FMCSA Safety Program Performance Measures

Intervention Model:
Roadside Inspection and Traffic Enforcement Effectiveness Assessment

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PREFACE

This report documents the methodology and results from an improved model to measure the effectiveness of two of the key safety programs of the Federal Motor Carrier Safety Administration (FMCSA). The research was conducted by the Research and Special Programs Administration's (RSPA) John A. Volpe National Transportation Systems Center (the Volpe Center) in Cambridge, MA under a project plan agreement with the FMCSA. The work on FMCSA Program Performance Measures addresses the requirements of the Government Performance and Results Act (GPRA) of 1993, which obligates federal agencies to measure the effectiveness of their programs as part of the budget cycle process.

Work on FMCSA Program Performance Measures was initiated during FY 93. In December 1994, a report titled "Office of Motor Carriers Safety Program - Performance Measurement" was prepared. That report provided a comprehensive breakdown of Office of Motor Carriers (OMC) safety programs and activities and described about a dozen potential evaluation models. (Note: The OMC later became the FMCSA.) Based on the OMC's review, the Volpe Center revised the report and recommended four evaluation models to assess the key OMC programs: roadside inspections conducted by participating states under the Motor Carrier Safety Assistance Program (MCSAP), on-site compliance reviews conducted by the OMC field offices and the states, commercial vehicle traffic enforcement also performed by the states under the MCSAP, and a comprehensive assessment of combined effects. Two initial evaluation models covering the roadside inspection program and the compliance review program were described in detail in a December 1998 report titled "OMC Safety Program Performance Measures." A review panel was convened to evaluate these models and made recommendations for improvement. The Volpe Center incorporated these recommendations together with other Volpe Center defined improvements into two "second-generation" models that measure the effectiveness of these two programs. This report describes the implementation of the Intervention Model, which covers not only the roadside inspection program, but also the traffic enforcement program.

At the FMCSA, the project is managed by Dale Sienicki of the Office of Data Analysis and Information Systems, Analysis Division. The Volpe Center project manager is Donald Wright, Chief of the Motor Carrier Safety Assessment Division in the Office of System and Economic Assessment. The analysis was performed at the Volpe Center by Donald Wright, Dennis Piccolo and Emmett Harris of EG&G Services, under contact to the Volpe Center, with assistance from Dr. Thomas M. Corsi of the Supply Chain Management Center, Robert H. Smith School of Business, University of Maryland, College Park, Maryland.

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EXECUTIVE SUMMARY

This report describes the Intervention Model, which is intended to provide the Federal Motor Carrier Safety Administration (FMCSA) with a means to gauge the effectiveness of two of its more critical safety programs – roadside inspections and traffic enforcements – in preventing crashes involving interstate motor carriers and in reducing related fatalities and injuries. The model is also intended to be a tool that the FMCSA can use periodically to measure the relative performance of its programs, and to analyze the effects of implementing different program changes.

The model measures program effectiveness in terms of reductions in the numbers of crashes involving commercial vehicles, and in the numbers of associated fatalities and injuries. Although the methodology is believed to be sound and roadside inspection results are judged to be complete and accurate, the model suffers from several limitations resulting from a lack of empirical data regarding driver behavior and the contribution that vehicle defects and driver faults have on crash causation. Nevertheless, the model defaults to other means (including expert judgment) to compensate for these shortcomings and establishes a benchmark to measure roadside inspection and traffic enforcement program effectiveness.

The model is based on the premise that the two programs – roadside inspection and traffic enforcement - directly and indirectly contribute to the reduction of crashes. As a result, the model includes two submodels that are used for measuring these different effects. Direct effects are based on the assumption that vehicle and/or driver defects discovered and then corrected as the results of interventions reduce the probability that these vehicles/drivers will be involved in subsequent crashes. The model calculates direct-effect-prevented crashes according to the number and type of violations detected and corrected during an intervention.

Indirect effects are considered to be the by-products of the carriers' increased awareness of FMCSA programs and the potential consequences that these programs pose if steps are not taken to ensure and/or maintain higher levels of safety. In order to measure these indirect effects, which are essentially changes in behavior involving driver preparation and practices and vehicle maintenance, the model calculates responses to exposure to the programs and the resulting reduction in potentially crash-causing violations.

Critical to the model is its ability to link vehicle and driver defects detected during inspections and/or traffic enforcement actions to crash probabilities. Currently available research and expert judgments provided the basis for establishing these linkages and assigning probabilities. Major investigations focusing on this linkage through special large truck crash data collections and crash reconstruction analysis are currently being sponsored by the FMCSA. The model's structure and analysis approach will enable the incorporation of the results of these efforts once they become available.

The initial model run calculated the 1998 effects resulting from the roadside inspection and traffic enforcement programs. Subsequent model runs calculated program effects for 1999 and 2000. The table below displays the results.

MCSAP Program Benefits: 1998-2000[1]

	1998[2]	1999	2000
Roadside Inspections			
Crashes Avoided	8,612	9,119	9,362
Lives Saved	369	391	420
Injuries Avoided	5,902	6,250	6,416
Traffic Enforcement			
Crashes Avoided	2,800	3,021	3,306
Lives Saved	120	130	142
Injuries Avoided	1,919	2,071	2,265

This model, which measures the effectiveness of the roadside inspection and traffic enforcement programs, when combined with the Compliance Review Impact Assessment Model, forms a powerful performance measurement capability that will facilitate a combined-effects assessment of the three FMCSA safety programs. The expectation is that the combined-effects assessment results will further guide FMCSA decision-making when directing resources to achieve optimal program effectiveness.

[1] Mean estimates. Higher and lower bound estimates were based on different risk assumptions, which may be found in Intervention Model: Roadside Inspection and Traffic Enforcement Effectiveness Assessment, Sept. 2002.
[2] Revised figures. See Section 4.5 for details.

