**Title**

# Commercial Motor Vehicle Inspection and Screening Stations: Evaluating Performance from the Perspective of Practitioners



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**July 6, 2009**

**ACKNOWLEDGEMENTS**

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## ABSTRACT

This report presents the findings of a study of commercial motor vehicle inspection and screening station practices with a focus on the use of various technologies to help address problems related to safety, security, roadway infrastructure, and air quality. A review of industry literature identified the various types of inspection and screening practices that have been and are being implemented including weight and size management, on-board equipment checking, driver-related violations and cargo monitoring, credential checking, and exhaust emissions monitoring. The review also identified technologies that have been employed as part of these practices as well as an assessment of their performance. The research also involved the use of a survey of State and Provincial Departments of Transportation in North America that have implemented specific practices. Survey findings indicate that to a certain degree a more integrated and multi-practice approach is being taken; a wide array of technologies is in use; and, technology evaluations show they have generally performed well.

**Key Words: commercial motor vehicles, roadside inspection and screening practices, technologies, evaluation**

## EXECUTIVE SUMMARY

This report constitutes the second interim deliverable for PATH Project Task Order 6105 under Contract Number 65A0208 – *Compliance & Commercial Vehicle Operators: A Systems Evaluation of the Problem & Virtual Solutions*.

The commercial motor vehicle (CMV) industry plays a crucially important role in the U.S. freight transportation system, which in turn is the lifeblood of the nation's economy. However, continued growth in freight movement in general and by trucks in particular has placed pressure on an already congested transportation system. In particular, commercial motor vehicle inspection and screening stations and associated practices have not kept pace with such growth in CMV volumes; if a substantial number of trucks need to be inspected then queues can form at these stations, contributing to a number of problems. Alternatively, station operators may choose to allow trucks to bypass overcrowded stations creating another set of problems. Together, such problems can directly impact safety, security, quality of roadway/bridge infrastructure, and air quality. The goal of this research was to provide guidance into understanding CMV inspection and screening practices and their impacts as well as the extent to which an integrated building-block approach is used relative to such practices with a focus on the use of technologies and their effectiveness.

Initially, we investigated background material based on previous research of technology and evaluation literature. The literature is well supplied with papers that document the use of various technologies that have been employed to advance the state of the practice of commercial motor vehicle inspection and screening activities together with assessments of their impacts including benefits. In these papers, the assessments of technologies have been based on direct experimental evaluation as well as analytical models and/or simulations. Evaluation findings show overall good performance under operational conditions.

As part of our continued investigation into the use of CMV inspection and screening stations the research team designed and administered by e-mail a web-based survey of North American State/Provincial Departments of Transportation that examined

1. Information about the respondent, including name, title, and position at work, telephone number, and e-mail address.
2. Importance of various commercial motor vehicle inspection and screening practices.
3. Importance of various potential impacts of the aforementioned inspection practices
4. Current implementation stage of each participants' CMV inspection and screening practices
5. Technologies associated with each CMV inspection and screening practice
6. Evaluations for each technology

While the response rate was 47%, (corresponding to 29 response sets representing 62 states and provinces) the set of respondents represented a close fit to the entire sample of potential participants receiving invitations to complete the survey. Findings indicate that there is a fairly wide distribution of primary work areas although with focus on research, operations, planning, and executive/administrative. The initial two survey questions asked participants to 1) rate the

level of importance to their state or province to be engaged in particular CMV inspection and screening practices, consisting of

- Weight management
- Size management
- On-board equipment checking
- Driver violations monitoring
- Cargo monitoring
- Credential checking, and
- Exhaust emissions monitoring

and to 2) rate the level of importance of potential impacts arising from such practices, consisting of

- Safety
- Security
- Road/bridge infrastructure quality, and
- Air quality

For the rated levels of importance for each of the seven CMV inspection and screening practices (see Figure ES-1), weight measurement expectedly receives the greatest ratings of all activities as 100% of responses indicate that this activity is either ‘Important’ or ‘Very Important’. Next, for size measurement and driver-related violations monitoring at least 90% of responses indicate that these two practices are either ‘Important’ or ‘Very Important’. For on-board equipment checking and credential checking, 72% and 86% of responses, respectively, rated these two activities either ‘Very Important’ or ‘Important’. For cargo monitoring 58.6% of responses indicate that this activity is ‘Very Important’ or ‘Important’. Finally, for the lowest rated activity, exhaust emissions monitoring/detection, only 31% of responses rated this activity as either ‘Very Important’ or ‘Important’.

The second question dealt with rating the level of importance of potential impacts that could result from engaging in such inspection and screening practices. For safety and roadway/bridge infrastructure impacts, 100% of the responses rated each as ‘Very Important’ or ‘Important’. For security, almost 90% of responses rated this impact as ‘Very Important’ or ‘Important’. For air quality, 65.5% of responses rated this impact as ‘Very Important’ or ‘Important’.

Approximately 83% of respondents’ agencies currently involve various technologies for at least one of the described CMV inspection and screening practices. Approximately 14% have been involved but no longer are and 3% have to-date not been involved, however do have plans to do so. For the 83% of respondents’ agencies currently involved in with technologies, weight measurement, credential checking, and size measurement are the inspection and screening practices identified by the ***most*** respondents as fully deployed and operational; weight measurement and credential checking are the most mature practices from the deployment perspective because of the decreasing percentage values for each of these practices as a function of the level of involvement from *fully deployed and operational* to *no involvement*; on-board equipment checking, cargo monitoring, and exhaust emissions monitoring/detection rate highest in terms of *no involvement* (see Figure ES-2).

