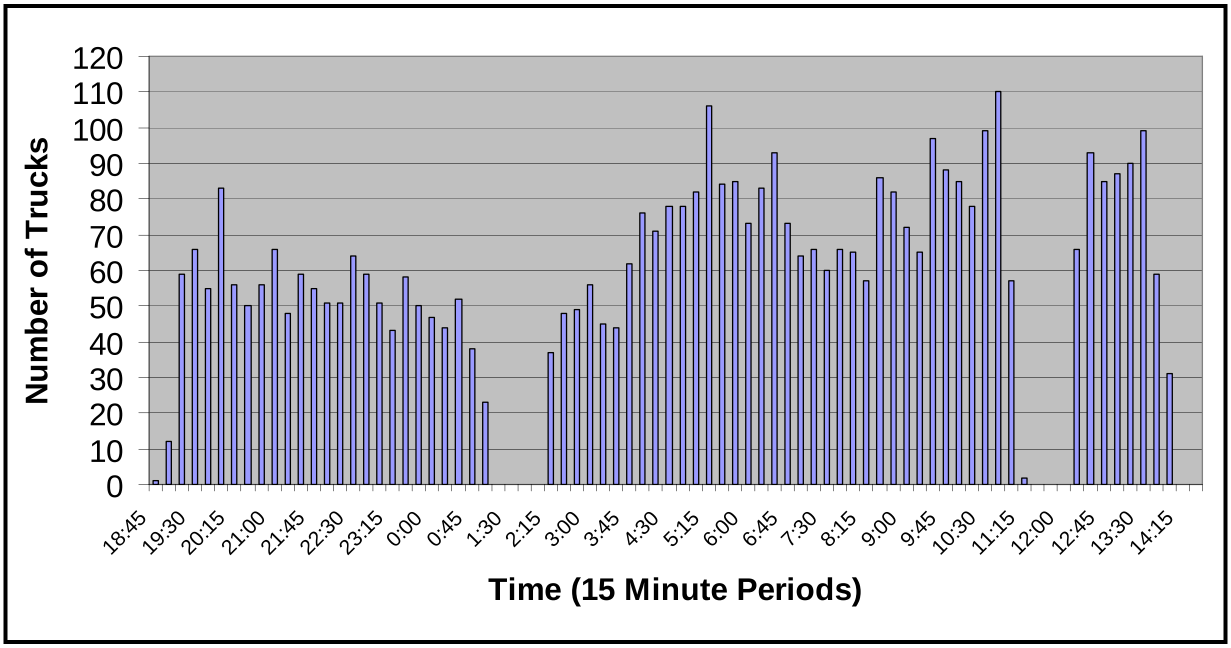


Figure 4-6. Perryville Weigh Station Counts.

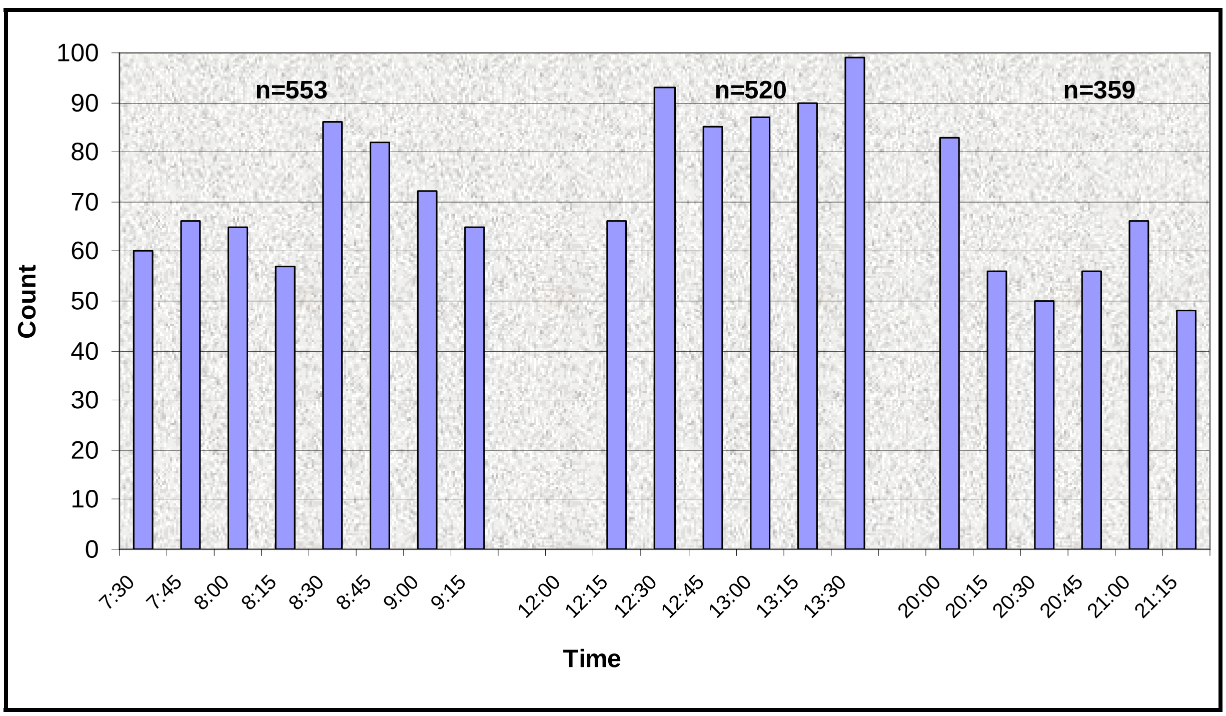


Figure 4-7. Perryville Weigh Station Truck Counts Per 15-Minute Time Period.

4.2 HYATTSTOWN WEIGH STATION TRUCK COUNTS

Figure 4-8 shows the truck counts obtained from the Hyattstown Weigh Station per 15-minute time period between December 2 and 3, 2002.

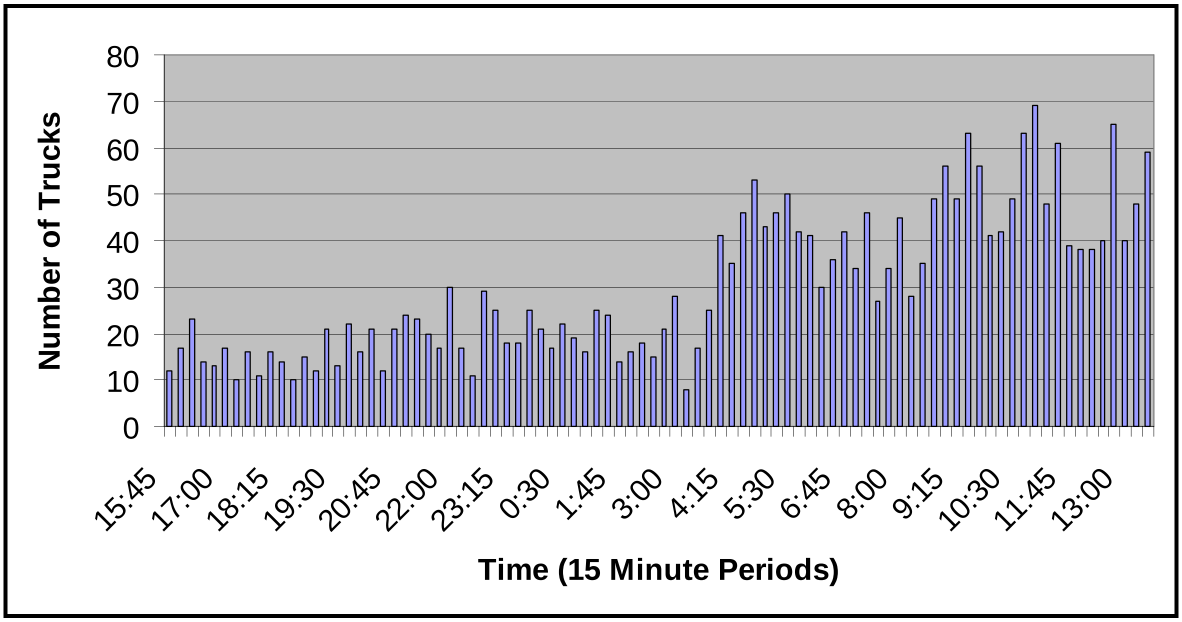


Figure 4-8. Hyattstown Truck Counts Per 15-Minute Time Period.

4.3 WEST FRIENDSHIP WEIGH STATION TRUCK COUNTS

Figure 4-9 shows the truck counts obtained from the West Friendship Weigh Station per 1-hour time period between December 9 and 10, 2002.