1. INTRODUCTION

1.1. PROJECT OBJECTIVE

The Intervention Model is designed to provide the Federal Motor Carrier Safety Administration (FMCSA) with a means to gauge the effectiveness of two of its more critical safety programs – roadside inspections and traffic enforcements – in preventing crashes involving interstate motor carriers and in reducing related fatalities and injuries. The model is also intended to be a tool that the FMCSA can use periodically to measure the relative performance of its programs, and to analyze the effects of implementing different program changes. Its use could provide a basis for making resource allocation and budgeting decisions that will help optimize the effectiveness and efficiency of the FMCSA's motor carrier safety programs.

1.2. PROJECT BACKGROUND

During the 1980s, Congress passed several acts intended to strengthen motor carrier safety regulations. This led to the implementation of safety-oriented programs both at the federal and state levels, and an interest in establishing methods for measuring the effectiveness of these programs.

The Surface Transportation Assistance Act of 1982 established the Motor Carrier Safety Assistance Program (MCSAP), a grants-in-aid program to states, to conduct roadside inspection and traffic enforcement programs aimed at commercial motor vehicles. The 1984 Motor Carrier Safety Act directed the U.S. Department of Transportation (U.S. DOT) to establish safety fitness standards for carriers. The U.S. DOT, along with the states, responded by implementing the MCSAP to fund roadside inspection and traffic enforcement programs, and the safety fitness determination process and rating system (based on on-site safety audits called compliance reviews).

1.3. PROJECT SCOPE

The Program Performance Measures project established and managed by the FMCSA includes roadside inspection, traffic enforcement, and compliance review activities and programs. This report describes the development of a model, the Intervention Model, that is intended to measure the effectiveness of two of the three programs - roadside inspection and traffic enforcement - in reducing crashes and avoiding fatalities and injuries.

It is believed that FMCSA safety program elements exert a positive influence, causing changes in driver behavior and carrier operations that lead to improvements in the level of motor carrier safety. At the same time, it is recognized that motor carriers are affected by exogenous influences, such as those attributable to the highway environment, that may intervene, impact or have some bearing on motor carrier safety. However, there is no accounting for these other influences and their associated consequences (i.e., fatalities and injuries) in this effort.

Concurrent with the development of the Intervention Model, an improved model for measuring the effectiveness of compliance reviews (known as the Compliance Review Impact Assessment Model) was developed and documented. The ultimate plan is to assess the combined effects of all three programs. In the meantime, efforts to improve these safety program measures and models will continue independently, and the models will be run on a recurring basis to meet program objectives of measuring effectiveness, and to support annual budgetary planning and resource allocation decisions.

1.4. REPORT STRUCTURE

This report includes descriptions of the evolution of the Intervention Model, the effects that it measures, and how the model is to be applied. The report also explains concepts driving the development process and affecting the model structure. Report sections include:

- Background on an earlier model, known as Safe-Miles, with an explanation of its limitations,
- A description of the model with results and descriptions of the calculation of direct and indirect effects, and
- A discussion of applications and future model enhancements.

Technical appendices have been prepared that provide a mathematical description of the model (Appendix A), detailed information on the types and classification of violations critical to running the model (Appendix B), and program benefits as estimated by the model using MCSAP inspection/violation inputs (Appendix C).

2. SAFE-MILES: INITIAL MODEL

2.1. MODEL OVERVIEW

The Safe-Miles Model that was also developed to measure the effectiveness of the roadside inspection program preceded the Intervention Model. It is discussed here by way of background, since the Intervention Model borrows substantially from the experience with the Safe-Miles Model. Included is a discussion of the direct and indirect effects approach first used in that model as well as the model's limitations leading to the development of the "second-generation" Intervention Model.

The Safe-Miles Model employed a two-step analysis process to perform the evaluation. Instances were recorded in which vehicles and/or drivers were taken out of service during roadside inspections. Next, subsequent travel by the out-of-service (OOS) vehicles and drivers, once conditions were corrected, was converted into "safe miles" and estimates were made concerning crashes avoided during the "safe-miles" period.

2.1.1. Direct Effects

Direct-effect benefits were accumulated from the point at which vehicles or drivers with OOS conditions were detected and removed from service. A three-month "safe" post-inspection period for vehicles was incorporated into the model. This time frame was considered appropriate since the Commercial Vehicle Safety Alliance (CVSA) has a three-month period after a vehicle receives a satisfactory inspection that it is exempt from additional inspections.[1] Lacking an empirical basis with which to govern the duration of the direct effect findings for drivers, the post-inspection safe period for corrected driver OOS defects was shortened to a more conservative period of two months.

2.1.2. Indirect Effects

Indirect effects are an equally important element of the roadside inspection program. The very existence of the program (as well as its magnitude) is believed to act as a deterrent. Knowledge of the program results in motor carrier managers making procedural changes that result in improvements in vehicle maintenance and inspection and in driver qualifications and behavior. These indirect effects, although assumed substantial, are much more difficult to quantify. The indirect effects are estimated in the Safe-Miles Model by assuming that carriers with a high frequency of (that is, greater exposure to) either vehicle or driver inspections, as a result of the

[1] Except under the following circumstances: 1) A North American Commercial Vehicle Critical Safety Item or OOS violation is detected, 2) When a Level IV (Special Inspection) exercise is involved, 3) When a statistically-based random inspection technique is being employed to validate an individual jurisdiction or regional OOS percentage, or 4) When inspections are conducted to maintain CVSA inspection quality assurance. Commercial Vehicle Safety Alliance website, http://www.cvsa.org/Inspections/CVSA_Decals/cvsa_decals.html, 2001.

enforcement of the roadside inspection program, change their behavior and voluntarily improve their safety, resulting in lower vehicle or driver OOS rates.

Direct effects (crashes avoided) were added to indirect effects to derive total roadside inspection program benefits. These benefits were also expressed as estimates in dollar terms by using crash cost factors. There was no traffic enforcement component in the Safe-Miles Model.