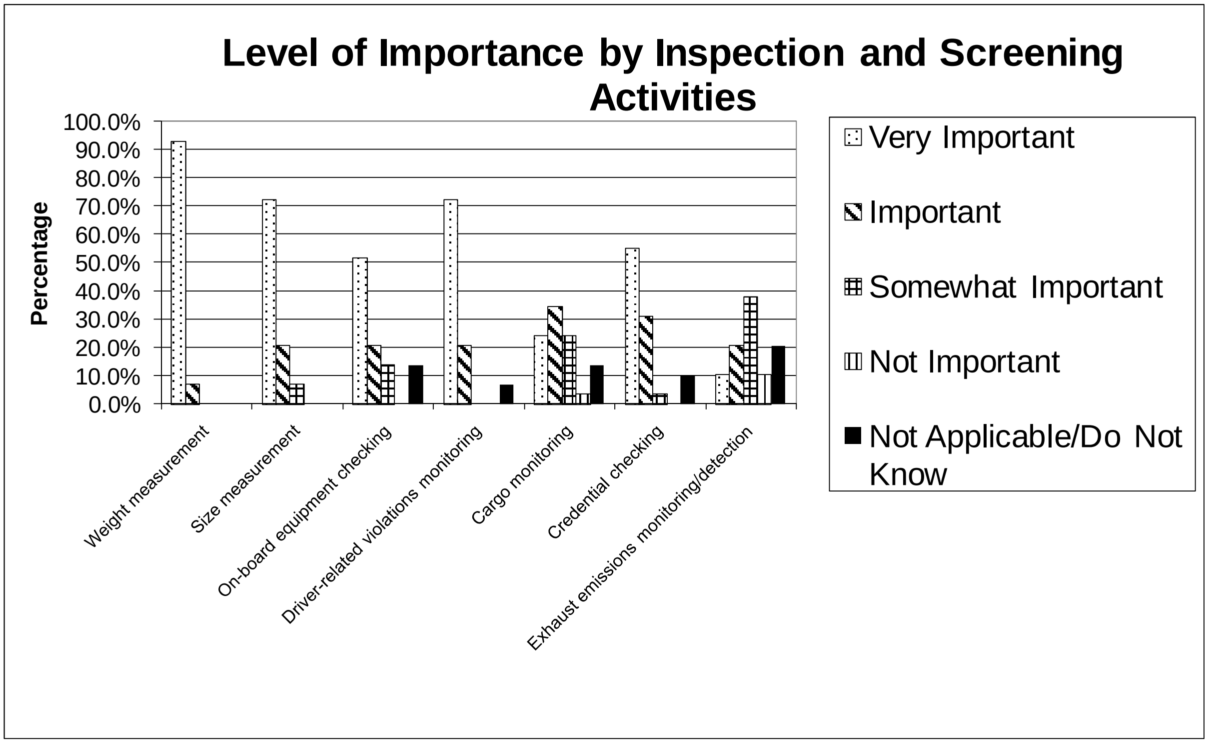


**FIGURE ES-1 Level of Importance by Inspection and Screening Activities**

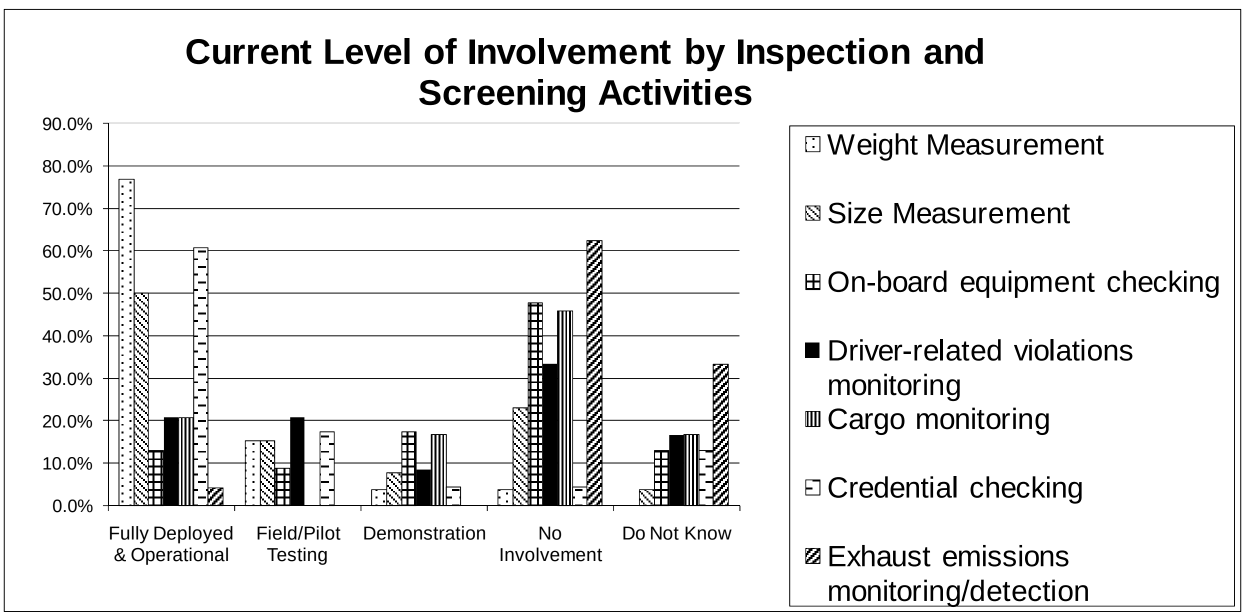


**FIGURE ES-2 Current Level of Involvement by Inspection and Screening Activities**

One-half of the respondents currently implementing technologies for CMV inspection practices have them fully deployed and operational in combinations of two to six practices. Whereas each multi-practice combination of any size contains weight measurement, only one multi-practice combination contains exhaust emissions monitoring. The most frequently appearing combination of inspection practices in the responses consists of weight and size measurement and credential checking. To a lesser degree, the combination of on-board equipment checking, weight and size measurement, and cargo monitoring is also used. Thus a multi-building block approach based on CMV inspection and screening practices is underway and it is important that additional measures be taken to further foster this holistic and integrated approach.

A wide assortment of technologies is being used to enhance the effectiveness of CMV inspection and screening practices. These technologies include weigh-in-motion systems, automated vehicle identification and classification systems, over-height and over-length detectors, license plate readers, biometrics, and infrared brake screening and detection systems.

More than seventy percent of survey respondents report that evaluations of these technologies have been performed. Based on responses to the evaluation-related survey questions, a typical evaluation was conducted within the last year, performed in-house at a State/Provincial DOT with a focus on technical performance criteria and resulted in an overall “Good” to “Excellent” rating. Evaluations are an essential tool to assess the effectiveness of CMV inspection and screening practices. Moreover, it is important that independent 3rd parties play a more prominent role as evaluator together with more diversified performance criteria used to conduct the evaluation.

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## 1.0 INTRODUCTION

The commercial motor vehicle (CMV) industry plays a crucially important role in the U.S. freight transportation system, which in turn is the lifeblood of the nation's economy. However, continued growth in freight movement in general and by trucks in particular has placed pressure on an already congested transportation system. For example, over the 23 year period between 1980 and 2002 U.S. truck travel grew by more than 90 percent while lane-miles of public roads increased by only 5 percent (*1*). This growth trend will continue as the Freight Analysis Framework estimates that the percentage of urban U.S. Interstates carrying 10,000 or more trucks will increase from 27 percent in 1998 to 69 percent in 2020. In terms of Average Annual Daily Truck Travel (AADTT) between 1998 and 2020, seven U.S. States will have AADTT increases of more than 100% and 31 States will have AADTT increases ranging between 75% and 99% (*2*).

In addition to lane-miles that have not kept pace with truck travel growth are commercial motor vehicle inspection and screening stations and associated practices. If a substantial number of trucks need to be inspected, then queues can form at these stations, contributing to a number of problems. For example, long wait times can compromise already slim profit margins for trucking companies; idling trucks waste fuel and contribute to air pollution; and if queues back up onto the highway, they can create safety hazards. Recognizing these problems, station operators may choose to allow trucks to bypass overcrowded stations, which compounds the problem since over-weight trucks lead to pavement and structure damage *(3 and 4)* significantly increasing roadway reconstruction and resurfacing costs. While truckers are among the safest category of drivers, crashes involving trucks are often catastrophic and over-weight and/or over-sized trucks can increase the likelihood of accidents. More recently, concerns about terrorism have underscored the need for increased freight monitoring. Thus such CMV inspection station issues can directly impact safety, security, quality of roadway/bridge infrastructure, and air quality. Table 1 depicts the relationships between several CMV inspection and screening practices and these impact areas.

**TABLE 1 Relationship between CMV Inspection/ Screening Activities and Impact Areas**

| CMV Inspection & Screening Activities | Road/Bridge Infrastructure | Safety | Security | Air Quality |
|---|---|---|---|---|
| **Weight Management** | X | X | | |
| **Size Management** | X | X | | |
| **On-Board Equipment Checking** | | X | | X |
| **Driver Violations Monitoring** | | X | X | |
| **Cargo Monitoring** | | X | X | |
| **Credential Checking** | | | X | |
| **Exhaust Emissions Monitoring** | | | | X |

The US DOT's Federal Motor Carrier Safety Administration and the Federal Highway Administration have sponsored technological solutions to such problems through their Smart Roadside Initiative Program. This report focuses specifically on the use of various technologies and their effectiveness to enhance the operational efficiency of the inspection and screening station practices listed in Table 1 to derive benefits in the areas of safety, security, roadway infrastructure, and air quality. Moreover, the report investigates the extent to which an integrated building-block approach is used relative to the implementation of inspection and screening practices.

Following this introduction, the next section offers background material based on previous research of the technology and evaluation literature. The report then discusses the methodology and findings of a web-based survey of U.S., Canadian, and Mexican State/Provincial Departments of Transportation (DOT), which were conducted to further investigate inspection and screening practices and their impacts. Finally, the report offers concluding remarks about this research.

## 2.0 PREVIOUS WORK

The literature is well supplied with papers that document the use of various technologies that have been employed to advance the state of the practice of commercial motor vehicle inspection and screening activities together with assessments of their impacts including benefits. In these papers, the assessments of technologies have been based on direct experimental evaluation as well as analytical models and/or simulations. This report discusses a small sample from the literature in the remainder of this section.

Trischuk, Berthelot and Taylor (5) used microsimulation to model traffic conditions at weigh stations. Their work examined 27 different scenarios with respect to several variables including hourly truck volumes, class 9 traffic load spectra and Weigh-in-Motion (WIM) accuracy. Their findings show that using WIM technology increases weigh station efficiency, which translate into considerable savings for both the enforcement agency relative to improved enforcement effectiveness and infrastructure protection and for the trucking industry relative to reduced user-delay costs.

Barnett and Benekohal (6) showed that accident reductions as a function of percent WIM-Automated Vehicle Identification (AVI) usage range between 30% and 40%. Their work consisted of a statistical analysis of accident data from eight Interstate highway weigh stations compared to a control group of similar freeways without weigh stations. Overall, there were significantly more accidents around weigh stations than for the control group, particularly during operating hours. By reducing turbulence in the mainline traffic stream around weigh stations, WIM-AVI technologies could potentially reduce rear-end and sideswipe crashes. A reduction in these types of crashes to the levels in the control group freeway segments cannot be realized because not all trucks will have a transponder and not all transponder-equipped trucks will be allowed to bypass; however, this study shows that accidents near weigh stations can be reduced the greater the usage of WIM/AVI technologies.

Bapna, Zaveri and Farkas (7) estimated the benefits and costs from WIM/AVI deployment in commercial vehicle operations (CVO) in Maryland by performing a benefit-cost analysis for state agencies, motor carriers and society at large. Six different scenarios were examined for three different discount rates and two deployment levels (low and high). The total benefits and costs for all stakeholders give a B/C ratio that varies from 3.17 (high discount rate, low deployment level) to 4.83 (low discount rate, high deployment level). Additional benefits are derived for

- Carriers and related state agencies due to automated credential processing.
- Motor carriers due to WIM and pre-clearance of legal and safe vehicles and drivers.
- Society at large due to identification of potentially high-risk carriers through inspection activities.

- Society at large due to identifying all illegally overweight carriers who otherwise may have caused accidents.

Kamyab et al, (8) estimated the effects of electronic screening on reducing travel time and enhancing productivity of weigh stations using a simulation model. Their results indicate that as participation grows enforcement agencies and participating and nonparticipating trucks all share in the benefits afforded by a more efficient system.

Stephens, et al (9) showed that WIM/Automated Vehicle Classification (AVC) systems provided significant benefits in overweight truck reduction as part of Montana's STARS (State Truck Activities Reporting System) Program, which uses WIM sensors and AVC technologies to automatically collect information on the characteristics of commercial vehicles operating on Montana highways. The system was evaluated over a two year period, and the data collected were used to support mobile weight enforcement activities and improve infrastructure pavement designs. The deployed system resulted in a 22% reduction of overweight vehicles in the traffic stream. The cost savings associated with the statewide reduction in pavement damage from overweight vehicles was $0.7 million.

Christiaen and Shaffer (10) conducted an evaluation of the Infrared Screening Inspection System (IRISystem) to detect brake-related defects on CMVs. The evaluation consisted of inspecting approximately 400 commercial vehicles in Georgia, Kentucky, North Carolina, and Tennessee during a one-year period using the IRISystem, which was housed in a mobile van and positioned in a roadside inspection facility where commercial vehicles applied their brakes to enter the facility. The IRISystem camera creates an infrared image of the vehicle showing the relative temperature of the vehicle's wheels. After the vehicle's brakes have been applied, a functioning brake appears bright white and a non-functioning brake appears dark. Evaluators found that the IRISystem could be used to effectively screen CMVs for inspection of brake-related problems.