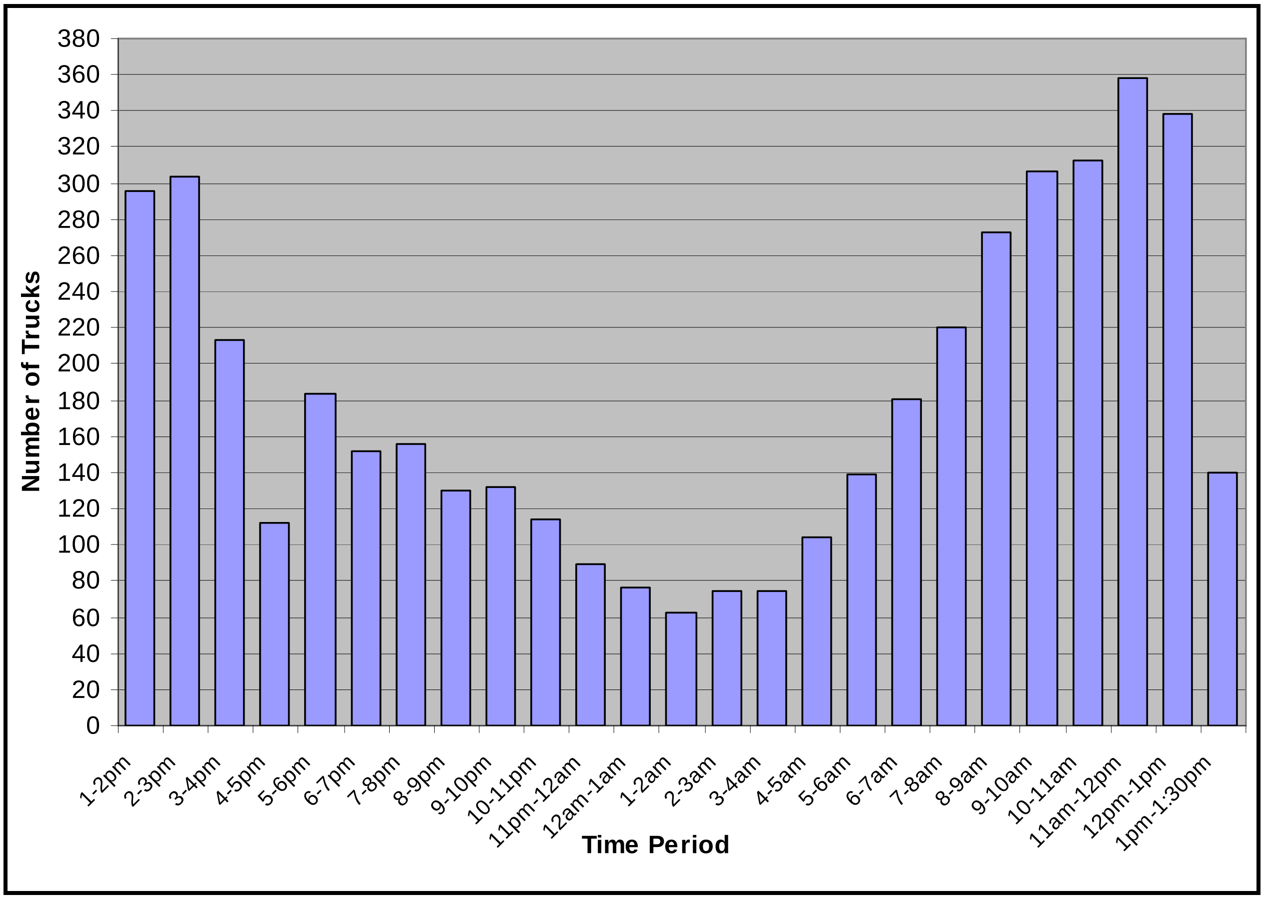


Figure 4-9. West Friendship Weigh Station Truck Counts Per 1-Hour Time Period.

4.4 NEW MARKET WEIGH STATION TRUCK COUNTS

Figure 4-10 shows the truck counts obtained from the New Market Weigh Station per 15-minute time period between January 21 and 22, 2003.

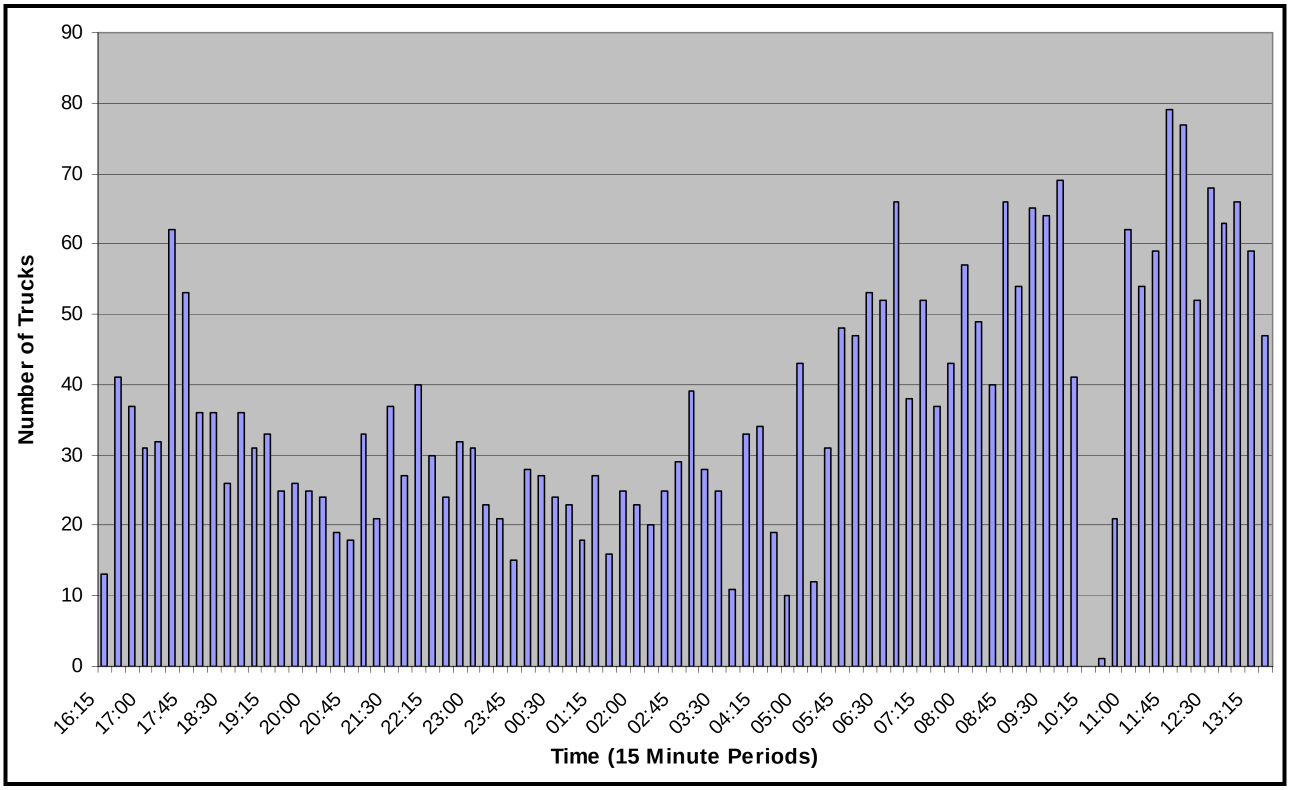


Figure 4-10. New Market Weigh Station Truck Counts Per 15-Minute Time Period.

4.5 UNION WEIGH STATION TRUCK COUNTS

Figure 4-11 shows the truck counts obtained from the Union Weigh Station per 15-minute time period on May 19, 2003.

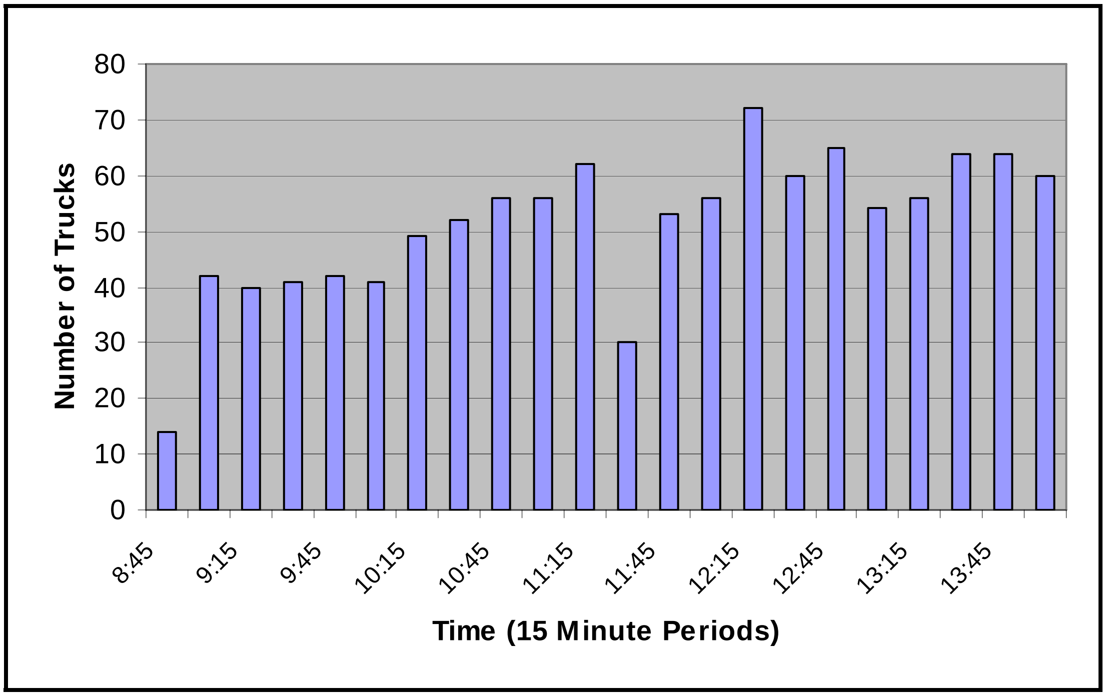


Figure 4-11. Union Weigh Station Truck Counts Per 15-Minute Time Period.

4.6 GREENWICH WEIGH STATION TRUCK COUNTS

Figure 4-12 shows the truck counts obtained from the Greenwich Weigh Station per 15-minute time period on May 21, 2003.