2.2. MODEL LIMITATIONS

The 1998 Volpe Center report - "OMC Safety Program Performance Measures" - identified the following limitations associated with the Safe-Miles Model:

- No observed evidence existed for the establishment of a driver safe-miles period. In future empirical studies of driver behavior, post-OOS violation detection would be required to establish the reliability of the two-month interval that was used.
- Each violation was considered in isolation. This precluded any heightening of the safety risk as a result of the presence of multiple violations found during an inspection.
- The lack of crash causation statistics hindered the ability to estimate the contribution of specified vehicle and driver defects to crash likelihood.

The deterrence component of the model (indirect effects) relied on measured changes in OOS rates of carriers that had multiple inspections as a foundation for calculating indirect effects from roadside inspections. However, overall improved preparation and compliance of drivers and vehicles motivated by the presence of a roadside inspection program were thought to be greater than improvements that could be measured by the model.

The research team defined the Intervention Model as a means to remedy these limitations. As with the Safe-Miles Model, the Intervention Model includes direct and indirect effect components; however, it:

- Eliminates the empirically weak "safe-miles" concept,
- Makes allowances for inspections with multiple violations, and
- Uses the latest available crash causation statistics to estimate the contribution of vehicle and driver faults to crash causation.

The model also considers **total** inspection results. This means that it includes non-OOS violations, although with a lesser-assigned weight, in its calculations. Finally, the Intervention model remedies a Safe-Miles omission by including MCSAP program traffic enforcements in its analysis. The benefits of the Intervention Model are expressed as fatalities and injuries avoided as well as crashes avoided.

3. INTERVENTION MODEL

3.1. MODEL DESCRIPTION

The Intervention Model was developed to determine the effectiveness of the MCSAP roadside inspection and traffic enforcement programs in reducing motor carrier crashes. The roadside inspection program consists of roadside inspections performed by qualified safety inspectors following the guidelines of the North American Standard, which was developed by the Commercial Vehicle Safety Alliance in cooperation with the FMCSA. Most roadside inspections by the states are conducted under a grant program (MCSAP) administered by the FMCSA. There are five levels of inspections including a vehicle component, a driver component or both. The traffic enforcement program is based on the enforcement of twenty-one moving violations noted in conjunction with a roadside inspection. Violations are included in the driver violation portion of the roadside inspection checklist.[1]

Figure 3-1 provides an overview of the Intervention Model. The diagram broadly illustrates:

- How the model begins with raw inspection violation data;
- Proceeds to the submodels, where separate algorithms are run to determine the direct and indirect effects; and
- Culminates, finally, with the calculation of program benefits for the respective programs. (For a mathematical description of the model, see Appendix A.)

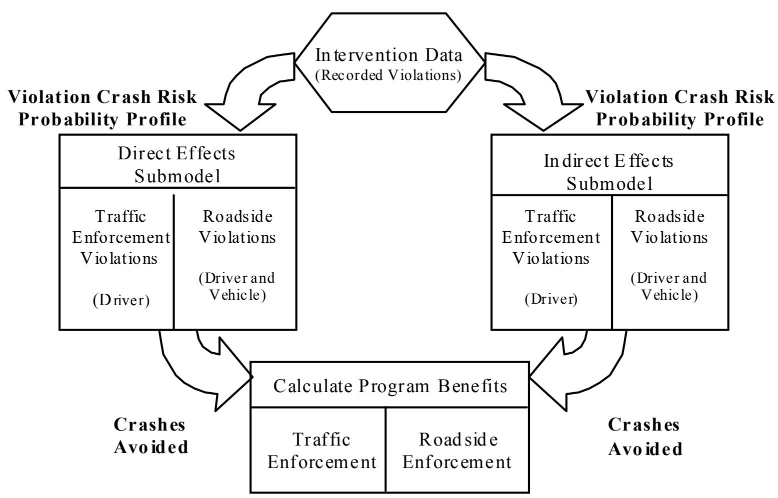

Figure 3-1. Overview of Intervention Model

[1] For a complete list of driver and vehicle violations associated with the roadside inspections and traffic enforcement, see Appendix B.

As with the Safe-Miles Model, this model is based on the premise that the two programs – roadside inspection and traffic enforcement - directly and indirectly contribute to the reduction of crashes. As a result, the model includes two submodels that are used for measuring these different effects. Direct effects are based on the assumption that vehicle and/or driver defects discovered and then corrected as the results of interventions reduce the probability that these vehicles/drivers will be involved in subsequent crashes. Indirect effects are considered to be the by-products of the carriers' increased awareness of FMCSA programs and the potential consequences that these programs pose if steps are not taken to ensure and/or maintain high levels of safety.

3.1.1. Crash Risk Probabilities

In the model, the assumption is made that observed deficiencies (OOS and non-OOS violations) discovered at the time of roadside inspections and/or traffic enforcements can be converted into crash risk probabilities. This assumption is based on the premise that detected defects represent varying degrees of mechanical or judgmental faults, and, further, that some are more likely than others to play a contributory role in motor vehicle crashes. The assumption is that these deficiencies can be noted and ranked into discrete risk categories, each of which possesses a probability that reflects the crash risk that it poses. The process by which the resulting Violation Crash Risk Probability Profile (VCRRP) is formed appears in Figure 3-2.