In SAIC (11), security-related technologies for a hazardous materials (HAZMAT) field operational test (FOT) were evaluated including equipment used for vehicle and cargo monitoring and tracking, and communications and identification technologies. The FOT's purpose was to quantify the security costs and benefits of an operational concept that applies technology and improved enforcement procedures to the transport of HAZMAT and addressed the following risk areas: driver verification, off-route vehicle alerts, stolen vehicles, unauthorized drivers, cargo tampering, and suspicious cargo deliveries.

Deployed technologies included wireless mobile communications systems consisting of satellite and terrestrial communications with GPS-provided vehicle tracking and two-way communications; digital phone tracking without GPS; in-vehicle technologies including on-board computers that process data from vehicle sensors; panic buttons and electronic cargo seals; personal identification technologies (biometrics; fingerprint recognition technology; smart card technologies). Different combinations of these technologies were used with four HAZMAT cargo trucks.

Evaluation findings indicate that the performance of the various commercially available technologies was good overall, with most technologies performing well under operational conditions. The exceptions were biometric login and electronic seals, which required additional product development to be fully functional in the HAZMAT trucking environment. The technologies showed promise to enhance not only security, but also operational efficiencies and potentially, safety.

## 3.0 METHODOLOGY

As part of our continued investigation into the use of CMV inspection and screening stations the research team designed and administered a survey of North American State/Provincial Departments of Transportation.

### 3.1 Designing the Survey Instrument

There were six parts to the online survey:

3. Information about the respondent, including name, title, and position at work, telephone number, and e-mail address.
4. Estimation of the importance of various commercial motor vehicle inspection and screening practices.
4. Estimation of how important are various potential impacts of the aforementioned inspection practices
7. Identification of the current implementation stage of each participants' CMV inspection and screening practices

8. Identification of the technologies associated with each CMV inspection and screening practice
9. Description of evaluations for each technology

### 3.2 Identifying the Participants and Administering the Survey

AASHTO has a Technology Implementation Group (TIG) that focuses on the implementation of technologies to further AASHTO's mission and stated goals and objectives, in particular, "to identify, communicate, and facilitate the use of emerging research technologies, materials, processes, and programs" (*12*). The TIG administered a survey in 2005 focusing on WIM systems to members of AASHTO's Research Advisory Committee. Our research team administered our survey to current members of the same committee, which contain representatives from each State's Department of Transportation, Canadian Provinces' Ministry of Transport, and Mexico's Ministry of Transport; in some cases there were more than one member per state or province and e-mail invitations were sent to each such member to increase the likelihood that a completed survey from that particular state or province would be submitted; In total the research team e-mailed 75 invitations to participate in the survey to potential respondents along with a link to the survey website, which provided a general overview of the project, the purpose of the survey, survey instructions, and a statement assuring confidentiality of identity and individual responses. To help gather as representative a sample of state and provincial departments (ministries) of transportation as possible, the team additionally sent two e-mail reminders giving respondents more than five weeks to complete the survey. In the invitation, the team encouraged each invitee to forward the survey-participation request to another individual within his/her organization if he/she were not the appropriate respondent.

### 3.3 Survey Limitations

Because our sample universe has a relatively small population – only 75 individuals – the team did not intend this survey to be an exclusively quantitative evaluation but rather a more qualitative one with study findings interpreted as an assessment of current opinions and expertise. Nonetheless, the team believed that a small, yet knowledgeable and experienced group of potential participants would provide valuable insight. Our intent was not to perform rigorous statistical hypothesis testing, but rather to provide guidance into understanding CMV inspection and screening practices and their impacts.

While the team is confident that the research design chosen provides valid results, there are other issues worth mentioning. First of all, we assume that the respondents were the recipients of our original invitations to participate or staff for whom the invitations were forwarded by the original recipients. One may, for example, expect that our respondents tended to be staff at transportation departments or ministries who had, on average, more inclination to reply than did others; perhaps because they had recently experienced a major event in their work associated with CMV inspection stations such as a major deployment. Such individuals may have felt the desire to share that event with the research community. Similarly, it is likely that invitees who had more free time were more likely to respond. However, the team did not expect that these various paths of self-selection led to a significant systematic bias toward one result or another.

## 4.0 ANALYSIS AND FINDINGS

### 4.1 Respondents

Among the 75 e-mail invitations sent to members of the AASHTO TIG's Research Advisory Group, the team received 43 responses, of which eight respondents gave their consent to participate but then answered no other survey question. Of the remaining 35 respondents, one told the research team that a completed survey would be forthcoming but it never arrived; three other respondents each submitted two completed surveys and another submitted three surveys and for each of these the multiple responses were merged into a single completed response. In fact in one case, the survey was intentionally distributed to two individuals whose responses did not overlap thus merging their responses was trivial. Thus, 29 response sets remained for analysis representing 62 states and provinces, for an effective response rate of 47%. The 29 responses are comprised of 26 from the U.S. (gray-shaded States in Figure 1 plus Maryland and Delaware) and three Canadian Provinces (British Columbia, Alberta, and New Brunswick).

Survey respondents varied in several important ways, for example, in the U.S. respondents represented States of various sizes and populations. Of additional note is that more than two-thirds of all U.S. States that border either Canada or Mexico responded to the survey and more than 40% of all respondents are border line States.

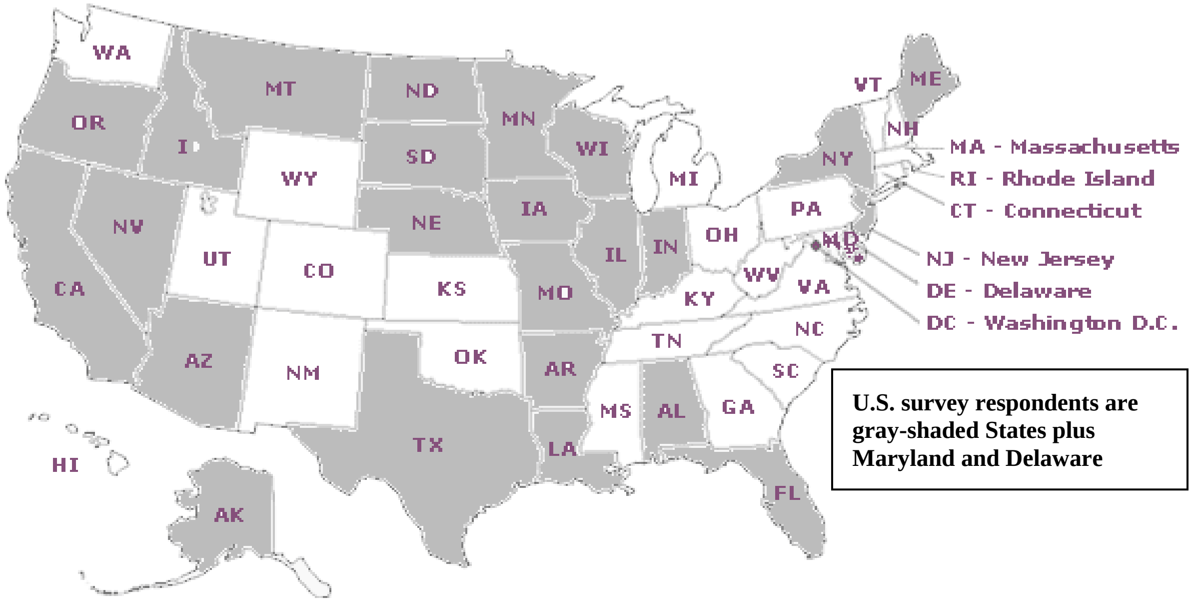


**FIGURE 1 U.S. Respondents to the Survey**

Another example of how the respondents varied is by primary work areas. Findings indicate that there is a fairly wide distribution of such areas although with focus on research, operations, planning, and executive/administrative as shown in Figure 2. These four areas cumulatively comprise over three-quarters of the work areas. Each respondent identified all work areas that were applicable to him/her and there were several respondents who identified multiple job areas. In these instances, each category identified was counted for these respondents. So, for example, if a respondent checked off “Research” and “Operations”, then both “Research” and “Operations” were counted as being his/her work areas.

To assess the representativeness of the survey respondents – at least the U.S. respondents – relative to the universe of state departments of transportation originally invited to participate in the survey, the team selected two criteria: 1) total volume of truck shipments (millions of tons) in 2002 within, from, and to each State and 2) total value (billions of 2002 dollars) of truck shipments for each State. Figures 3 and 4 show the distributions for these two criteria for, respectively, all 50 States and for those 26 States corresponding to the 26 respondents. In general, the distributions for truck shipment volume for all 50 States and the set of 26 respondents’ States are similar; there is even a closer fit between the distributions for truck shipment value for all 50 States and the set of 26 respondents’ States. Hence relative to the two selected criteria, the set of U.S. respondents reasonably represent the entire U.S.