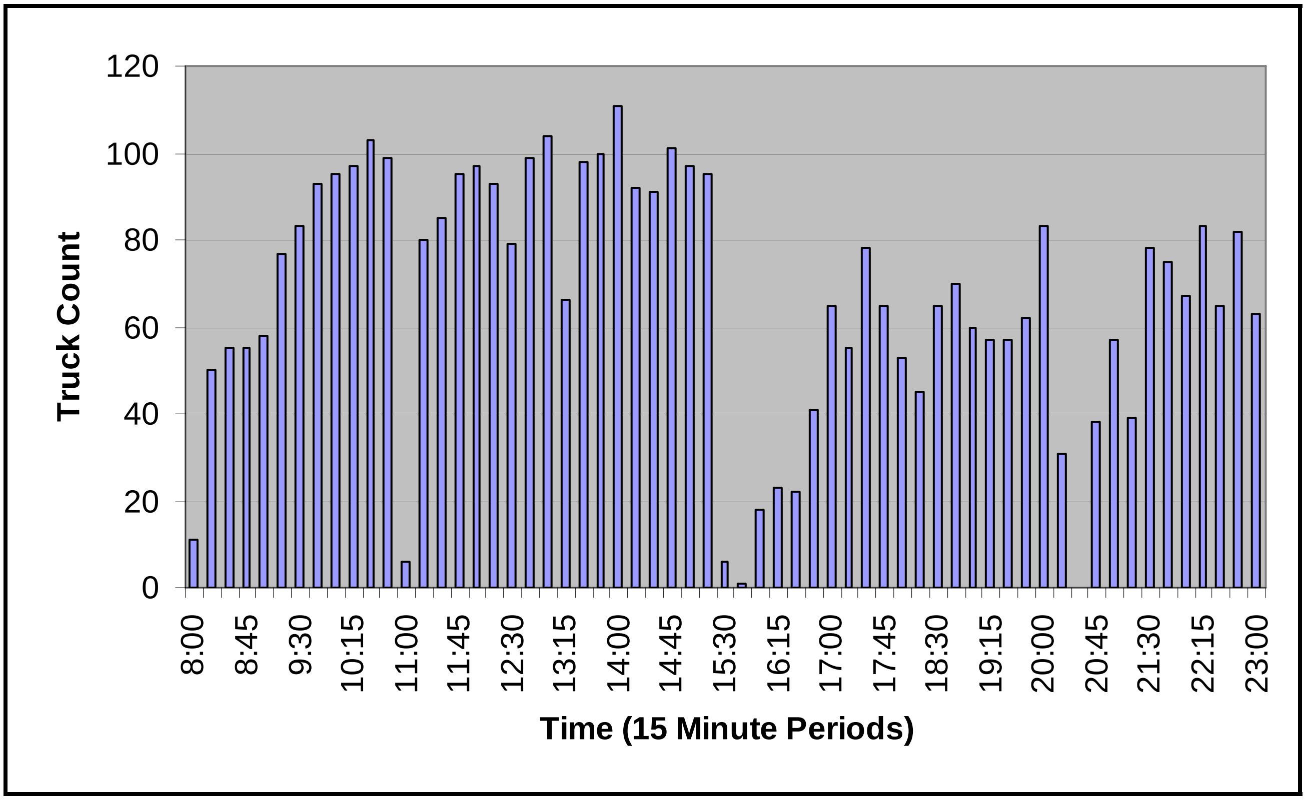


Figure 4-12. Greenwich Weigh Station Truck Counts Per 15-Minute Time Period.

5 SAFETY DOCUMENTS SUMMARY

1. *Benefit-Cost Assessment of the Commercial Vehicle Information Systems and Networks (CVISN) in Maryland (November 1998).* This paper focuses on the benefits and costs associated with CVISN deployment, and analyzes its usefulness. Transponders are discussed as a cost and safety as a benefit but they are never directly related in the paper. The conclusion of the paper is that the benefits of CVISN strongly outweigh the costs. Accessed from: http://www.eng.morgan.edu/~ntc/Final.pdf.

2. *Maryland Motor Carrier Program Safety Profile of Commercial Motor Carriers Traveling in Maryland at the Perryville Scale House Under the Jurisdiction of the Maryland Transportation Authority Police (January 2001).* There is very little mention of transponders in this report. The focus is on the Inspection Selection System, and how it is improving safety and efficiency. The assumption is that although transponders are not yet the standard mode of identification for ISS they will be some day, and thus, contribute to increased safety. However, again, there is no analysis.

3. *Oregon Green Light CVO Evaluation (June 2000).* This is an interview focusing on the weigh station pre-clearance in Oregon. The transponder deployment is discussed as well as the safety benefits from the pre-clearance. Some of the larger issues with transponders are also discussed, such as the cost and the interoperability with other transponder systems. While the discussion does offer a connection between the increased safety due to the program and the transponder's integral part in that program, there is no analysis of the relationship. Accessed from: http://www.odot.state.or.us/trucking/its/evaluation/Agency_Acceptance.pdf.

4. *The Roadside Inspection Selection System (ISS) for Commercial Vehicles (March 1997).* This paper discusses the reasons for implementing ISS, its current success, and briefly discusses the role that transponders are expected to have in identifying the vehicles within the system. Accessed from: http://www.ndsu.edu/ndsu/ugpti/DPpdf/DP116.pdf.

6 MOTOR CARRIER SURVEY

Thank you for agreeing to participate in this survey. This survey is being administered by Science Applications International Corporation (SAIC), in association with the Maryland Motor Truck Association (MMTA), on behalf of the U.S. Department of Transportation. The results of this survey will be used to determine motor carriers' perceptions of electronic toll collection (such as E-ZPass) and electronic screening technologies. **All responses will be kept strictly confidential, and results will be reported in summary form only**. This questionnaire contains 27 questions and should take less than 20 minutes to complete. If you have any questions, please contact Nick Owens of SAIC at (703) 676-2408 or Louis Campion of MMTA at (410) 644-4600.

Electronic Toll Collection

1. From your company's perspective, should there be lanes for electronic toll collection dedicated to trucks?
   - ❑ No (go to question 2)
   - ❑ Yes

   1a. HOW MANY of these dedicated lanes would be sufficient?
   - ❑ 1 lane out of 10
   - ❑ 2 lanes out of 10
   - ❑ 3 or more lanes out of 10

2. Is your company enrolled in electronic toll collection?
   - ❑ Yes (since when? __________________) (go to question 3)
   - ❑ No

   2a. What are the reasons your company is NOT enrolled in electronic toll collection? (Please mark all that apply.)
   - ❑ It's too difficult to register
   - ❑ It costs too much to participate
   - ❑ There aren't enough incentives to participate
   - ❑ We are currently in the process of enrolling
   - ❑ Other (please specify) ___________________________________

   Below, please provide any other information on why you are NOT enrolled:

   ____

   ____

   (Please skip to question 12 in the Electronic Screening section.)

3. To what extent has the use of electronic toll collection impacted your drivers' travel times through toll facilities?
   - ❑ No travel time savings whatsoever
   - ❑ Less than a 10% reduction in travel times
   - ❑ 11 – 20% reduction in travel times
   - ❑ 21 – 30% reduction in travel times
   - ❑ More than a 30% reduction in travel times

4. To what extent does confinement to "Truck Only" lanes at electronic toll collection facilities <u>in Maryland</u> impact your drivers' <u>travel times</u> through these toll facilities?
   - ❑ It doesn't take any longer to get through the "Truck Only" lanes than it does the E-ZPass lanes
   - ❑ Less than 10% longer travel times
   - ❑ 11 – 20 % longer travel times
   - ❑ 21 – 30% longer travel times
   - ❑ More than 30% longer travel times

5. Did your company use any method <u>other than cash</u> for toll collection (e.g., ticket books, toll cards) prior to using E-ZPass?
   - ❑ No → **(Please skip to question 9.)**
   - ❑ We're not enrolled in E-ZPass → **(Please skip to question 9.)**
   - ❑ Yes (go to question 6)

6. Has the switch from your old method of paying tolls to electronic toll collection impacted your company's <u>costs</u> (either positively or negatively)?
   - ❑ No, and we don't expect to see any impacts (go to question 7)
   - ❑ Not yet, but we expect to see impacts in the future (go to question 7)
   - ❑ Yes

6a. Please rate the extent to which the switch from your company's old method of paying tolls to electronic toll collection has impacted the following:

	More than 20% Decrease	**11 – 20% Decrease**	**1 to 10% Decrease**	**No Impact**	**1 to 10% Increase**	**11 – 20% Increase**	**More than 20% Increase**	**Not Sure or N/A**
Fuel usage	❑	❑	❑	❑	❑	❑	❑	❑
Time/cost of enrolling owner-operators	❑	❑	❑	❑	❑	❑	❑	❑
Time/cost of maintaining accounts	❑	❑	❑	❑	❑	❑	❑	❑
Time/cost of record keeping	❑	❑	❑	❑	❑	❑	❑	❑
Time/cost of auditing drivers' log books	❑	❑	❑	❑	❑	❑	❑	❑

6b. Please indicate your company's level of agreement with the following statement (use a scale of 1 to 5, where 1 is "strongly disagree" and 5 is "strongly agree"):

	Strongly Disagree 1	**2**	**3**	**4**	**Strongly Agree 5**	**Not Sure**
The costs associated with our participation in electronic toll collection outweigh any savings	❑	❑	❑	❑	❑	❑

7. Please indicate your company's level of agreement with the following statement (use a scale of 1 to 5, where 1 is "strongly disagree" and 5 is "strongly agree"):

	Strongly Disagree 1	2	3	4	Strongly Agree 5	Not Sure
We prefer our old method of paying tolls to electronic toll collection	❑	❑	❑	❑	❑	❑

8. In what ways has the reduction in toll discounts with E-ZPass impacted your company's COSTS?
(Please mark all that apply.)
   - ❑ It has not impacted our costs
   - ❑ Our maximum discount is now a little lower
   - ❑ Our maximum discount is now much lower
   - ❑ We're a small company and no longer qualify for discounts
   - ❑ We don't travel on toll roads enough to qualify for discounts now
   - ❑ Other (please specify) ____

9. Which of the following best represents your company's opinion of the general design and implementation of electronic toll collection as it relates to your company's operations?
   - ❑ Good—has had positive impacts on our operations (go to question 10)
   - ❑ OK—but could benefit from modifications that could further improve operations
   - ❑ Poor—was designed to improve passenger car operations, not truck operations
   - ❑ I'm not sure (go to question 10)

9a. How could the design/implementation be enhanced to improve your operations?