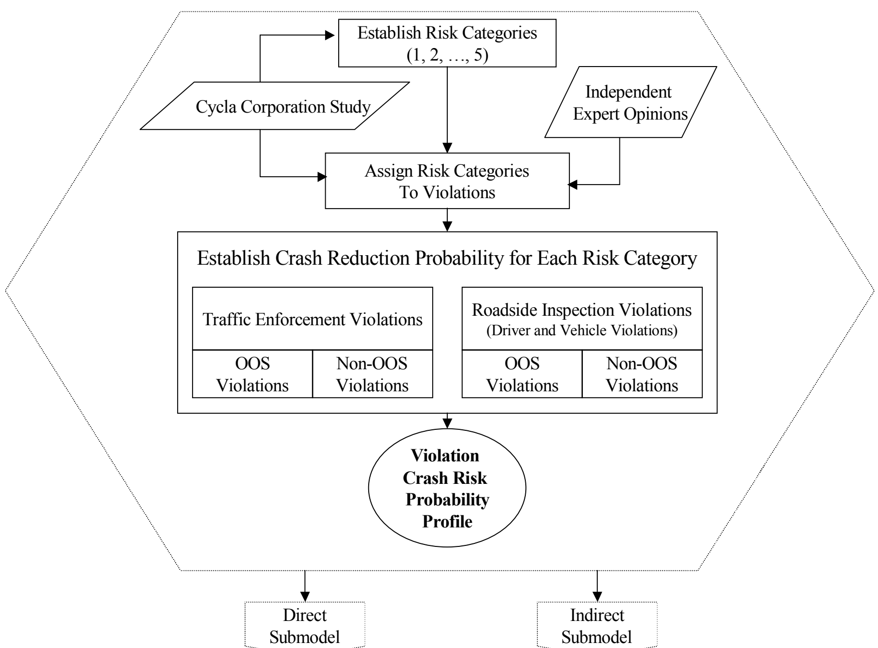

Figure 3-2. Violation Crash Risk Probability Profile

The development of risk categories for violations relied upon a recent study conducted by Cycla Corporation.[2] Each violation was classified according to the risk caused by the conditions of the violation. Cycla's report defined risk as "the likelihood of a violation leading to a crash" and, subsequently, divided the violations into five categories based on the level of risk. The risk categories and their descriptions are as follows:

Risk Category 1 – The violation is the *potential single, immediate* factor leading to a crash or fatalities/injuries from a given crash.

Risk Category 2 – The violation is the *potential single, eventual* factor leading to a crash or fatalities/injuries from a given crash.

Risk Category 3 – The violation is a *potential contributing* factor leading to a crash or fatalities/injuries from a given crash.

Risk Category 4 – The violation is an *unlikely potential contributing* factor leading to a crash or fatalities/injuries from a given crash

Risk Category 5 – The violation has *little or no connection* to crashes or the prevention of fatalities/injuries.

While covering most inspection violations, Cycla's assignment of violations to risk categories was incomplete. This required Volpe Center analysts to make violation assignments for those driver or vehicle violations not included in the Cycla risk assessment. These assignments were made based on comparability with the Cycla list.

In the Cycla study, recommended weights were given to each of the risk categories, as shown in Table 3-1. The heaviest weight (1,000) was assigned to Risk Category 1 since these violations are considered to represent a significant safety hazard. Risk Categories 2 through 5 were given lesser weights (100, 10, 1, and 0.1, respectively). Cycla justifies this by stating that since "each relative numerical weight represents a different order of magnitude of likelihood, the weights decrease by a factor of ten." The Cycla study cautions, however, that the values do not refer to any "absolute" risk level. (The detailed list of roadside inspection violations and traffic enforcement violations, and associated risk categories appears in Tables B-1 and B-2 in Appendix B. Each table indicates the source of the categorization - either Cycla or Volpe Center.)

To execute the model, Volpe Center analysts converted Cycla's relative numerical weights into crash reduction probabilities.[3] Each probability is an estimate of the portion of a crash avoided when an inspection uncovers a particular violation. For example, if a violation carried a probability of 0.001, inspectors would have to discover that violation 1,000 times in order for the model to "take credit" for avoiding a crash. Since driver-related errors are thought to be more of

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[2] Cycla Corporation, *Risk-based Evaluation of Commercial Motor Vehicle Roadside Violations: Process and Results*, July 1998. Note: The twenty-one traffic enforcement violations that fall under MCSAP were also included in the Cycla evaluation.

[3] See Appendix A for the explanation of how the relative weights from Cycla were converted into crash risk probabilities.

a factor in crash causation relative to mechanical defects, traffic enforcement violations were assigned higher probabilities. In fact, a 4 to 1 ratio separates the two types of violations based on expert judgments formed from the results of previous studies and available data.[4]

Table 3-1. Relative Weights for Driver and Vehicle Violation Risk Categories[5]

Risk Category		Relative Weight
1	**Violation** is the potential single, immediate factor leading to a crash or fatalities/injuries from a given crash.	1,000
2	**Violation** is the potential single, eventual factor leading to a crash or fatalities/injuries from a given crash.	100
3	**Violation** is a potential contributing factor leading to a crash or fatalities/injuries from a given crash.	10
4	**Violation** is an unlikely potential contributing factor leading to a crash or fatalities/injuries from a given crash.	1
5	**Violation** has little or no connection to crashes or the prevention of fatalities/injuries.	0.1

3.1.2. Direct Effects

This section describes the methodology employed to estimate the number of direct-effect crashes avoided.

Conceptually, the approach at the heart of the Direct Effects Submodel is straightforward. Since the occurrence of a single violation implies a certain degree of crash risk, each inspection that uncovers at least one violation can be interpreted as having reduced the risk linked with its noted violation(s). The model expresses this risk reduction in terms of the likelihood of a crash being avoided by each inspection violation that was noted and corrected. For an individual intervention, the avoided crash probability will be dependent upon the number and type of violations. Multiple violations, of course, will have a compounding effect, thereby increasing the likelihood of a prevented crash. By accounting separately for the two types of violations (roadside and traffic enforcement) and summing the portions of crashes avoided for all inspections within each group, it is possible to estimate direct-effect crashes that have been avoided due to the *programs*.

Figure 3-3 depicts the process used to determine program direct effects.

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[4] Based on preliminary findings from crash causation studies conducted by the University of Michigan Transportation Research Institute. An ongoing, more comprehensive crash causation study at the NHTSA is expected to bolster these assumptions.

[5] Ibid, p. 21.