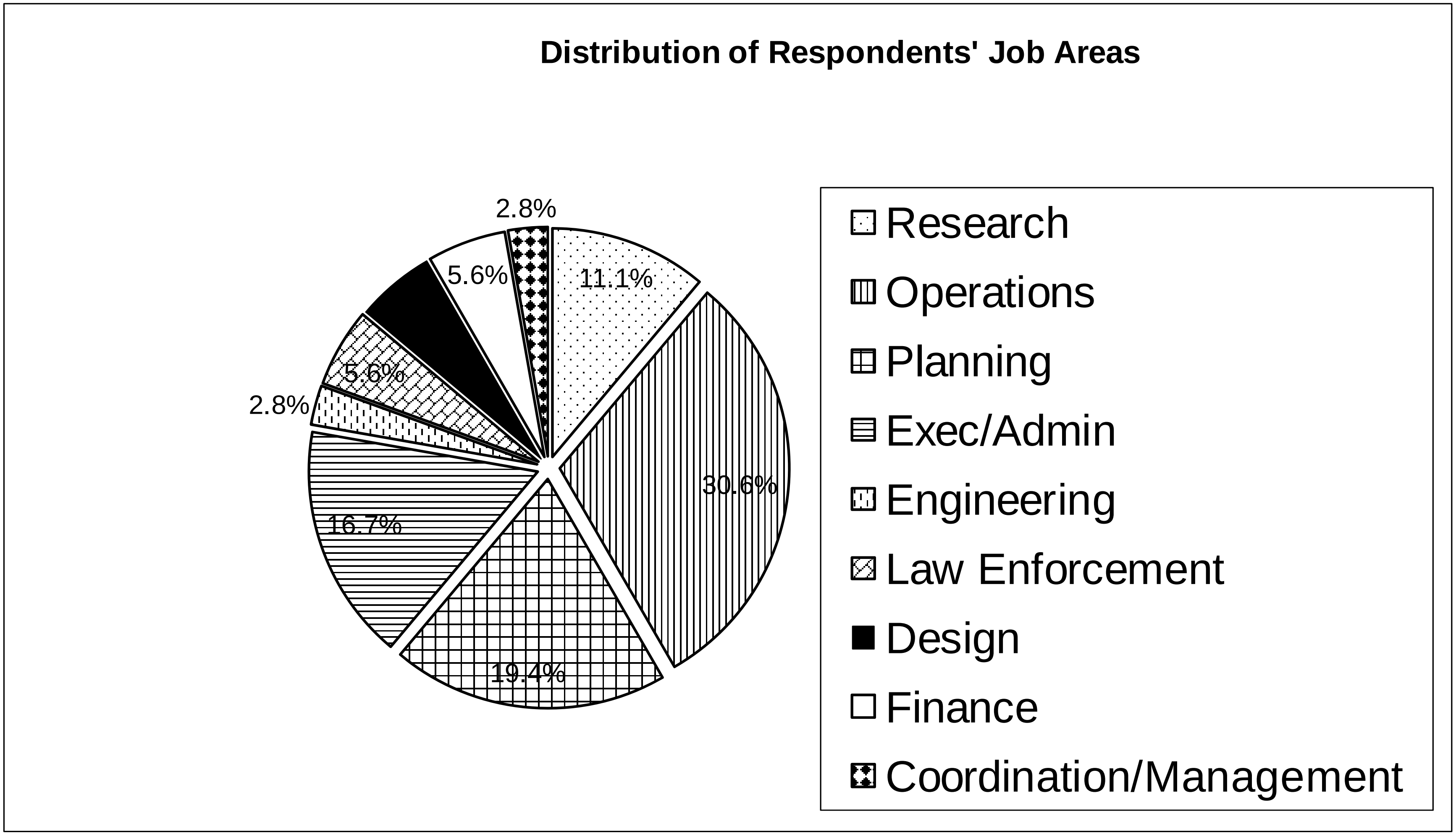


**FIGURE 2 Distribution of Respondents' Job Areas**

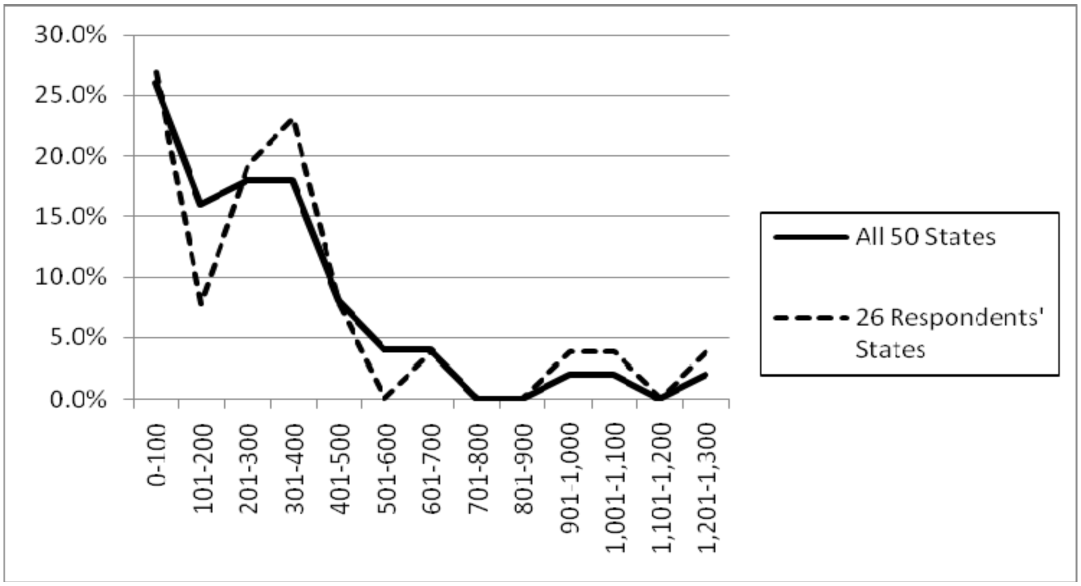


**FIGURE 3 Distribution of State Departments of Transportation by Volume of Truck Shipments (Millions of Tons)**

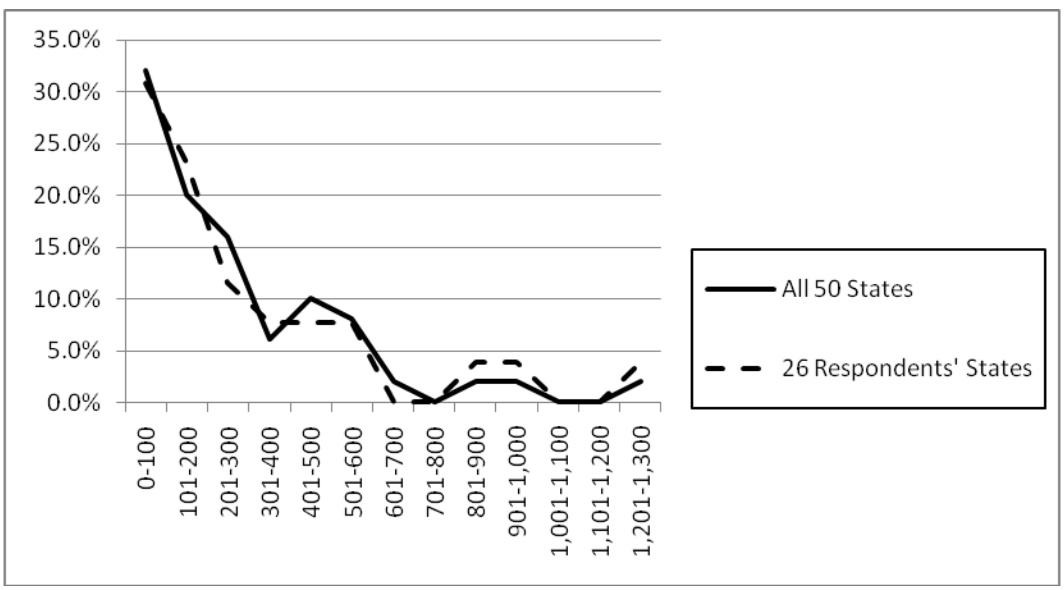


**FIGURE 4 Distribution of State Departments of Transportation by Value of Truck Shipments (Billions of 2002 Dollars)**

## 4.2 Responses

In this section, the report discusses the survey responses including the rating of CMV inspection and screening activities and their impacts; identification of current implementation stages for

CMV inspection and screening practices; identification of technologies associated with CMV inspection and screening practices; and description of technology evaluations.

### 4.2.1 Rating CMV Inspection and Screening Activities and their Impacts

The initial two survey questions asked participants to 1) rate the level of importance to their state or province to be engaged in particular CMV inspection and screening practices and 2) to rate the level of importance of potential impacts arising from such practices; each question used a 4-point *Likert* scale. Figure 5 shows the rated levels of importance for each of the seven CMV inspection and screening practices. Focusing on the top two tiers of the *importance* rating, that is, ‘Very Important’ and ‘Important’, we see that weight measurement expectedly receives the greatest ratings of all activities as 100% of responses indicate that this activity is either ‘Important’ or ‘Very Important’. Next, for size measurement and driver-related violations monitoring at least 90% of responses indicate that these two practices are either ‘Important’ or ‘Very Important’. For on-board equipment checking and credential checking, 72% and 86% of responses, respectively, rated these two activities either ‘Very Important’ or ‘Important’. For cargo monitoring 58.6% of responses indicate that this activity is ‘Very Important’ or ‘Important’. Finally, for the lowest rated activity, exhaust emissions monitoring/detection, only 31% of responses rated this activity as either ‘Very Important’ or ‘Important’.

Another way at looking at the responses to this question is to determine the average ranking for each inspection and screening practice using a numerical scoring of 1.00 for ‘Very Important’; 2.00 for ‘Important’; 3.00 for ‘Somewhat Important’; and 4.00 for ‘Not Important’ and calculate the average over all the responses as well as standard deviations; Table 2 shows the results. An average score of 1.00 would indicate that all respondents rated the attribute as “very important”, and an average score of 4.00 would indicate that all respondents rated the attribute as “not important”. As is typical with *Likert*-scale measurement, significant response clustering is evident, with nearly all average scores falling within the almost one-point interval [1.07, 2.08]. Table 2 divides the seven inspection and screening practices measured in our survey into four groups: the top activity (weight measurement) with an average score near 1.0 (Group 1); the second group on the *Likert* scale centers around approximately 1.40 (Group 2); the third group consists of a single activity (cargo monitoring) with an average score near 2.1; the fourth group again consists of a single activity (exhaust emissions monitoring/detection) with an average score near 2.60. The team notes that lower score (more important) activities correspond to those for which familiarity and experience is greatest.