____

____

10. Has your company used E-ZPass customer service?
   - ❑ No (go to question 11)
   - ❑ Yes

10a. How often does your company contact E-ZPass customer service?
- ❑ At least once a week
- ❑ 2-3 times per month
- ❑ Once a month
- ❑ Once every few months
- ❑ 1-2 times per year or less

10b. Please rate how often the following statements are TRUE for your company (use a scale of 1 to 5, where 1 is "almost never" and 5 is "almost always"):

	Almost Never 1	2	3	4	Almost Always 5	Not Sure
We have success contacting E-ZPass customer service by phone	❑	❑	❑	❑	❑	❑
The quality of the info received from E-ZPass customer service is good	❑	❑	❑	❑	❑	❑

11. Please rate your company's level of satisfaction with the following issues related to electronic toll collection (use a scale of 1 to 5, where 1 is "extremely dissatisfied" and 5 is "extremely satisfied"):

	Extremely Dissatisfied 1	2	3	4	Extremely Satisfied 5	Not Sure or N/A
Travel time savings benefit	❑	❑	❑	❑	❑	❑
Cost of use	❑	❑	❑	❑	❑	❑
Impact on your operational efficiency	❑	❑	❑	❑	❑	❑
Eligibility criteria for obtaining toll discounts	❑	❑	❑	❑	❑	❑
Ability to reach E-ZPass customer service	❑	❑	❑	❑	❑	❑
Information received from E-ZPass customer service	❑	❑	❑	❑	❑	❑
Your company's experience with electronic toll collection to this point	❑	❑	❑	❑	❑	❑
Level of cooperation between E-ZPass and public toll facilities	❑	❑	❑	❑	❑	❑

Electronic Screening

12. Is your company enrolled in Maryland's electronic screening program?

❑ Yes (since when? __________________) (go to question 13)

❑ No

12a. What are the reasons your company is NOT enrolled in electronic screening in Maryland? (Please mark all that apply.)

- ❑ We aren't familiar with electronic screening
- ❑ We are familiar with it, but we weren't aware of the program in Maryland
- ❑ We were aware of the Maryland program, but don't know how/where to register
- ❑ It's too difficult to register
- ❑ We don't pass inspection facilities in Maryland often enough to enroll
- ❑ We would not receive as many bypasses as other carriers due to the loads we haul
- ❑ Availability at few locations along I-95 is not a strong incentive to enroll
- ❑ Electronic screening simply does not offer enough benefits
- ❑ Other (please specify)

____

12b. Please rate your company's level of agreement with the following statement:

	Strongly Disagree 1	2	3	4	Strongly Agree 5	Not Sure
If electronic screening were available on more routes that we frequently run, we would participate.	❑	❑	❑	❑	❑	❑

12c. In what other electronic screening programs is your company registered?
(Please mark all that apply.)
❑ NORPASS (skip to question 16)
❑ PrePass (skip to question 16)
❑ Other (please specify and skip to question 16) -
____
❑ We are not registered in any other electronic screening program

(Please skip to question 22.)

13. How did your company learn about electronic screening in Maryland? (Please mark all that apply.)
❑ Through a colleague or other company
❑ Information we received when we registered for E-ZPass
❑ Through a state trucking association (e.g., newsletter)
❑ Information we received through NORPASS
❑ Other (please specify)
____

14. Since your company has been using the transponder for electronic screening, on average, HOW OFTEN does each of your drivers receive green light bypasses in Maryland?
❑ 1 – 3 out of 10 times past the weigh station
❑ 4 – 6 out of 10 times past the weigh station
❑ 7 or more out of 10 times past the weigh station
❑ They've never received a bypass (go to question 15)
❑ I'm not sure (go to question 15)

14a. To what extent have these bypasses at the Perryville weigh station in Maryland impacted your drivers' travel times?
❑ No travel time savings whatsoever
❑ Less than a 10% reduction in travel times
❑ 11 – 20% reduction in travel times
❑ 21 – 30% reduction in travel times
❑ More than a 30% reduction in travel times

15. In what other electronic screening programs is your company registered?
(Please mark all that apply.)
❑ NORPASS
❑ PrePass
❑ Other (please specify)
____
❑ We are not registered in any other electronic screening program

16. Please indicate the extent to which the following factors influenced your company's decision to participate in electronic screening (use a scale of 1 to 5, where 1 is "little to no influence" and 5 is "strong influence")

	Little to no Influence 1	2	3	4	Strong Influence 5	Not Sure
Participation could increase overall safety compliance.	❑	❑	❑	❑	❑	❑
Participation could decrease stops/delays at weigh stations.	❑	❑	❑	❑	❑	❑
Participation could improve operational efficiency.	❑	❑	❑	❑	❑	❑
We were pressured to participate.	❑	❑	❑	❑	❑	❑
Other (please specify): _______________	❑	❑	❑	❑	❑	❑

17. Using a scale of 1 to 5, please rate your company's level of agreement with the following statements related to the potential safety benefits of electronic screening.

	Strongly Disagree 1	2	3	4	Strongly Agree 5	Not Sure
Electronic screening will improve overall motor carrier safety by focusing enforcement on trucking companies that aren't compliant.	❑	❑	❑	❑	❑	❑
The benefits that electronic screening offers encourage our company to maintain compliance in order to participate.	❑	❑	❑	❑	❑	❑
One drawback to electronic screening is that unsafe drivers, who work for reputable companies, will not be adequately identified.	❑	❑	❑	❑	❑	❑
There are no safety benefits of electronic screening.	❑	❑	❑	❑	❑	❑

18. Please choose the response that best completes the following sentence for your company:

Participating in electronic screening …

- ❑ has in no way impacted our operational efficiency (go to question 19)
- ❑ has somewhat improved our operational efficiency
- ❑ has significantly improved our operational efficiency

18a. Please indicate how it has improved:

____

____

____

19. Which of the following statements BEST describes your company's opinion of the concept and operation of electronic screening:

- ❑ Both the concept and current operation of electronic screening are good
- ❑ The concept of electronic screening is good, but the current operation needs improvement
- ❑ Neither the concept nor the current operation of electronic screening is good
- ❑ I'm not sure

20. Has the use of electronic screening impacted your company's costs (either positively or negatively)?

- ❑ No, and we don't expect to see any impacts (go to question 21)
- ❑ Not yet, but we expect to see impacts in the future (go to question 21)
- ❑ Yes

20a. Please rate the extent to which electronic screening has impacted the following:

	More than 20% Decrease	11 – 20% Decrease	1 to 10% Decrease	No Impact	1 to 10% Increase	11 – 20% Increase	More than 20% Increase	Not Sure or N/A
TRAVEL TIMES	❑	❑	❑	❑	❑	❑	❑	❑
FUEL USAGE	❑	❑	❑	❑	❑	❑	❑	❑
OTHER:________	❑	❑	❑	❑	❑	❑	❑	❑

20b. Using a scale of 1 to 5, rate your company's level of agreement with the following statement:

	Strongly Disagree 1	2	3	4	Strongly Agree 5	Not Sure
The costs associated with our participation in electronic screening outweigh the savings/benefits	❑	❑	❑	❑	❑	❑

21. Using a scale of 1 to 5, please rate your company's level of satisfaction with the following related to electronic screening:

	Extremely Dissatisfied 1	2	3	4	Extremely Satisfied 5	Not Sure or N/A
Travel time savings benefit	❑	❑	❑	❑	❑	❑
Cost of use	❑	❑	❑	❑	❑	❑
Public promotion of the program in Maryland	❑	❑	❑	❑	❑	❑
Ease of determining how to register in Maryland	❑	❑	❑	❑	❑	❑
User friendliness of online registration in Maryland	❑	❑	❑	❑	❑	❑
Reliability of online registration in Maryland	❑	❑	❑	❑	❑	❑
Your company's experience with electronic screening to this point	❑	❑	❑	❑	❑	❑

22. Using a scale of 1 to 5, please rate your company's level of agreement with the following statements:

	Strongly Disagree 1	2	3	4	Strongly Agree 5	Not Sure
Electronic screening would be a success if we had one transponder for all weigh stations nationwide	❑	❑	❑	❑	❑	❑
The concept of an interoperable transponder for electronic toll collection and E-screening is good	❑	❑	❑	❑	❑	❑

Company Information

23. How many power units does your company operate?

Long Haul:		Local:	
	❑ 1 – 5		❑ 1 – 5
	❑ 6 – 19		❑ 6 – 19
	❑ 20 – 50		❑ 20 – 50
	❑ 51 – 100		❑ 51 – 100
	❑ 101 – 249		❑ 101 – 249
	❑ 250 – 500		❑ 250 – 500
	❑ More than 500		❑ More than 500

24. Approximately what percent of your drivers are owner-operators? ________________ %

25. Please indicate which of the following best represents your company:
❑ We operate on an intra-state basis
❑ We operate on a regional basis
❑ We operate on a national basis

26. About what percentage of the time do your drivers spend on interstate highways?
❑ Less than 25% of the time
❑ 26 – 50% of the time
❑ 51 – 75% of the time
❑ More than 75% of the time

27. What commodities does your company haul? (Please mark <u>all that apply</u>.)
❑ General freight—truckload
❑ General freight—less-than-truckload
❑ Household goods—Movers
❑ Automotive parts/vehicles
❑ Bulk—dump trucking
❑ Hazardous materials
❑ Intermodal
❑ Other

Please provide any other comments you would like to make about electronic toll collection and/or electronic screening:

____

____

Thanks for your participation!

7 LITERATURE REVIEW – ENVIRONMENTAL ASSESSMENT

7.1 ENVIRONMENTAL TEST

7.1.1 Introduction

Diesel engines, by virtue of combustion characteristics significantly different from gasoline-engine vehicles, are a primary source of NOX and particulate matter. Vehicles using diesel combustion engines emit a variety of pollutants determined by the U.S. Environmental Protection Agency (USEPA) and other organizations to be hazardous to human health. Emissions of oxides of nitrogen (NOX) – a major precursor to the formation of tropospheric ozone – and particulate matter from these diesel-fueled vehicles are significant, and disproportionately greater than from light-duty gasoline powered vehicles.