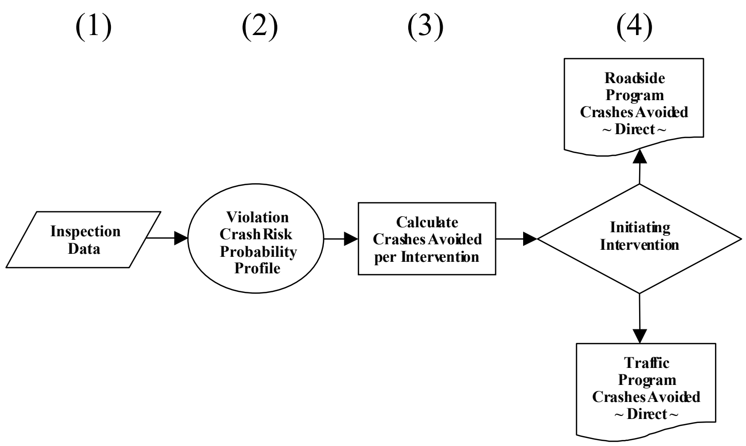

Figure 3-3. Direct-Effect Approach

Four steps make-up the direct-effect approach.

- **Step 1** - One year of inspection data is extracted from the Motor Carrier Management Information System (MCMIS) database. The MCMIS contains information compiled from federal and state safety agencies. Each intervention has its own set of associated driver and/or vehicle violations.

- **Step 2** - An inspection's violations are matched to the Violation Crash Risk Probability Profile, whereby a list of crash reduction probabilities becomes attached to that inspection. This list becomes the basis for calculating the inspection's effect on avoiding a crash.

- **Step 3** - The likelihood of an avoided crash for each inspection is calculated by using the crash reduction probabilities of the inspection. An inspection with multiple violations will have a greater likelihood of an avoided crash than will an inspection with a single violation. This result reflects the belief that multiple violations compound the safety hazard posed from driver deficiencies and/or vehicle defects.

- **Step 4** - Once each inspection has been assigned its probability of avoiding a crash, the inspections are grouped by their initiating intervention. An inspection with a traffic enforcement driver violation is classified as traffic enforcement with a driver and/or vehicle roadside inspection component(s). All other inspections are classified as entirely driver and/or vehicle roadside inspections. Direct-effect crashes-avoided totals are simply the summation of 1) the portions of crashes avoided for all traffic enforcement violations and 2) the summation of the portions of crashes avoided for all roadside inspection violations.

3.1.3. Indirect Effects

The fundamental premise of the indirect-effect approach is that once carriers have been exposed to the combination of roadside inspection and traffic enforcement actions, they will change their behavior. This change in behavior will result in higher levels of compliance, fewer future violations, and, therefore, a reduction in the number of crashes. This section presents a summary of the methods used in the model to arrive at program indirect effects. The deterrent-effects part of the model – that is, the Indirect Effects Submodel - follows a similar pattern to that of the Direct Effects Submodel.

Indirect effects, by their nature, defy measurement. However, changes in behavior represented by changes in the number of violations recorded for a carrier over time can be used to identify and evaluate the *result*s of the indirect effects. In other words, if a carrier receives fewer and fewer violations as it is subjected to more inspections, it will be determined that compliance behavior has been affected and the resulting likelihood of crashes has been reduced. To measure these effects, multiple successive years of intervention data are required.

The Indirect Effects Submodel compares the results of inspections carrier by carrier from one year to the next in order to measure the effects of the exposure to having inspections on compliance. A carrier's performance in a base year is compared to its performance in a subsequent year. What is sought is an improvement, i.e., a reduction, in the likelihood of a crash resulting from increasingly fewer violations being recorded. The difference between the totals is calculated as the indirect-effect crashes-avoided effect. Depending upon the initiating intervention, it is tallied as indirect-effect crashes avoided for either the roadside inspection or traffic enforcement programs.

Figure 3-4 illustrates the processes involved in assessing the indirect effects of the model.

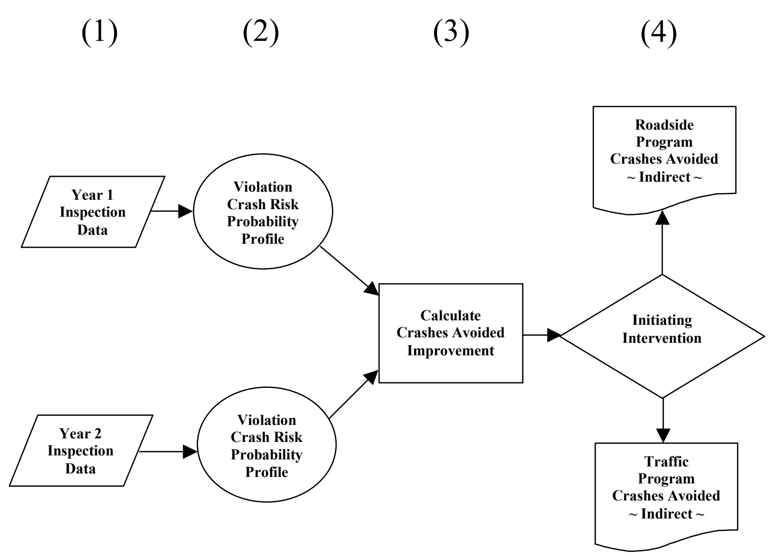

Figure 3-4. Indirect-Effect Approach

The indirect effects calculation is similar to that of the direct effects. **Steps 1** and **2** are equivalent, with one exception, to their counterparts in the Direct Effects Submodel. The Indirect Effects Submodel uses two years of MCMIS intervention data, whereas the Direct Effects Submodel uses one. **Step 3** creates year one and year two average fractional crashes-avoided figures for each carrier. The two figures are compared and improvements are noted. **Step 4** separates inspections and attributes the results to the initiating intervention. Traffic enforcement driver moving violations are assigned to the traffic enforcement program. All others (including driver and vehicle inspections done in conjunction with traffic stops) are assigned to the roadside inspection program. Indirect-effect crashes-avoided totals are the summation of the improvements in calculated crashes avoided.[6]

3.2. IMPLEMENTATION OF THE INTERVENTION MODEL

The use of the model requires intervention data inputs (as discussed in the submodel sections) in order to produce estimates of the numbers of crashes avoided that are attributable to the roadside inspection and traffic enforcement programs. For the purpose of testing the model, 1998 data was used, as shown in Table 3-2.