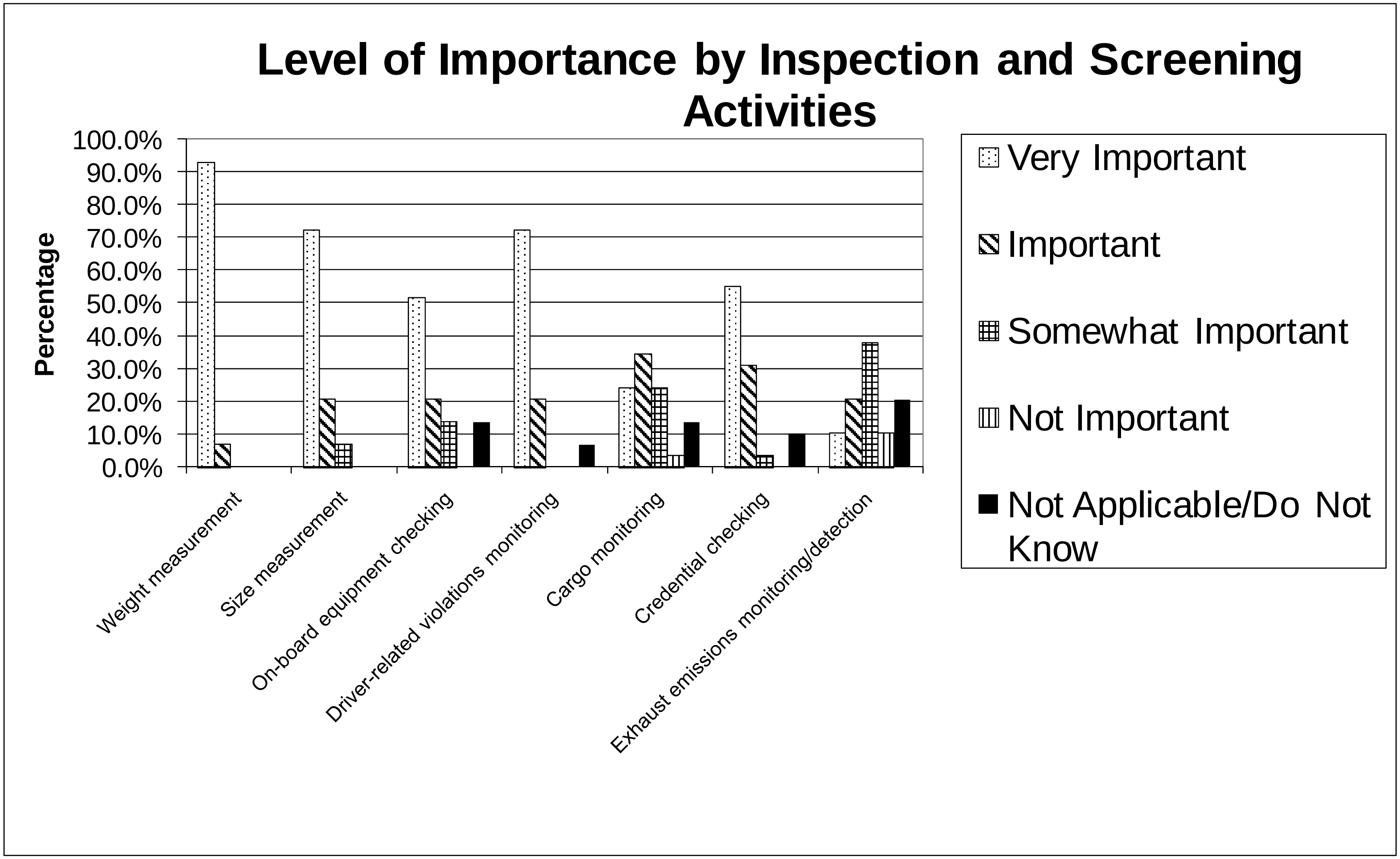


**FIGURE 5 Level of Importance by Inspection and Screening Activities**

**TABLE 2 Average Activity Scores**

| | CMV Inspection and Screening Practice | Mean Score | Standard Deviation | |
|---|---|---|---|---|
| 1 | Weight measurement | 1.07 | 0.26 | Group 1 |
| 2 | Driver-related violations monitoring | 1.22 | 0.42 | Group 2 |
| 3 | Size measurement | 1.34 | 0.61 | |
| 4 | Credential checking | 1.42 | 0.58 | |
| 5 | On-board equipment checking | 1.56 | 0.77 | |
| 6 | Cargo monitoring | 2.08 | 0.86 | Group 3 |
| 7 | Exhaust emissions monitoring/detection | 2.61 | 0.89 | Group 4 |

Figure 6 depicts the results of the second question that dealt with rating the level of importance of potential impacts that could result from engaging in such inspection and screening practices. For safety and roadway/bridge infrastructure impacts, 100% of the responses rated each as ‘Very Important’ or ‘Important’. For security, almost 90% of responses rated this impact as ‘Very Important’ or ‘Important’. For air quality, 65.5% of responses rated this impact as ‘Very Important’ or ‘Important’.

The team next looked at the average ranking for each inspection and screening practice impact again using the same numerical scoring method as previously used for each practice. Again, significant response clustering is evident with all average scores falling within the one-point interval [1.10, 2.08]. The mean scores for safety, roadway/bridge infrastructure, security, and air quality are, respectively, 1.10, 1.17, 1.54, and 2.08.

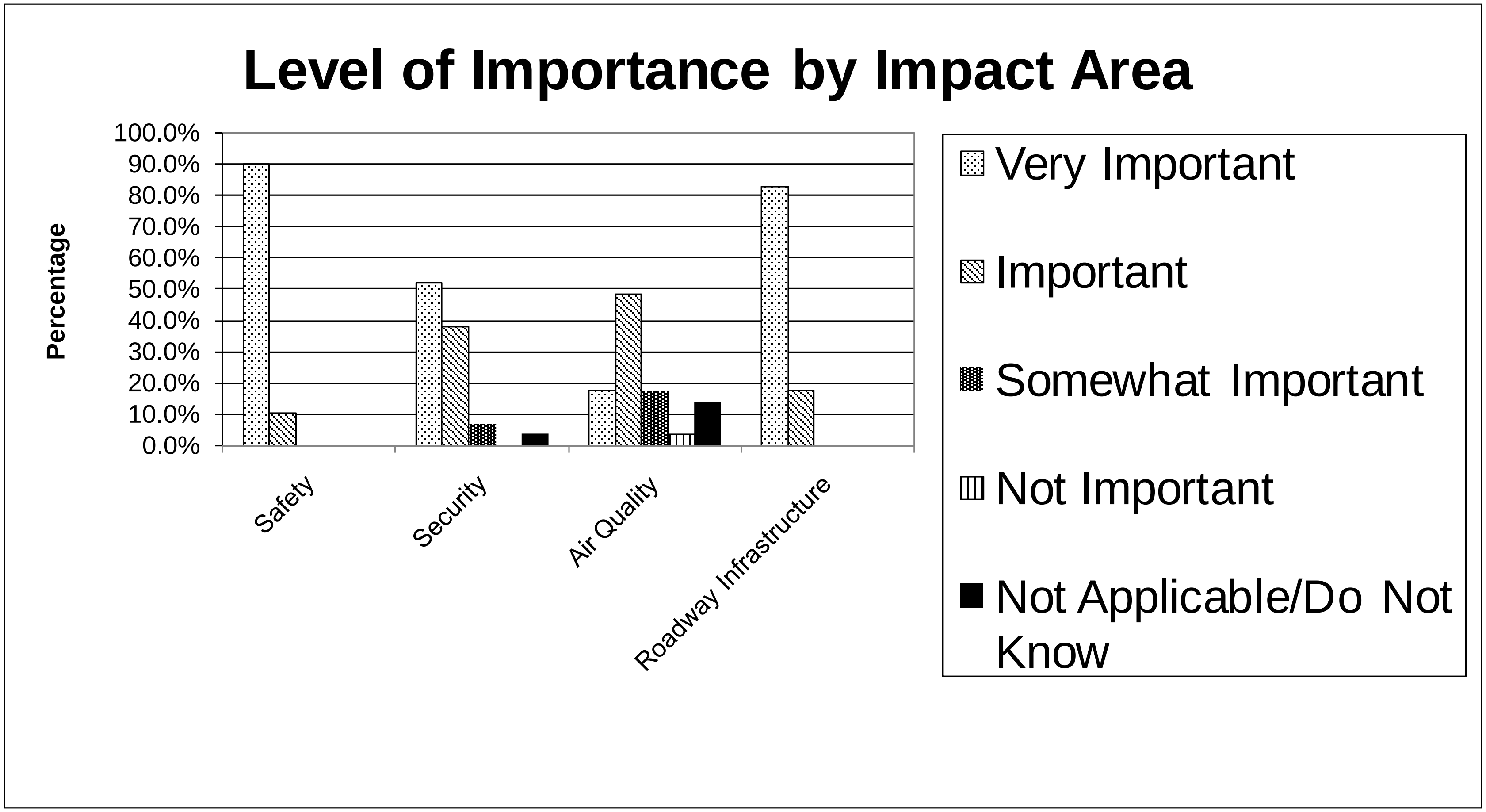


**FIGURE 6 Level of Importance by Impact Area**

#### 4.2.2 Commercial Motor Vehicle Inspection and Screening Activities: Level of Involvement

Approximately 83% of respondents' agencies currently involve various technologies for at least one of the described CMV inspection and screening practices. Approximately 14% have been involved but no longer are and 3% have to-date not been involved, however do have plans to do so. For the remainder of this report we focus on those responses corresponding to the 83% of the respondents' agencies currently involved with technologies. Figure 7 depicts current levels of these respondents' involvement from which the team makes the following observations:

- Weight measurement, credential checking, and size measurement are the inspection and screening practices identified by the ***most*** respondents as fully deployed and operational: 76.9%, 50.0%, and 60.9%, respectively.
- Weight measurement and credential checking are the most mature practices from the deployment perspective by noting the decreasing percentage values for each of these practices as a function of the level of involvement from *fully deployed and operational* to *no involvement*.
- On-board equipment checking, cargo monitoring, and exhaust emissions monitoring/detection rate highest in terms of *no involvement*: 47.8%, 45.8%, and 62.5%, respectively. The high percentages for these three inspection and screening practices are consistent with their level of importance ratings (See Figure 5) especially for exhaust/emissions monitoring/detection.