Having made progress in reducing emissions from gasoline powered vehicles, USEPA is now working to clean up and mitigate the adverse effects of diesel engine exhaust. This effort has three main tracks. The first is regulatory – to set a series of increasingly stringent standards for diesel emissions and mandating the use of ultra-low sulfur fuel. The second track is technological, involving cleaner combustion and post-combustion clean up of the diesel exhaust stream. Efforts to curtail the emissions from diesel-fueled on-road vehicles involve significantly reducing the sulfur content in diesel fuel, the application of sophisticated engine management control technologies to new heavy-duty diesel (HDD) vehicles entering the national fleet, treatment of engine-out exhaust gases, and more efficient operation of HDD vehicles. The third prong of the USEPA approach is yet another major revision of the models used to estimate emissions from on-road diesel vehicles, to be used in assessing conformity with air quality standards and in predicting air quality in light of expected numbers of vehicle and mileage.

7.1.2 Diesel Combustion Engines

On-road application of diesel engines in the United States is common to buses, commercial vehicles, and over the road trucks, with penetration into the consumer market limited to a few European automobile models, and some domestically manufactured pick-up trucks and SUVs [1] [2]. Diesel-powered automobiles, because of the fuel efficiency inherent in the more energetic diesel fuel, are much more common outside the United States where fuel costs can offset the greater cost of a diesel engine vehicle within a reasonable time frame due to substantially higher fuel prices. Because diesel fuel requires much less refining than gasoline, it is often less expensive than gasoline (on a cost per mile basis) making it the fuel of choice for HDD vehicle operations where high annual vehicle miles traveled (VMT) is of concern. The greater inherent efficiency of a diesel engine over a gasoline engine can also further lower fuel bills, reducing overall operating costs. The diesel combustion cycle permits these engines to operate at lower temperature than gasoline engines, a significant factor in the greater durability of diesel engine power plants. Consequently, diesel engines are employed over much greater distances than gasoline engines, as diesel engines routinely operate for several hundred thousand miles between rebuilds, often remaining in service for 800,000 miles or more. This durability of diesel engines is another reason leading to their favor in heavy-duty vehicle applications.

7.1.3 Diesel Emissions

While vehicles with diesel engines may not make up a great proportion of the United States national vehicle fleet in proportion to the number of gasoline engine vehicles, vehicles with diesel engines do represent a significant portion of the VMT traveled every year. Emissions from these vehicles, accordingly, is significant:

> Although trucks account for under 6 percent of the miles driven by highway vehicles in the United States, they are responsible for one-quarter of smog-causing pollution from highway vehicles, over half the soot from highway vehicles and the majority of the cancer threat posed by air pollution in some urban areas….[3]

Reliance on HDD truck as a principal mode of commercial transportation in the United States is not forecast to diminish.

> By some estimates freight to be moved on our nation's transportation system is expected to double within the next 15 years. Truck transportation is expected to account for the vast majority of shipments, [with] significant growth in truck tonnage, mileage and trips expected over the next decades.[4]

Thus, the nation's HDD truck fleet is a target for emissions reduction, with USEPA anticipating "…a reduction of 1.1 million tons per year in ozone precursors" alone from on-road truck and bus engines by the year 2020 [5].

Efforts by USEPA to control vehicle-induced air pollution have focused most attention on the much more common gasoline engine [6]. A major step in cleaning up emissions from gasoline engine vehicles was mandating the removal of lead from gasoline. To meet increasingly stringent emission standards set by USEPA, vehicle manufacturers concentrated on catalytic converter technology to remove much of the harmful pollution exhausted from the engine.

Automotive engineers also worked "upstream" of the combustion process, greatly increasing the metering precision of the fuel/air mixture into the engine combustion chamber, seeking to optimize this ratio to minimize the unburned and partially burned fuel that leads to the noxious compounds in gasoline-engine vehicle exhaust. Increasingly powerful computers and advancements in the science of fluid dynamics and wave propagation led to greater understanding of internal combustion engine functioning, and how its operation could be optimized to suit real world conditions. A portion of this computational power moved from the laboratory to under the hood of the typical gasoline engine vehicle, with the widespread deployment of sophisticated electronic engine management systems controlling fuel/air mixture, inlet- and exhaust-valve timing, and ignition spark timing and duration to balance maximum engine power, fuel economy and tailpipe emissions.

Diesel engines operate in significantly different fashion than do more familiar gasoline engines [7]. Rather than relying on spark plugs producing very high temperature flames for brief intervals, resulting in very rapid controlled burning of volatile gasoline, diesel engines rely on much greater compression of the fuel/air mixture in the cylinder to ignite less-volatile diesel fuel. Diesel-fuel engines operate with an air/fuel ratio that provides more oxygen than is required during combustion – unlike gasoline engines. The differences in fuel characteristics, the combustion process, and engine operation result in significantly different pollutant by-products between gasoline and diesel engines, with diesel engines producing more NOX and particulate matter (PM) [8, 1] [7] (see Figure 7-1).[7] Sulfur dioxide (SO_2), while not a significant by-product of

[7] *Highway Sources of Pollution,* From: Rolling Smokestacks: Cleaning Up America's Trucks and Buses, Union of Concerned Scientists, 2000.

gasoline combustion engines, is a concern with diesel engines due to the presence of significant quantities of sulfur in diesel fuel.

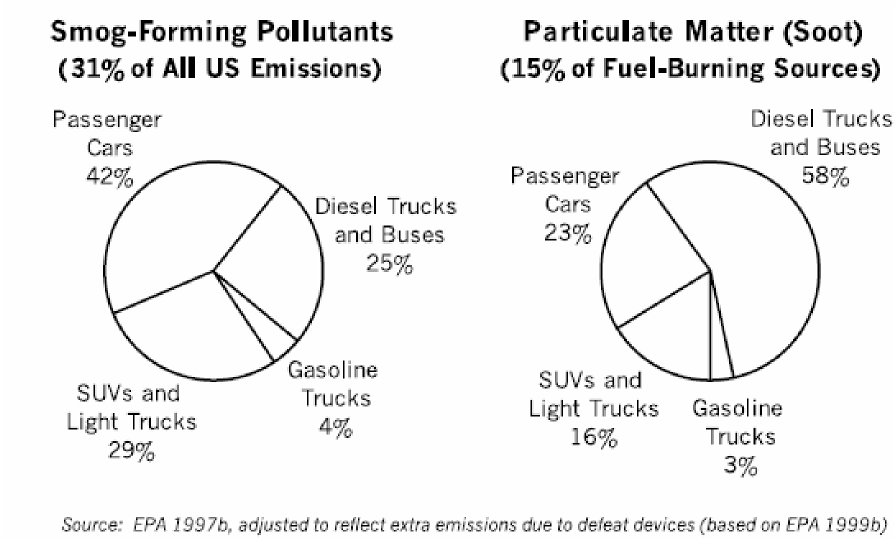


Figure 7-1. Highway Sources of Pollution.

Vehicles with diesel engines are now receiving the same sort of attention from USEPA as have gasoline engines previously [2]. In 1990, USEPA dramatically reduced the permissible levels of SO_2 in diesel fuel; the agency is in the midst of rule making to further lower sulfur content in diesel fuel to .05 percent sulfur by weight for diesel fuel used in on-road vehicles [9], removing some 97 percent of the sulfur previously present in diesel fuel [3]. This will not only directly reduce the sulfur by-products emitted by diesel engines, but is important in enabling the application of technologies intended to clean the engine exhaust stream, such as catalytic converters, as high levels of sulfur can impair the operation of or destroy these devices [8].

USEPA has published standards to greatly reduce pollutants, especially NOX and particulate matter, from on-road diesel engines beginning in 2007, with further reductions scheduled for 2010. It is anticipated these regulations as applied to new trucks will result in a 95 percent reduction of smog-causing nitrogen oxides and a 90 percent reduction of soot over current levels [3]. Table 7-1 presents the truck emissions standards for the years 1989 through 2004+.[8]

[8] *Highway Sources of Pollution,* From: Rolling Smokestacks: Cleaning Up America's Trucks and Buses, Union of Concerned Scientists, 2000.

Table 7-1. Truck Emission Standards.

Years	Smog-Forming Emissions (g/bhp-hr)[a]		Particles (g/bhp-hr)[a]
	HC	NO_x	PM
uncontrolled (pre-1974)		15–16	1.0
1985–1987	1.3	10.7	uncontrolled
1988–1989	1.3	10.7	0.6
1990	1.3	6.0	0.6
1991–1993	1.3	5.0	0.25
1994–1997	1.3	5.0	0.1
1998–2003	1.3	4.0	0.1
2004+	2.5 (combined HC + NO_x)[b]		0.1

a. The EPA measures truck pollution in grams per brake-horsepower-hour (g/bhp-hr), which is the weight of pollutant emitted per unit of energy produced by the engine. Emissions expressed in g/bhp-hr can be converted into grams per mile (the way car pollutants are measured). For example, under the 2004 standard above, trucks will emit 4.5 grams per mile of smog-forming pollution and 0.55 grams per mile of soot on average.

b. Under a recent legal settlement, several manufacturers will meet these standards beginning in October 2002.

7.1.3.1 Air Quality Standards

In accordance with the Clean Air Act (CAA) and its amendments, the U.S. Environmental Protection Agency (USEPA) is responsible for determining how well the national standards for ambient air quality (NAAQS) are being met [10-12]. Mobile sources – vehicles – are tracked for their contribution to the presence in the atmosphere of *criteria pollutants*: carbon monoxide (CO), lead (PB), oxides of nitrogen (NOX), ozone (O_3), oxides of sulfur (largely sulfur-dioxide, SO_2), and particulate matter (PM 10 and PM 2.5) (see Table 7-2) [12].[9] With the banning of lead as a fuel additive, concentrations of lead in the nation's air attributable to highway vehicle emissions decreased by 93 percent [13]. There are a variety of toxics emitted from vehicle tailpipes, which USEPA recognizes, but has yet to regulate [12].