Table 3-2. Data Inputs Used to Test the Model

	1998[7]
Total Interventions	2,217,000[8]
Roadside Inspections with No Violations	572,000
Roadside Inspections with Violations	1,129,000
Traffic Enforcements with Violations	516,000

The Direct Effects Submodel yielded a mean estimate of 6,995 motor carrier crashes avoided as a result of the roadside inspection program in 1998, and another 2,331 crashes avoided due to the traffic enforcement program. The Indirect Effects Submodel, using the same 1998 input data, produced mean estimates of 1,617 roadside inspection and 469 traffic enforcement crashes avoided. Summation of the submodel totals provided estimates of the overall roadside inspection and traffic enforcement program results. Thus, the total numbers of crashes avoided in 1998 by

[6] Readers should note that the allocation of violations to programs actually occurs earlier in the indirect-effect calculation process. To simplify the presentation, however, the submodel has been presented in the form appearing above. This does not materially affect the model outline.

[7] To determine indirect effects, the Model looked at carriers that had interventions in 1998 and 1999, then noted the difference between the two years' data. This was done because behavioral changes (i.e., indirect effects) brought about by 1998 interventions will only be seen through the impact that they have upon a carrier/driver over the course of the following year.

[8] Source: MCMIS file, March 2001. Figures appearing in the table have been rounded to the nearest thousand.

the roadside inspection program and the traffic enforcement program were 8,612 and 2,800, respectively.[9]

3.3. PROGRAM BENEFITS

The model also estimates program benefits expressed in terms of lives saved and injuries avoided. Figure 3-5 illustrates the overall approach that is used by the model to determine these program benefits that are attributable to the roadside inspection and traffic enforcement programs.

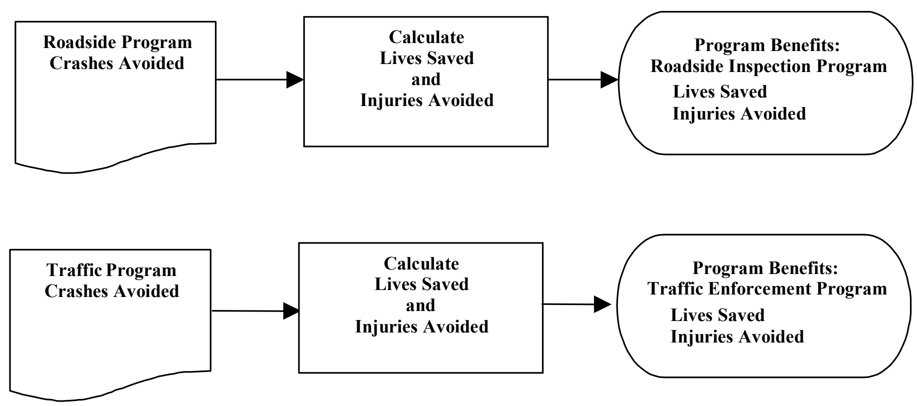

Figure 3-5. Program Benefits Determination

Continuing with the 1998 data, the model converted the 8,612 crashes avoided by the roadside inspection program into program benefits of 369 lives saved and 5,902 injuries avoided. Likewise, the model converted the estimate of 2,800 crashes avoided as a result of the traffic enforcement into 120 lives saved and 1,919 injuries avoided. The set of tables in Section C.1 of the Appendix displays model-calculated national program results for calendar year 1998, as well as subsequent years for which the model was run.

The model's flexibility lends itself to finer divisions of examination, such as scrutiny by state, which then can be used to guide the allocation of MCSAP resources and the design of state truck safety programs. The tables of Sections C.2 and C.3 in Appendix C show the estimated program benefits resulting from each state's MCSAP programs. Section C.2 tables show output from the model for state roadside inspections and the Section C.3 tables summarize traffic enforcement results.

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[9] Model output figures represent the mean between totals derived from two sets of crash risk probabilities. An explanation of the probability range and its effects on the model appears in Appendix A.

4. ENHANCEMENTS, APPLICATIONS, AND ANALYSES

4.1. INTRODUCTION

Additional model improvements are planned. They include improving the model inputs, such as the crash probabilities, and conducting additional assessments and analyses leading to improved application practices. Some of these improvements include:

- employing the results of planned studies of crash causation to improve crash probabilities, and capturing the compounding impact of multiple defects,
- incorporating hazardous materials violations, and the potential effect of these violations, particularly when combined with driver and vehicle effects, and
- determining the effectiveness of the programs in reducing crashes among different carrier classes allowing for an improved “targeting” of resources.

Besides implementing model enhancements that will improve the measurement of the effectiveness of the roadside inspection and traffic enforcement programs, there will be ongoing efforts to examine how the model fits into a combined effects assessment of the three major FMCSA programs (including the compliance review (CR) program). Work will be initiated to establish an approach using the Intervention Model and the Compliance Review Impact Assessment Model to examine the combined effects and relative separate effectiveness of the programs.

4.2. INTERVENTION MODEL ENHANCEMENTS

4.2.1. Strengthen Crash Probabilities

The Intervention Model is conservative in developing crash risk reduction probability estimates for individual violations as well as for individual inspections with multiple violations. Though the model clearly recognizes that multiple vehicle and driver problems occurring simultaneously greatly enhance the likelihood of a future crash, more empirical data on the compounding impact of multiple defects could result in much more accurate estimates of crash probabilities.

While the Cycla effort to differentiate among violations based on their respective risk category provides a means to estimate the prospect that a crash would occur had the vehicle/driver not been stopped, further data on linkages between vehicle/driver problems and crash occurrences would improve the model’s accuracy. The FMCSA and the National Highway Traffic Safety Administration (NHTSA) are currently conducting detailed post-crash investigations on a sample of crashes.[1] The objective of this study is to obtain information on the connections between vehicle/driver problems and crash causation.

4.2.2. Incorporate Hazardous Materials Violations

Another enhancement that will be made during future model runs is the effect of hazardous materials violations. Currently, the model does not address the issue of hazardous materials violations discovered during inspections or the effects that these violations (particularly when combined with driver and vehicle effects) may have on causing crashes or increasing the severity of crashes. This refinement is clearly warranted, given the potential effects of hazardous materials violations, especially when combined with vehicle and driver violations.