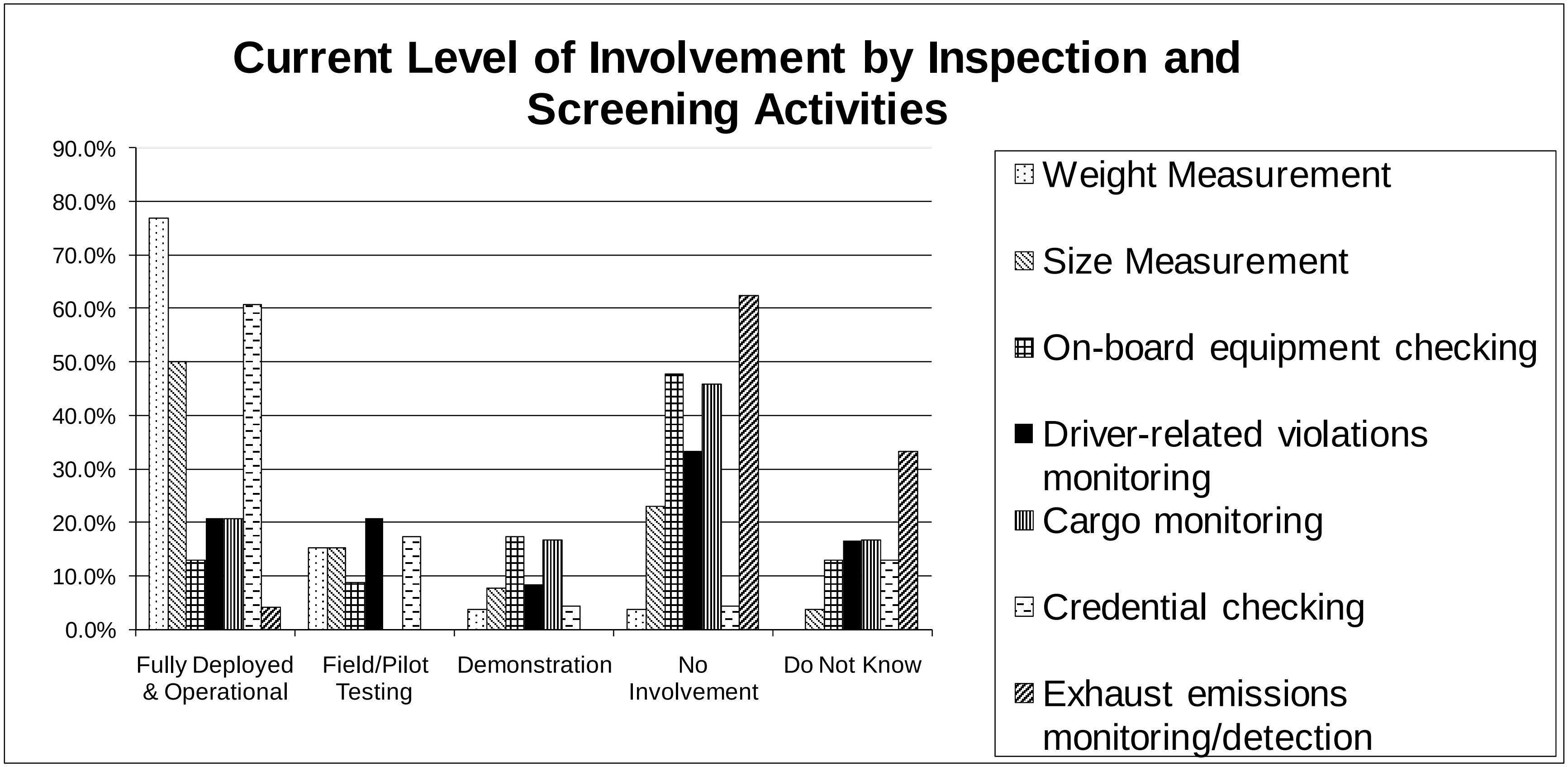


**FIGURE 7 Current Level of Involvement by Inspection and Screening Activities**

### 4.2.3 The Use of Technologies

The team next investigated the use of technologies for CMV inspection and screening practices; Table 3 shows the survey findings where those technologies listed are only those that respondents provided. Additional technologies clearly exist, for example, the PrePass and Oregon Green Light transponders, yet only the NORPASS transponder was mentioned by survey respondents.

For weight measurement, WIM systems are employed exclusively by all respondents; while for size measurement, WIM systems are again used though not across all respondents. For on-board equipment checking, survey respondents identified brakes as the sole equipment on-board trucks that are checked for proper functioning. A large array of technologies is used for driver violations monitoring and credential checking. While not explicitly listed in Table 3, *manual means* were also used for some of the CMV inspection and screening practices, such as size measurement, on-board equipment checking, driver violations monitoring, cargo monitoring, and exhaust emissions monitoring and detection.

**TABLE 3 Technologies Associated with Commercial Motor Vehicle Inspection and Screening Activities**

| CMV Inspection and Screening Practices | Technologies |
|---|---|
| Weight measurement | • Weigh-in-motion systems |
| Size measurement | • Weigh-in-motion systems<br>• Over-height and over-length detectors |
| On-board equipment checking | • Infrared brake screening/detection systems |
| Driver violations monitoring | • License plate readers<br>• CVISN with CVIEW<br>• Biometrics, SWIC reader<br>• NORPASS transponder<br>• Automated Vehicle Identification (AVI) system<br>• National Safety Code database<br>• Pre-clearance PrePass |
| Cargo monitoring | • Vehicle Infrastructure Integration (VII)<br>• License plate readers<br>• Hazmat detection methods |
| Credential checking | • CVISN e- credentialing and e-screening<br>• Pre-Pass system<br>• NORPASS system<br>• WIM enhancements |

| CMV Inspection and Screening Practices | Technologies |
|---|---|
| | • AVI at WIM stations<br>• CVIEW (commercial vehicle information exchange window system) |
| Exhaust emissions monitoring/detection | • Mobile emissions inspection system |

### 4.2.4 Evaluation of Technologies

The team next looked at the evaluation of the technologies associated with the inspection and screening practices. Questions covered the following topics:

- Conditions under which evaluations have been performed
    - On an as needed basis in response to problems
    - Part of regular reviews
    - As part of an audit resulting from the hiring of a new management team
    - Other
- Evaluation time frame
    - Within the last year
    - Between one and two years ago
    - Between two and three years ago
    - Three or more years ago
- Type of evaluator
    - In-house State DOT or Provincial MOT
    - Enforcement agency
    - A hired consultant/contractor
    - An independent 3rd party
    - Other
- Types of performance measures used
    - Technical performance
    - User satisfaction
    - Cost effectiveness
    - Changes relative to specific factors in a before-and-after comparison
    - Level of cross-agency coordination
    - Other
- Types of data collected

- Evaluation findings

Of the set of respondents who are currently involved in inspection and screening practices (24/29), 71% have performed technology evaluations. For those respondents who have not conducted such an evaluation, the primary reasons include resource constraints and insufficient in-service time. The primary reasons for conducting the evaluation are that 1) there were problems to be resolved and 2) it was part of regular assessments. About 2/3 of the evaluations were performed within the last year while approximately 30% of them were conducted at least three years ago. For the type of evaluator – with multiple responses permitted – ¾ of responses indicated that in-house evaluations were performed, while 35% employed consultants, 41% were conducted by enforcement agencies, and 24% by independent 3rd parties, such as a university. Independent 3rd parties received the lowest response percentage, which is understandable, as such evaluations tend to be more time consuming and expensive yet also have the image of enhanced credibility and standing relative to other types of evaluations. For the measures of performance used, approximately 82% of responses used technical performance, e.g., accuracy and reliability, while 47% employed user satisfaction, 53% used cost effectiveness, 24% used before/after comparisons and only 6% used level of institutional coordination. The high percentage rate of technical performance measures is not surprising given the correspondingly high percentage of evaluations conducted in-house. It is also notable how few evaluations utilized inter-organizational coordination as a performance measure. In the survey respondents also rated the overall performance of the technologies. Approximately 59% indicated a "Good" rating, while 35% (6 responses) and 6% (1 response) responded with "Excellent" and "OK" ratings, respectively. Notwithstanding the very small response sizes to this question in absolute terms, it is still notable that all but one of the "Excellent" responses was performed in-house and that the only "OK" response was performed by a combination of an independent 3rd party, in-house, and an enforcement agency.

## 5.0 CONCLUSIONS

This report documents the findings of a study of commercial motor vehicle inspection and screening practices and their impacts. The research consisted of conducting a survey of U.S., Canadian, and Mexican State/Provincial DOTs. The research team investigated the degree to which an integrated systems approach is employed for CMV inspection and screening practices and the use and assessment of various technologies for such practices.

One-half of the respondents who are currently implementing technologies for CMV inspection practices have them fully deployed and operational in combinations of two to six practices. Whereas each multi-practice combination of any size contains weight measurement, only one multi-practice combination contains exhaust emissions monitoring. The most frequently appearing combination of inspection practices in the responses consists of weight and size measurement and credential checking. To a lesser degree, the combination of on-board equipment checking, weight and size measurement, and cargo monitoring is also used. Thus a multi-building block approach based on CMV inspection and screening practices is underway and it is important that additional measures be taken to further foster this holistic and integrated approach.