[9] National Ambient Air Quality Standards, from 40 CFR 86.

Table 7-2. National Ambient Air Quality Standards

Pollutant	Primary Standards	Averaging Times	Secondary Standards
Carbon Monoxide	9 ppm (10 mg/m^3)	8-hour[1]	None
	35 ppm (40 mg/m^3)	1-hour[1]	None
Lead	1.5 µg/m^3	Quarterly Average	Same as Primary
Nitrogen Dioxide	0.053 ppm (100 µg/m^3)	Annual (Arithmetic Mean)	Same as Primary
Particulate Matter (PM_{10})	50 µg/m^3	Annual[2] (Arith. Mean)	Same as Primary
	150 ug/m^3	24-hour[1]	
Particulate Matter ($PM_{2.5}$)	15 µg/m^3	Annual[3] (Arith. Mean)	Same as Primary
	65 ug/m^3	24-hour[4]	
Ozone	0.08 ppm	8-hour[5]	Same as Primary
	0.12 ppm	1-hour[6]	Same as Primary
Sulfur Oxides	0.03 ppm	Annual (Arith. Mean)	-------
	0.14 ppm	24-hour[1]	-------
	-------	3-hour[1]	0.5 ppm (1300 ug/m^3)

[1] Not to be exceeded more than once per year.

[2] To attain this standard, the expected annual arithmetic mean PM10 concentration at each monitor within an area must not exceed 50 ug/m^3.

[3] To attain this standard, the 3-year average of the annual arithmetic mean $PM_{2.5}$ concentrations from single or multiple community-oriented monitors must not exceed 15 ug/m^3.

[4] To attain this standard, the 3-year average of the 98th percentile of 24-hour concentrations at each population-oriented monitor within an area must not exceed 65 ug/m^3.

[5] To attain this standard, the 3-year average of the fourth-highest daily maximum 8-hour average ozone concentrations measured at each monitor within an area over each year must not exceed 0.08 ppm.

[6] (a) The standard is attained when the expected number of days per calendar year with maximum hourly average concentrations above 0.12 ppm is <= 1.

(b) The 1-hour standard is applicable to all areas notwithstanding the promulgation of 8-hour ozone standards under Sec. 50.10. On June 2, 2003, (68 FR 32802) EPA proposed several options for when the 1-hour standard would no longer apply to an area.

7.1.3.2 Health Hazards of Diesel Pollutants

The primary pollutant of concern from automobiles in the U.S. is hydrocarbons – specifically carbon dioxide (CO_2); NOX and particulate matter are currently the most troublesome by-products of the diesel-engine combustion cycle. NOX is a precursor to ground-level ozone, and also contributes to the development of acid rain and eutrophication of the nation's waters. Particulate matter increases atmospheric opacity, the haze reducing visibility, and can be a serious lung irritant [14]. A recently completed USEPA report summarizes the adverse effects of diesel emissions on health:

> The assessment concludes long-term (i.e., chronic) inhalation exposure is likely to pose a lung cancer hazard to humans, as well as damage the lung in other ways depending on exposure. Short-term (i.e., acute) exposures can cause irritation and inflammatory symptoms of transient nature, these being highly variable across the population. The assessment also indicates that evidence for exacerbation of existing allergies and asthma symptoms is emerging [2].

The World Health Organization [15], California Air Resources Board [16], and Health Effects Institute [8] have all underwritten research studying the effects of diesel exhaust on human health. While debate continues within the USEPA, environmental groups, and the medical community over epidemiological methodology and study conclusions regarding diesel emissions, there is general consensus that NOX and particulate matter from diesel exhaust have an adverse effect on human health. A Rowan University study concluded the hazards from diesel engine particulate matter were higher inside the diesel school bus under study, than particulate levels in the ambient air outside the bus [17]. In 2000, the California Air Resources Board estimated diesel particulate matter was responsible for 70 percent of the state's airborne toxics cancer risk [18]. Most recently, the Union of Concerned Scientists (UCS) evaluated the economic impact of diesel related health problems, finding "the relatively modest costs of pollution cleanup could pay off in reduced hospitalizations, fewer asthma cases, and saved lives." [19] Agency conclusions regarding the carcinogenic potential of diesel emissions are summarized in Table 7-3.[10]

Table 7-3. National Ambient Air Quality Standards

Year	Organization	Conclusion
2002	U.S. Environmental Protection Agency	Likely human carcinogen
2001	American Council of Government Industrial Hygienists (proposal)	Suspected human carcinogen
2001	U.S. Department of Health and Human Services	Reasonably anticipated to be a human carcinogen
1998	California Air Resources Board	Toxic air contaminant
1996	World Heath Organization International Programme on Chemical Safety	Probable human carcinogen
1995	Health Effects Institute	Potential to cause cancer
1990	State of California	Known to cause cancer
1989	International Agency for Research on Cancer (IARC)	Probable human carcinogen
1988	National Institute for Occupational Safety and Health (NIOSH)	Potential occupational carcinogen

[10] From 40 CFR 86, Sick of Soot: Reducing the Health Impacts of Diesel Pollution in California, Union of Concerned Scientists, 2004.

With the implementation of cleaner diesel fuel, it is expected diesel engines will be equipped with particulate traps and/or catalytic converters to meet more stringent USEPA emission standards. There is great concern over a greater incidence of PM2.5 (shorthand reference to particles 2.5 microns in diameter and smaller) [20] [21]. The same technologies that "strain" larger particles from diesel engine exhaust leave the smaller particles free to pass through [22]. Technology to capture these small particles is limited [23], and has become the focus of significant research [24] [23]. For the immediate future, however, the net result may be that by cleaning up diesel exhaust to remove SO_2, NOX, and PM 10 the volatility of PM 2.5 is increased, with concurrently greater negative affects on human cardiovascular and respiratory systems [29]. As reflected by current EPA rulemaking regarding particulate matter 2.5 microns in diameter and smaller, marked concern exists over these very small particles. Figure 7-2 presents the projected emissions from U.S. trucks in 2030.[11]

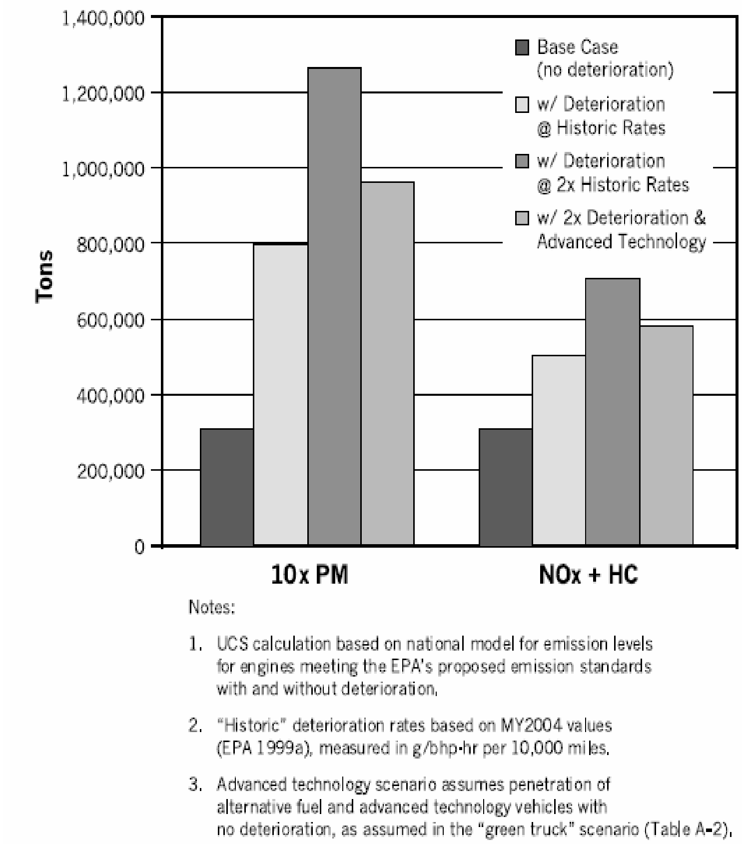


Figure 7-2. Emissions from US Trucks in 2030.

7.1.3.3 Emissions Modeling

The 1970 Clean Air Act required the USEPA take specific actions to reduce pollutants from the nation's vehicles [30]. Among the first steps taken was to set standards for air quality--embodied in the NAAQS. As part of the CAA congress also required the agency to assess the amount of pollution being emitted by the nation's vehicles. The USEPA was also directed to take measures to reduce levels of the six criteria pollutants discussed earlier. Significantly, the companion 1970 Federal Highway Act directed FHWA to balance proposed highway construction with State

[11] From: Rolling Smokestacks: Cleaning Up America's Trucks and Buses, Union of Concerned Scientists, 2000.

Implementation Plans (SIPs) – legally requiring the USDOT to formally account for USEPA-set air quality standards in its construction planning [31].

Congress mandated USEPA model the emissions of the national fleet of vehicles in order to estimate regional emissions, assess NAAQS conformity, and to predict levels of vehicle pollutants in future. Under direction of the National Research Council, USEPA developed models to estimate emissions, complying with congressional direction [32]. After several years in development, the first iteration of vehicle emission model was fielded in 1978. The output from this model and future iterations is used by USEPA, state, and regional air quality planners as one component of the formal estimates of air quality – the SIPs [33]. The model output was also used to assess whether the criteria in a SIP are being met – a transportation conformity determination. In the 1990 Clean Air Act Amendments congress "…establish[ed] (sic) significant new challenges to transportation and air quality modelers to improve estimates of traffic and emissions from mobile sources" [34].

Congress continued to stress the role of emissions modeling in the Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA) [35] and most recently in the Transportation Efficiency Act (TEA-21) [36]. As a result, on February 24, 2004 the USEPA released final policy guidance regarding use of its most recently updated mandatory vehicle air pollution model – MOBILE v6.2 – and development of state implementation plans [37].