4.3. INTERVENTION MODEL APPLICATIONS

4.3.1. Carrier Class Studies

By using motor carrier categories, or classes, such as those developed by Dr. Thomas Corsi of the Robert H. Smith School of Business at the University of Maryland, the model can be used to study program effectiveness among carrier classes. Differences in fleet size, driver age, length of haul, etc., may contribute to differences in direct-effect and indirect-effect program impacts. A better understanding of carrier classes and how they react to interventions will aid in the application and development of the roadside inspection and traffic enforcement programs.

4.3.2. Alternate Treatments

As a corollary to the investigation of carrier types, alternate forms of treatment to reduce crashes should be sought. If patterns were to be discovered in particular strata of carriers, then the proposal and implementation of effective means of addressing these groups would become critical in the effort to increase the number of lives saved and injuries avoided from intervention programs.

4.4. FUTURE INTERVENTION MODEL ANALYSES

The model is designed to be used as an ongoing measurement tool. It is anticipated that initial runs of the model will generate benchmarks that will assist in tracking program performance over time. In particular, emphasis should be placed on assessing the indirect effects component of the model, since it is the portion of the model that analyzes the effects that have an impact on

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[1] The U.S. Department of Transportation's Federal Motor Carrier Safety Administration (FMCSA) and National Highway Traffic Safety Administration (NHTSA) are conducting the Large Truck Crash Causation Study. The Motor Carrier Safety Improvement Act of 1999 (MCSIA) provided for the study.

future carrier behavior. Additional years of data would serve to substantiate the concept of the deterrence effect and improve the measurement of that effect as well.

Finally, the results of the model are to be employed in a comprehensive assessment of the combined effects of all MCSAP safety programs. It is expected that combining the results of both the Compliance Review Impact Assessment and Intervention Models will create a more powerful program effectiveness measurement capability, which will enable the FMCSA to meet the requirements of the Government Performance and Results Act of 1993. The FMCSA will also employ this enhanced capability to improve the safety programs.

4.5. SUBSEQUENT MODEL RUNS

Upon completion of the Model's initial testing, two subsequent Model runs were performed to determine program benefits in 1999 and 2000. These runs were to produce program performance benchmarks and act as a final test of the Model's ability to measure program performance across multiple years.

Analysis of the new results showed an unanticipated drop in program benefits between 1998 and 1999. This occurred despite an increase in the overall number of interventions carried out in 1999. Further investigation of the underlying data was undertaken to discover the source of this apparent anomaly (e.g., an actual downward trend in program benefits, instability of the Model, etc.).

Examination of the data uncovered a reporting inconsistency with one of the general driver violations (392.2D - "local laws/other driver violations"). Usage of this violation dropped dramatically between 1998 and 1999 and was offset by a concurrent increase in usage of another general driver violation (392.2 - "local laws/ general").   Whereas 392.2D was assigned to Risk Category 1, violation 392.2, as well as all other general driver violations, was classified as Risk Category 2. Consequently, Volpe Center staff opted to reclassify 392.2D as Risk Category 2 because a) it is a nonspecific violation that obscures the potential hazard of the behavior being cited, and b) doing so conforms with the classification established for other general driver violations.

A new set of Model runs was completed after the reclassification for calendar years 1998, 1999, and 2000. The updated results appear in Appendix C.

APPENDIX A. MATHEMATICAL DESCRIPTION OF THE INTERVENTION MODEL

A.1. OVERVIEW

The Intervention Model measures the effectiveness of the MCSAP roadside inspection and commercial vehicle traffic enforcement programs.[1] Effectiveness, for the purposes of this analysis, is defined as the estimated reduction in motor carrier crashes attributable to the existence and implementation of the aforementioned MCSAP safety programs. The model is a key element of the FMCSA's Program Performance Measures project.

This appendix presents a more detailed description of the model than that provided in the preceding text. It also contains mathematical explanations of the algorithms employed in the model.

A.2. INTERVENTION DATA

Raw intervention data serve as the inputs from which all further determinations flow. The data consist of individual records of roadside inspections and traffic enforcements carried out during a given period. The model creates a crashes-avoided figure for each intervention based on the number and type of violations present.

A.2.1. Roadside Inspections

Roadside inspections are interventions performed by qualified safety inspectors at fixed roadside locations (e.g., weigh stations) using North American Standard (NAS) guidelines.[2] The NAS is a vehicle and driver inspection structure established by the FMCSA and the Commercial Vehicle Safety Alliance. A checklist of each roadside inspection lists uncovered violations of safety regulations.

[1] "The MCSAP is a Federal grant program that provides financial assistance to States to reduce the number and severity of accidents … involving commercial motor vehicles (CMVs). … Investing grant monies in appropriate safety programs will increase the likelihood that safety defects, driver deficiencies, and unsafe motor carrier practices will be detected and corrected before they become contributing factors to accidents." http://www.fmcsa.dot.gov/safetyprogs/mcsap.htm.

[2] See http://www.inspector.org/37stepin.htm.

A.2.2. Traffic Enforcements

MCSAP traffic enforcements are a subset of traffic enforcements in general.[3] MCSAP traffic enforcements include only those enforcement stops that lead to an on-the-spot roadside inspection. The enforcement agent, if qualified, performs the subsequent roadside inspection. Otherwise, a safety inspector is called to the scene to conduct it. Since a traffic infraction precipitates the ensuing roadside inspection, 21 moving violations are incorporated into the driver section of the roadside checklist. The model classifies an intervention as traffic enforcement when at least one traffic violation is present in the intervention record.

A.3. INTERVENTION-LEVEL IMPACT

As the name implies, the Intervention Model places a great deal of importance on individual interventions. The reason for this is that violation tabulations come from interventions and those tabulations are matched against a Violation Crash Risk Probability Profile, which then serves as a basis for determining the number of crashes avoided for a given intervention. Aggregates developed from the intervention-level crashes avoided numbers eventually form national and state statistics.