A wide assortment of technologies is being used to enhance the effectiveness of CMV inspection and screening practices. These technologies include weigh-in-motion systems, automated vehicle identification and classification systems, over-height and over-length detectors, license plate readers, biometrics, and infrared brake screening and detection systems.

More than seventy percent of survey respondents report that evaluations of these technologies have been performed. Based on responses to the evaluation-related survey questions, a typical evaluation was conducted within the last year, performed in-house at a State/Provincial DOT with a focus on technical performance criteria and resulted in an overall “Good” to “Excellent” rating. Evaluations are an essential tool to assess the effectiveness of CMV inspection and screening practices. Moreover, it is important that independent 3rd parties play a more prominent role as evaluator together with more diversified performance criteria used to conduct the evaluation.

## 6.0 REFERENCES


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# APPENDIX A:

# The Survey Instrument

## About our Study

We are researchers at the Institute of Transportation Studies at the University of California, Berkeley. Our research team consists of Mr. Mark Miller (Lead Investigator) and Mr. Antonios Garefalakis (Research Associate). We are working on a project sponsored by the California Department of Transportation (Caltrans) that is investigating the use of *Virtual Inspection and Compliance Stations* for commercial vehicles (CV) for activities such as

- Measuring truck weight and size
- Detecting faulty on-board equipment (e.g. brakes or tires)
- Monitoring cargo
- Checking credentials (e.g. liability insurance, payment of fuel taxes)
- Monitoring for driver-related violations (e.g. logbook, hours of service), or
- Monitoring truck emissions

We are examining the use of technologies (e.g., WIM sensors, or infrared heat detection systems) that focus on these activities. Moreover, implementing such technologies can have an impact on roadway pavement infrastructure, safety, security, and/or air quality and we are also studying these impacts.

As part of this investigation, we are conducting this online survey of US State Departments of Transportation, and Canadian Provincial and Mexican State Ministries of Transport to learn more about the use of technologies in the context of Virtual Inspection and Compliance Stations.

## About Your Informed Consent to Participate

This survey should take about 1/2 hour to complete and because it is conducted online, if you do not complete the survey today, your responses may be saved and you can return later if you want to; however, you will need to resume the survey on the same computer. You are under no obligation to complete the survey once you have started it, and your participation is completely voluntary.

Your individual responses will be viewed only by the project team and will not be shared with Caltrans, or any other individuals or organizations. Further, none of your responses will be presented in any publications or other materials produced from this research in a way that identifies you or your organization without your explicit and previous authorization.

There are no foreseeable risks to you from participating in this research. There are, in fact, potentially direct benefits to your department of transportation/ministry of transport (DOT/MOT) because our primary deliverable for this project will be an assessment of technologies that DOTs/MOTs can use to support them in their decision-making as they consider technologies for future deployment in their state/province. There will be no costs to you, other than your time to complete the survey.

All of the information that we obtain from you during the research will be kept confidential. At the start of the survey, we will request your name, work telephone number, and work e-mail address; this information will be stored in a database on a password-protected computer with access given only to the Lead Investigator and his Research Associate. Your name or other identifying information will absolutely not be used in any reports stemming from this research. Moreover, this personal information (name, telephone number, e-mail address) will be deleted from the database once the survey has been administered. One final item: All information you provide is transmitted over a secure network with SSL encryption.

Mark Miller's contact information is provided below if you would like to contact him about this research. If you have questions regarding your rights as a research subject, you may contact the UC Berkeley Office for Protection of Human Subjects at 510-642-7461.

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E-mail: mamiller@path.berkeley.edu

If you want to participate, then please click "Yes" below. By clicking "Yes", you are giving your informed consent to participate and you will then have the opportunity to complete this survey. If you do not want to participate, simply click "No". In either case, after providing your answer, click "Save and Go to Next Page >>".

Thank you very much.

○ Yes ○ No

## Online Survey Instructions

*Save your Responses* -- To save your responses on any page of the survey, simply click on "Save and Go to Next Page >>" at the bottom of that page. So, if you do not complete the survey in a single session, click "Save and Go to Next Page >>" then click "Exit This Survey >>" in the top right hand corner of the page. When you leave the survey you will be taken to the Institute of Transportation Studies/UC Berkeley web site.

*Return at a Later Time* -- To return to the survey later, simply click on the same link (on the same computer) you received in our e-mail message to you. Upon your return, you will be brought to the page immediately following the page you saved.

*Edit your Responses* -- You may go back and change your existing responses until you complete and submit the survey. Once you have hit the "Submit this Survey >>" button on the last page, you will not be able to re-enter the survey.

*Answer your Questions* -- If you have questions about the survey, please contact Antonios Garefalakis by e-mail at adonisgare@berkeley.edu.

## Information About You

First, we'd like to request some information about you.

What is your name?

What is your title at work?

What is your primary area of work?

- Planning
- Operations
- Research
- Marketing
- Executive/Administrative
- Finance/Budgeting
- Other

If you checked "Other" in the question immediately above, please provide additional detail here; otherwise, proceed to the next question.

What is your telephone number at work?

What is your e-mail address at work?

## Information About Your Department / Ministry

Where is your department or ministry located? Please make your selection from this drop-down menu.

## Inspection and Compliance Program Activities

How important is it for your State or Province to be engaged in the following listed CV inspection and compliance activities?

For each activity, please select one of the following: "Very Important", "Important", "Somewhat Important", "Not Important". If you do not know how important a specific area is or do not think the area applies to your State or Province, please select "Not Applicable/Do Not Know".

| | Very Important | Important | Somewhat Important | Not Important | Not Applicable/Do Not Know |
|---|---|---|---|---|---|
| Weight measurement | ○ | ○ | ○ | ○ | ○ |
| Size measurement | ○ | ○ | ○ | ○ | ○ |
| On-board equipment checking (e.g. brakes) | ○ | ○ | ○ | ○ | ○ |
| Driver-related violations monitoring (e.g. hours of service) | ○ | ○ | ○ | ○ | ○ |
| Cargo monitoring | ○ | ○ | ○ | ○ | ○ |
| Credential checking (e.g. liability insurance) | ○ | ○ | ○ | ○ | ○ |
| Exhaust emissions monitoring/detection | ○ | ○ | ○ | ○ | ○ |

## Impacts of Program Activities

The various inspection and compliance activities whose importance you just rated can impact the commercial vehicle industry as well as have impacts on society at large. Such impacts include *safety*, *security*, *roadway/bridge infrastructure*, and *air quality*.

Please tell us your views on the importance of each such potential impact by selecting one of the following: "Very Important", "Important", "Somewhat Important", "Not Important". If you do not know how important a specific impact area is or do not think the impact area applies to your State or Province, please select "Not Applicable/Do Not Know".

| | Very Important | Important | Somewhat Important | Not Important | Not Applicable/Do Not Know |
|---|---|---|---|---|---|
| Safety | ○ | ○ | ○ | ○ | ○ |
| Security | ○ | ○ | ○ | ○ | ○ |
| Air Quality | ○ | ○ | ○ | ○ | ○ |
| Roadway/Bridge Infrastructure | ○ | ○ | ○ | ○ | ○ |

## Implementing Technologies for CV Inspection and Compliance Work

Which <u>one</u> of the following four statements most closely matches the status for your State's or Province's CV inspection and compliance activities in terms of technological implementation?

◯ We are currently implementing technologies for at least one of the following activities: Weight/size measurement, on-board equipment checking, driver-related violations monitoring, cargo monitoring, credential checking, or exhaust emissions monitoring/detection.

◯ We have previously implemented technologies for at least one of these activities but are no longer implementing any technology.

◯ We have never implemented technologies for any of these activities; however we do have plans to do so in the future.

◯ We have never implemented technologies for any of these activities and currently have no plans to do so.

## Currently Implementing Technologies for CV Inspection and Compliance

For each of the following listed CV inspection and compliance activities, please indicate the implementation stage that most closely matches your department's/ministry's current level of involvement?

| | Fully Deployed & Operational | Field/Pilot Testing | Demonstration | No Involvement | Do Not Know |
|---|---|---|---|---|---|
| Weight measurement | ☐ | ☐ | ☐ | ☐ | ☐ |
| Size measurement | ☐ | ☐ | ☐ | ☐ | ☐ |
| On-board equipment checking | ☐ | ☐ | ☐ | ☐ | ☐ |
| Driver-related violations monitoring | ☐ | ☐ | ☐ | ☐ | ☐ |
| Cargo monitoring | ☐ | ☐ | ☐ | ☐ | ☐ |
| Credential checking | ☐ | ☐ | ☐ | ☐ | ☐ |
| Exhaust emissions monitoring/detection | ☐ | ☐ | ☐ | ☐ | ☐ |
| Other | ☐ | ☐ | ☐ | ☐ | ☐ |

If you checked "Other" in the question immediately above, please provide additional detail here; otherwise, proceed to the next question.

## Currently Implementing Technologies for CV Inspection and Compliance (conti...

For *each* of the activities your department/ministry is involved with (and that you checked off in the previous question), please indicate the technologies you are currently using.

For example, for weight measurement, you could list *Weigh-In-Motion (WIM)* technology systems if appropriate; for on-board equipment checking, you could list *infrared heat detection systems* for brakes, if appropriate.

Weight measurement

Size measurement

On-board equipment checking

Driver-related violations monitoring

Cargo monitoring

Credential checking

Emissions monitoring

Other (as listed above)

If you require additional space, please use this area.

## Evaluating Technologies for CV Inspection and Compliance

Has the performance or effectiveness of any of these technologies been evaluated?