7.2 MOBILE

The mobile source emissions factor model, "MOBILE", is one of several models approved by the USEPA and mandated for use in air quality planning and regulation [32]. MOBILE estimates CO, volatile organic carbons (VOCs), and NOX in grams per mile. When combined with vehicle VMT for a fleet of vehicles, road-way types (highway, secondary, or surface street), and environmental factors (particularly temperature, humidity and cloud cover), MOBILE produces a vehicle emissions estimate in tons per day for the geographic area under study. Separate computer models associated with MOBILE are used to estimate toxics (MOBTOX) and particulate matter (PART 5). MOBILE estimates total vehicular emissions – not just tailpipe emissions. Included in MOBILE output are evaporative emissions from vehicle refueling and from the vehicle fuel tank and engine when the vehicle is not operating, and estimates for tire and brake dust particulates.

Three categories of data are needed to run the MOBILE model – transportation, vehicular, and environmental [38]. Transportation data denotes the type of roadway facility – an allocation between freeway, arterial, and local roads. The second entering argument describes the vehicle fleet under study. Portions of this description include the average speed maintained by the vehicle fleet over the facilities. The vehicle fleet is segregated into one of 28 vehicle types, further categorized by year and odometer mileage, so that the fleet of vehicles used in the MOBILE model is adjusted to match vehicle registrations in the geographic area under study. The Reid fuel vapor pressure – a measure of fuel volatility – is another essential vehicle-related input. VMT for the fleet of vehicles under study is the last fleet-related entry. The third entering data set is comprised of environmental factors including ambient air temperature, relative humidity, and cloud cover. MOBILE also reflects vehicle starts and trip distributions throughout the day, on an hourly basis. With these inputs MOBILE output estimates emissions to the thousandth digit. These factors are multiplied by the number of vehicle miles in a typical SIP, rolling up estimates of grams per mile per vehicle to total tons of pollutant emitted per day, month, or year in the region under study.

MOBILE is built on the vehicle emissions captured from each vehicle – estimated from running vehicles on a chassis dynamometer on a routine that mimics a proscribed driving route of varying speeds and engine loads – the Federal Test Procedure (FTP). Various test cycles are developed to be run on the dynamometers, incorporating different profiles of speed and simulated road grade. The FTP program relies on a series of emission profiles for every make and model of vehicle operated in the United States, further broken into specific engine displacements and transmissions, by year. The emissions are then aggregated according to vehicle sales matching the national fleet. (While chassis dynamometer testing is widespread among cars, such testing is much more difficult and expensive for HDD trucks and buses; consequently dynamometer testing of these vehicles is not as extensive as for automobiles. Alternatively, HDD engines may be tested out of the vehicle on test stands. On-road testing for heavy-duty vehicles is much less extensive among HDD vehicles than automobiles. Engine manufacturers – gasoline or diesel – test a sample of all engines produced to demonstrate they meet emissions standards when new. The result of using emissions from these FTP cycles is a model built on data from simulated real-world driving conditions, and an accepted yardstick for control, replicability, and measurement of engine emissions conformity under laboratory conditions.

Emissions from diesel engines have not been well characterized by MOBILE. Before a consent degree against the major U.S. diesel engine manufacturers in 1998 [39], diesel engines were sold with “defeat devices” permitting over the road truck operators to significantly increase fuel mileage at the expense of greater emissions, by altering the engine operation to increase fuel mileage and horsepower, at the expense of emissions. Engine operation in such fashion was contrary to operation under the testing conditions used to ascertain that engines met the USEPA-mandated emission standards. As late as 2002, USEPA was continuing enforcement action against diesel engine manufacturers, who continued to build engines emitting up to four times permitted NOX levels [39]. The subterfuge called into question the validity of the FTP procedures used to develop the emission factors in the USEPA’s models, and an acknowledged shortcoming of MOBILE in modeling real-world emissions.

“Cheating” aside, systemic problems exist in estimating emissions of diesel engines at idle or low operating speeds. The problems in using MOBILE to estimate HDD emissions at idle as stated by one researcher are,

> The PART5 idle emission factors are based on data obtained from engine manufacturers, presumably from engine dynamometer testing under engine certification conditions. MOBILE5 factors are obtained from an algorithm that converts low speed (2.5 mph) g/mi emissions to g/min idle emissions. The MOBILE5 factors are also obtained from engine certification data. The PART5 model does not allow altitude as input[40].

7.2.1 Emissions Studies

Recognition of these shortcomings resulted in a number a number of studies. There are several methodologies used to measure on-road emissions, validating emission profiles generated during chassis dynamometer test runs, and the emission databases that form the entering argument for MOBILE.

7.2.2 Tunnel Studies

The fixed volume of tunnels and controlled vehicle access to tunnels lends investigators a great degree of control in minimizing factors that may confound vehicle emission studies. In 1987, a tunnel experiment in Van Nuys, California revealed USEPA's models badly under-predicted CO and HC. In 1992, a time-phased study of vehicle emissions in the Fort McHenry Tunnel (Baltimore), and the Tuscarora Mountain Tunnel (Pennsylvania) Tunnel [41, 42] measured levels of CO, NO, NOX and other hydrocarbon compounds during 11 one-hour periods. The median age of vehicles using the tunnels during the period was estimated from observations taken, and the number of vehicles was tallied. Both tunnels exhibited high-speed, steady flow traffic. The 1992 tunnel study was the second time a tunnel study was used to validate then current USEPA emission models. By the time of the 1992 study, USEPA had updated the model to MOBILE v4.1, and developed a major new update – MOBILE v5. The 1992 study indicated that emissions were predicted to within plus or minus 50 per cent, with MOBILE v5 having a tendency to overprediction. The study authors had several recommendations to improve the MOBILE models, including use of real-world data to as a means to determine real-world exhaust-only profiles (removing the effects of background levels of pollutants under study in the ambient air).

Despite recognized limitations, the ability to measure emissions from a large number of on-road vehicles under fairly controlled real-world conditions continues to tunnel studies appealing. Such studies could also provide

> …an updated assessment of fine particle emissions from light- and heavy-duty vehicles…due to recent changes to the composition of gasoline and diesel fuel, more stringent emission standards applying to new vehicles sold in the 1990s, and the adoption of a new ambient air quality standard for fine particulate matter (PM 2.5) in the United States [43].

Accordingly, Kirchstetter measured emissions from vehicles in a northern California roadway tunnel during summer 1997. He found that

> …heavy-duty diesel trucks emitted 24, 37, and 21 times more fine particle, black carbon, and sulfate mass per unit mass of fuel burned than light-duty vehicles. Heavy-duty diesel trucks also emitted 15-20 times the number of particles per unit mass of fuel burned compared to light-duty vehicles. Diesel-derived particulate matter contained more black carbon (51+/-11percent of PM2.5 mass) than did light-duty fine particle emissions (33+/-4 percent)…Sulfate emissions measured in this study for heavy-duty diesel trucks are significantly lower than values reported in earlier studies conducted before the introduction of low-sulfur diesel fuel, suggesting that heavy-duty diesel vehicles in California are responsible for nearly half of oxides of nitrogen emissions and greater than three-quarters of exhaust fine particle emissions from on-road motor vehicles.

7.2.3 Remote Sensing

While not as controlled as tunnel studies, "remote" road-side sensing is another method employed to measure the pollution at specific points along a roadway [44-46]. Various techniques are applied to the data collected to account for levels of pollutants in the ambient air – background pollution that would otherwise confound the observations. A significant study of this type was conducted in Las Vegas, Nevada from April 2000 through May 2002, measuring some 61,000 gasoline and nearly 1200 diesel powered vehicles [47]. The study measured CO, NO, HC, and PM emissions per unit of fuel burned. Researchers recorded vehicle speed and acceleration. Vehicles were classified by age, weight class and fuel type by matching vehicle license plates to state registration data. The authors compared fuel-based emission factors from their observations to the emission factors in MOBILE v6, finding good agreement between the observed and modeled estimations for HC. Measured NO factors were in good agreement with MOBILE for vehicle less than 7 years old. However, MOBILE CO emissions were approximately twice as great as for measured CO in vehicles less than 13 years old. Measured PM clearly increased with vehicle age; MOBILE v6 PART5 estimates of particulate matter were erratic – attributed by the authors to the small vehicle sample used by USEPA to build the database for this factor in the model.

7.2.4 "Behind-Rig" Sampling

On-road testing of heavy-duty diesel vehicles was mandated by the courts to ascertain engine manufacturers' compliance with the resulting consent decree, and to update USEPA's HDD emission models. Consequently, the University of California (Riverside) and a consortium of universities led by the University of Minnesota each developed heavy-weight mobile laboratories to measure emissions from the exhaust plumes trailing heavy duty diesel vehicles operating on-road (see Figure 7-3).[12] Brown [48] details the operation of the USEPA's "behind-rig" tractor-trailer, comparing it with current chassis dynamometer test procedures. The author concludes that behind-rig sampling can be used to validate chassis dynamometer testing, and more importantly gather data under vehicle operating modes outside the capability of U.S. chassis dynamometers. Such testing was a way to validate inputs to the MOBILE model over the course of a trip that tunnel studies or remote sensing could not; it was also a way to spot check diesel engine manufacturers for compliance with terms of the consent decree.

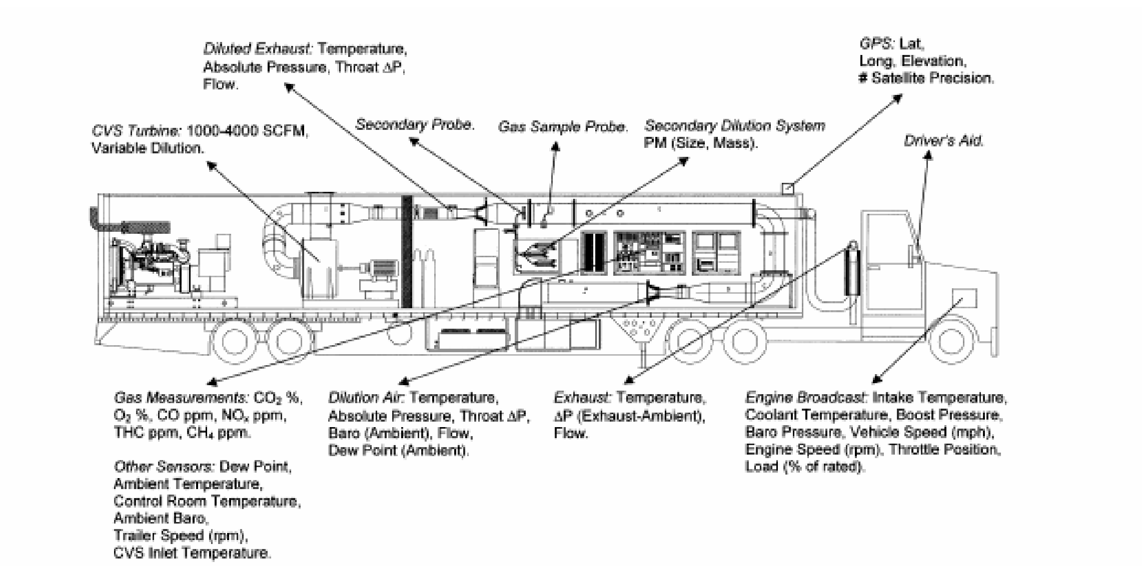


Figure 7-3. Mobile Emission Laboratory.

Because of the very limited number of these rigs, this testing expensive, hence limited in its applicability. Despite these limitations, the extensive and detailed characterization of diesel emissions under on-road conditions these rigs make possible cannot be obtained in any other fashion. Analysis of data from such testing is proving particularly important in the further study

[12] From: Development and Application of a Mobile Laboratory for Measuring Emissions from Diesel Engines. 1. Regulated Gaseous Emissions, Environmental Science and Technology, 2004.

and setting of standards for diesel-fueled engine emission toxics and hazardous air pollutants (HAPs) now being studied [49] [48][22, 50] [51] [52, 53].

7.2.5 HDD Idling Emissions

Heavy-duty diesel trucks spend a significant amount of time with their engines idling, substantially increasing the pollutant emissions from these vehicles. According to one study, many of the 458,000 long-haul trucks in the US that travel more than 500 miles from home base each day could idle somewhere between 3.3 and 16.5 hours per day [54]. Broderick estimated HDD trucks idle the equivalent of 1,830 hours per truck per year parked, consuming about 838 million gal of diesel fuel in the process [55]. Operators idle their engines to provide power for truck accessories, to provide climate control for sleeper cabs (most long-haul truckers sleep in their cabs while on the road, according to Brodrick), to recharge batteries, or to keep the engine and fuel system warm. [3] HDD trucks can also spend a significant amount of time at idle in traffic. Figure 7-4 presents the distribution regarding the percentage of idle attributed to various causes.[13]

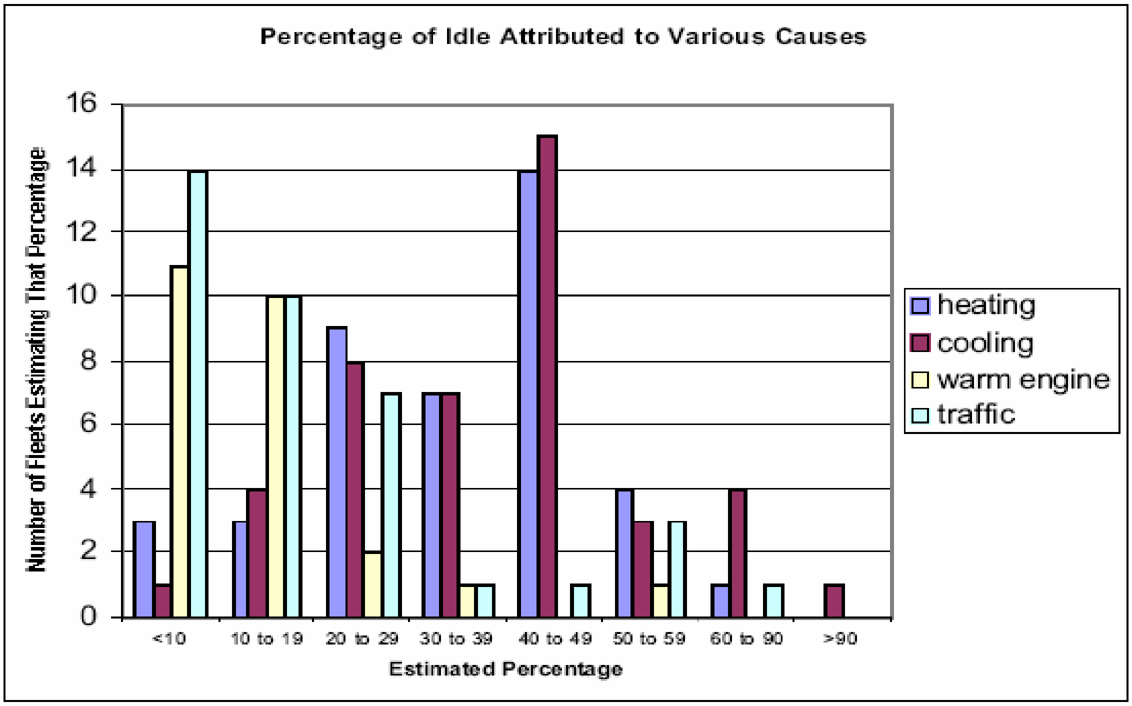


Figure 7-4. Distribution of the Percentage of Idle Attributed to Various Causes

Idling is a significant issue for a variety of reasons. Idling is a poor application of resources, burning fuel and producing wear on the engine without the vehicle making any progress in delivering its goods. Idling produces airborne emissions and noise. Despite this, there is no federal standard on idling operations. Rather, idling restrictions are the purview of states and localities, resulting a hodge-podge of rules and regulations [56].

Idling also does not occur in the efficient range of diesel engine operation, as HDD operators often increase engine speed during idle to power accessories, air conditioning and recharge

[13] From: Idle Reduction Technology Needs Assessment, National Renewable Energy Laboratory (NREL) 2003.

batteries. In 1998, the USEPA published pollutant emission tables for winter and summer conditions [57].

McCormick examined idle emissions (THC, CO, NOX, and PM), as well as VOF and aldehyde from 24 heavy-duty diesel-fueled (12 trucks and 12 buses) and 4 heavy-duty CNG-fueled vehicles using procedures comparable to those used in engine certification testing [40]. (Experiments were conducted at 1609 m above sea level.) McCormick compared results of the study with idle emissions factors obtained from U.S. Environmental Protection Agency inventory models (MOBILE 5, and PART5), concluding that

> …the models significantly (45 – 75 percent) overestimated emissions of THC and CO in comparison with results measured from the fleet of vehicles examined in this study. Measured NOX emissions were significantly higher (30 – 100 percent) than model predictions.

Broderick, in a study with Southwest Research Institute (SwRI) decomposed the HDD idling operational regime further, concluding that "…raising the engine speed from 600 to 1050 revolutions per minute (rpm) and turning on the air conditioning resulted in an increase in NOX emissions of 2.5 times and an increase in CO emissions." [55] The effects of elevated idle speed, use of accessories, and air conditioning is evident in Table 7-4..[14]

Table 7-4. Emissions Test Results

Mode	HCs	CO	NOX	CO_2
	(grams per hour)			
Idle after cruise	1.8	14.6	103	4034
Idle after transient cycle	2.9	15.9	105	4472
Idle at 1050 rpm with a/c	N/A	86.0	254	9441
Long idle at 1050 rpm with a/c	86.4	189.7	225	9743
Cruise 55 mph, no a/c	5.6	65.1	713	60,590
Cruise at 55 mph, with a/c	3.9	57.4	777	60,320

Oak Ridge National Laboratory personnel measured CO, HC, NOX, CO_2, O_2, PM, aldehyde, and ketone emissions from HDD trucks at idle as part of a multi-agency study concerning emissions and fuel consumption from heavy-duty diesel truck idling [58]. Five class-8 trucks (model years 1992 to 2001) were tested in the U.S. Army's Aberdeen Test Center's climate-controlled chamber. Trucks were idled at a high and low engine speeds at 90 °F, 65 °F, and for approximately three hours, with the air conditioning or heater in the truck cab adjusted to maintain a target cabin temperature of 70 °F.

> Results for PM emissions showed a wide range of emissions rates ranging from less than 1 g/hr to over 20 g/hr, with the newest trucks in the 1-5 g/hr range. PM emissions generally decreased with an increase in ambient temperature and increased disproportionately with an increase in engine speed. Aldehyde mass

[14]From: Effects of Engine Speed and Accessory Load on Idling Emissions from Heavy-Duty Diesel Truck Engines, 2002.

emissions rate increased with both decreasing temperature and increasing engine speed.

7.2.6 Implications

Emissions from HDD trucks are a significant health concern, cited as carcinogenic by USEPA, CARB, and HEI. This concern is likely to increase markedly with the greater number of vehicle miles traveled forecast for HDD vehicles, and perhaps with the greater increase in PM2.5 engendered in the application of new USEPA standards.

For a variety of reasons, USEPA's models appear unlikely to accurately capture the full impact of HDD truck emissions at idle, leading to an underestimation of the negative effects of idling. This underestimation also does little to provide empirical support for concerted efforts to develop procedures and technologies to reduce HDD idling. Research along varied tracks continues to suggest revisions to USEPA models to better account for real-world HDD emissions. In this regard, idling emissions of these vehicles is an area of particular USEPA interest.

HDD idling accounts for a significant portion of the time these vehicles are operated. Measures to reduce idling promise to not only increase the efficiency of these trucks, but also reduce noise and pollution. Efforts to reduce idling emissions are likely to restrict current operational practice and seek to reduce idling in traffic.

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