- ◯ Yes
- ◯ No

## Evaluating Technologies for CV Inspection and Compliance (continued)

Under what conditions are such evaluations conducted? Please check all that apply.

- [ ] On an as needed basis in response to problems
- [ ] Part of regular (e.g., annual) reviews
- [ ] As part of an audit resulting from the hiring of a new management team
- [ ] Other

If you checked "Other" in the question immediately above, please provide additional detail here; otherwise, proceed to the next question.

When was this (these) evaluation(s) conducted?

- ○ Within the last year
- ○ Between one and two years ago
- ○ Between two and three years ago
- ○ Three or more years ago

Who conducted the evaluation(s)? Please check all that apply.

- [ ] In-house at State DOT or Provincial MOT
- [ ] Enforcement agency (e.g. State or Provincial police)
- [ ] A hired consultant/contractor
- [ ] An independent 3rd party (e.g., a university)
- [ ] Other

If you checked "Other" in the question immediately above, please provide additional detail here; otherwise, proceed to the next question.

What criteria or measures of effectiveness were used in this evaluation? Please check all that apply.

- [ ] Technical performance (e.g., accuracy, reliability, or failure rates for weight measurement)
- [ ] User satisfaction
- [ ] Cost effectiveness (e.g., benefit-cost ratio)
- [ ] Changes relative to specific factors (e.g., number of accidents or compliance rates) in a before-and-after comparison.
- [ ] Level of cross-agency coordination
- [ ] Other

If you checked "Other" in the question immediately above, please provide additional detail here; otherwise, proceed to the next question.

Please describe the types of data that were collected to perform this (these) evaluation(s). For example, data could include truck weight measurements, truck volumes, and/or cost data (e.g, purchase price, installation cost, and/or cost of operation and maintenance) on technology systems.

Please describe the findings from this (these) evaluation(s); if documented in a report(s) please provide a link to it, if available, or e-mail the report to us at adonisgare@berkeley.edu.

Overall, how would you rate the performance of this (these) technology (ies)? Please note that you must answer this question to proceed.

- Excellent
- Good
- OK or Average
- Fair
- Poor

## Evaluating Technologies for CV Inspection and Compliance (continued)

Why haven't these technologies been evaluated yet? Select all that apply and note that you must answer this question to proceed.

- [ ] Haven't been in service long enough
- [ ] Enforcement agency (e.g, Highway Patrol) is monitoring performance so we don't have to
- [ ] Scheduled for a later date as needed
- [ ] Resource constraints (time and money)
- [ ] Other

If you checked "Other" in the question immediately above, please provide additional detail here; otherwise, proceed to the next question.

## Previous Implemention of Technologies for CV Inspection and Compliance

For each of the following listed CV inspection and compliance activities, please indicate the implementation stage(s) that most closely matches your department's/ministry's past level of involvement.

| | Fully Deployed & Operational | Field/Pilot Testing | Demonstration | No Involvement | Do Not Know |
|---|---|---|---|---|---|
| Weight measurement | ☐ | ☐ | ☐ | ☐ | ☐ |
| Size measurement | ☐ | ☐ | ☐ | ☐ | ☐ |
| On-board equipment checking | ☐ | ☐ | ☐ | ☐ | ☐ |
| Driver-related violations monitoring | ☐ | ☐ | ☐ | ☐ | ☐ |
| Cargo monitoring | ☐ | ☐ | ☐ | ☐ | ☐ |
| Credential checking | ☐ | ☐ | ☐ | ☐ | ☐ |
| Exhaust emissions monitoring/detection | ☐ | ☐ | ☐ | ☐ | ☐ |
| Other | ☐ | ☐ | ☐ | ☐ | ☐ |

If you checked "Other" in the question immediately above, please provide additional detail here; otherwise, proceed to the next question.

## Previous Implementation of Technologies for CV Inspection and Compliance (c...

For *each* of the activities your department / ministry is involved with (and that you checked off in the previous question), please indicate the technologies you have previously used.

For example, for weight measurement, you could list *Weigh-In-Motion (WIM)* technology systems, if appropriate; for on-board equipment checking, you could list *infrared heat detection systems* for brakes, if appropriate.

Weight measurement

Size measurement

On-board equipment checking

Driver-related violations monitoring

Cargo monitoring

Credential checking

Emissions monitoring

Other (as listed above)

If you require additional space, please use this area.

## Previous Evaluation of Technologies for CV Inspection and Compliance

Has the performance or effectiveness of any of these technologies been evaluated prior to discontinuing them?

- ◯ Yes
- ◯ No

## Previous Evaluation of Technologies for CV Inspection and Compliance (conti...

Under what conditions were such evaluations conducted? Please check all that apply.

- [ ] On an as needed basis in response to problems
- [ ] Part of regular (e.g., annual) reviews
- [ ] As part of an audit resulting from the hiring of a new management team
- [ ] Other

If you checked "Other" in the question immediately above, please provide additional detail here; otherwise, proceed to the next question.

When was this evaluation conducted?

- ○ Within the last year
- ○ Between one and two years ago
- ○ Between two and three years ago
- ○ Three or more years ago

Who conducted the evaluation(s)? Please check all that apply.

- [ ] In-house at State DOT or Provincial MOT
- [ ] Enforcement agency (e.g. State or Provincial police)
- [ ] A hired consultant/contractor
- [ ] An independent 3rd party (e.g., a university)
- [ ] Other

If you checked "Other" in the question immediately above, please provide additional detail here; otherwise, proceed to the next question.

What criteria or measures of effectiveness were used in this evaluation? Please check all that apply.

- ☐ Technical performance (e.g., accuracy, reliability, or failure rates for weight measurement)
- ☐ User satisfaction
- ☐ Cost effectiveness (e.g., benefit-cost ratio)
- ☐ Changes relative to specific factors (e.g., number of accidents or compliance rates) in a before-and-after comparison.
- ☐ Level of cross-agency coordination
- ☐ Other

If you checked "Other" in the question immediately above, please provide additional detail here; otherwise, proceed to the next question.

Please describe the types of data that were collected to perform this (these) evaluation(s). For example, data could include truck weight measurements, truck volumes, and/or cost data (e.g, purchase price, installation cost, and/or cost of operation and maintenance) on technology systems.

Did the results of this (these) evaluation(s) influence the decision to discontinue implementing these technologies?

- ◯ Yes
- ◯ No

Please describe the findings from this (these) evaluation(s); if documented in a report(s) please provide a link to it, if available, or e-mail the report to adonisgare@berkeley.edu.

Overall, how would you rate the performance of this (these) technology (ies)? Please note that you must answer this question to proceed.

- ○ Excellent
- ○ Good
- ○ OK or Average
- ○ Fair
- ○ Poor

## Previous Evaluation of Technologies for CV Inspection and Compliance (conti...

Why weren't these technologies ever evaluated? Please note that you must answer this question to proceed.

- [ ] Haven't been in service long enough
- [ ] Enforcement agency (e.g., Highway Patrol) is monitoring performance so we don't have to
- [ ] Scheduled for a later date as needed
- [ ] Resource constraints (time and money)
- [ ] Other

If you checked "Other" in the question immediately above, please provide additional detail here; otherwise, proceed to the next question.

## Plans for Implementing Technologies for CV Inspection and Compliance

Why do you think your department/ministry has not implemented technologies for any of these program activities so far? Please select all that apply.

- [ ] Too costly
- [ ] Just wasn't a priority
- [ ] Only recently became aware of it
- [ ] Only recently came to agreement with enforcement agency (e.g., highway patrol) on enforcement policy
- [ ] Other

If you checked "Other" in the question immediately above, please provide additional detail here; otherwise, proceed to the next question.

Which program activities does your department/ministry plan to get involved in? Please check all that apply.

- [ ] Weight measurement
- [ ] Size measurement
- [ ] On-board equipment checking
- [ ] Driver non-compliance monitoring
- [ ] Cargo monitoring
- [ ] Credential checking
- [ ] Emissions monitoring
- [ ] Other

If you checked "Other" in the question immediately above, please provide additional detail here; otherwise, proceed to the next question.

## Plans for Implementation of Technologies for CV Inspection and Compliance <...

For *__each__* of the program activities you checked off above, please indicate which technologies you plan to use, if known. For example, for weight measurement, you could list *Weigh-In-Motion (WIM)* technology systems, if appropriate; for on-board equipment checking, you could list *infrared heat detection systems* for brakes, if appropriate.

Weight measurement

Size measurement

On-board equipment checking

Driver non-compliance monitoring

Cargo monitoring

Credential checking

Emissions monitoring

Other (as listed above)

## *Mobile* vs *Fixed* Inspection and Compliance Stations

Please describe your state's or province's experience with *mobile* versus *fixed* inspection and compliance station sites in terms of any official policy toward using them, locations, applications, or type.

## Enforcement Efforts at Inspection and Compliance Stations

Please describe your state's or province's experience with the use of technologies to alert the enforcement agency (e.g., State or Provincial Police or Highway Patrol) of possible compliance violators and then dispatching an officer to intercept the vehicle.

## Automation of Virtual Inspection and Compliance Stations

Please describe your state's or province's views on the use of a fully automated system designed to collect data on truck non-compliance violations, e.g., by capturing video images of vehicle license plates.

## Thank You!

On behalf of the entire Project Team, thank you for your time. To exit this survey, click on "Exit this Survey >>" in the top right corner of this page and you will be returned to your web browser at the Institute of Transportation Studies/UC Berkeley website.

Mark Miller
Lead Investigator
Evaluation of Virtual Inspection and Compliance for Commercial Vehicles Project
Institute of Transportation Studies
University of California, Berkeley

## You have completed the survey!

On behalf of the entire Project Team, thank you for completing the survey. At this time simply click on "Submit this Survey >>" and you will be returned to your web browser at the Institute of Transportation Studies/UC Berkeley website.

Mark Miller
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