A.3.1. Violation Crash Risk Probability Profile

The model assumes that observed deficiencies (OOS and non-OOS violations) can be converted into crash risk probabilities. This assumption is based on the belief that detected defects represent varying degrees of mechanical or judgmental faults and, as a result, some are more likely than others to play contributory roles in causing motor carrier crashes. These differences can be estimated and ranked into discrete risk categories. Thus, the Violation Crash Risk Probability Profile (VCRPP) contains all violation codes, each with an assigned risk category and a corresponding crash probability.

Using Cycla's risk categories and the relative weights assigned to the categories, the Volpe Center analysts sought to account for error margins by opting for two probability sets – a Higher Bound set and a Lower Bound set. The outputs computed from the two sets are used to compute a mean with a range of ± 20 percent. Because crash causation data is still forthcoming, users are reminded to employ caution interpreting the Model's results.

The figures in Tables A-1a and A-1b indicate the Higher Bound and Lower Bound numbers of violations that would have to be discovered to cause the model to credit one of the programs with

[3] § Sec.350.111 of the Federal Motor Carrier Safety Regulations defines a MCSAP traffic enforcement as follows: "Traffic enforcement means enforcement activities of State or local officials, including stopping CMVs operating on highways, streets, or roads for violations of State or local motor vehicle or traffic laws (e.g., speeding, following too closely, reckless driving, improper lane change). To be eligible for funding through the grant, traffic enforcement must include an appropriate North American Standard Inspection of the CMV or driver or both prior to releasing the driver or CMV for resumption of operations."

an avoided crash. Keep in mind, however, the numbers in the tables are not meant to be definitive. They constitute the best guesses of industry experts interpreting available data. Volpe Center analysts used these figures to test and calibrate the model. As more reliable crash causation statistics become available, table quantities may have to be revised.[4] These revisions will not affect the overall soundness of the model.

Note that in moving from Risk Category (RC) 1 to RC 2, from RC 2 to RC 3, and so on, each step varies by a factor of ten. This tracks Cycla's variation in designated relative weights between risk categories. Note further that the weight given to uncovered traffic enforcement violations is four times that of the roadside inspection counterpart violations. Tables A-1a and A-1b illustrate the factor and weighting differences. For example, the tenfold factor variation can be seen when Traffic Enforcement RC1 OOS Violations jump from 30 to 300 when stepping to Traffic Enforcement OOS Violations RC2. Additionally, it takes quadruple the number of Roadside Inspection OOS Violations in RC1 (120) to have the same impact as Traffic Enforcement OOS Violations in RC1 (30), demonstrating the reduced weight given to roadside inspection violations vis-à-vis traffic enforcement violations. Volpe Center analysts used the latest, preliminary data available from ongoing crash causation studies to support this difference. The studies found that driver faults represented by traffic enforcement violations are more likely to lead to motor carrier crashes than are roadside-inspection driver or vehicle faults of an equivalent risk category.[5]

Table A-1a. Lower Bound Corrected Violation Estimates to Avoid One Crash, by Risk Category

Risk Category	Roadside Inspection Number of Violations		Traffic Enforcement Number of Violations	
	OOS Violations	Non-OOS Violations	OOS Violations	Non-OOS Violations
1	120	240	30	60
2	1,200	2,400	300	600
3	12,000	24,000	3,000	6,000
4	120,000	240,000	30,000	60,000
5	1,200,000	2,400,000	300,000	600,000

[4] Crash causation studies are underway at the University of Michigan Transportation Research Institute and the NHTSA.

[5] Ibid.

Table A-1b. Higher Bound Corrected Violation Estimates to Avoid One Crash, by Risk Category

Risk Category	Roadside Inspection		Traffic Enforcement	
	Number of Violations		Number of Violations	
	OOS Violations	Non-OOS Violations	OOS Violations	Non-OOS Violations
1	80	160	20	40
2	800	1,600	200	400
3	8,000	16,000	2,000	4,000
4	80,000	160,000	20,000	40,000
5	800,000	1,600,000	200,000	400,000

Tables A-2a and A-2b display the higher bound and lower bound probabilities, respectively. The crash reduction probabilities are the reciprocals of the numbers in Tables A-1a and A-1b, so it follows that the probabilities also experience a tenfold change between steps. The crash reduction probabilities associated with each violation form the VCRPP.

Table A-2a. Lower Bound Crash Reduction Probabilities

Risk Category	Roadside Inspection		Traffic Enforcement	
	Crash Reduction Probability		Crash Reduction Probability	
	OOS Violations	Non-OOS Violations	OOS Violations	Non-OOS Violations
1	.00833	.004167	.033	.0167
2	.000833	.0004167	.0033	.00167
3	.0000833	.00004167	.00033	.000167
4	.00000833	.000004167	.000033	.0000167
5	.000000833	.0000004167	.0000033	.00000167

Table A-2b. Higher Bound Crash Reduction Probabilities

Risk Category	Roadside Inspection		Traffic Enforcement	
	Crash Reduction Probability		Crash Reduction Probability	
	OOS Violations	Non-OOS Violations	OOS Violations	Non-OOS Violations
1	.0125	.00625	.05	.025
2	.00125	.000625	.005	.0025
3	.000125	.0000625	.0005	.00025
4	.0000125	.00000625	.00005	.000025
5	.00000125	.000000625	.000005	.0000025

A.3.1.1. Applied to Recorded Violations

Because each inspection used in the analysis has one or more violations, the model classifies recorded violations according to their VCRPP ratings. Table A-3 displays the classification process for two example inspections.

Inspection A is a roadside-initiated intervention, since no traffic enforcement violations are present. It contains roadside RC 1 OOS violations and both OOS and non-OOS RC 2 violations. Using the VCRPP, the violations receive their respective probabilities from the Higher Bound and Lower Bound probability sets.

The VCRPP is also applied to Inspection B. Unlike Inspection A, Inspection B is classified as a traffic enforcement-initiated intervention, because it has at least one traffic enforcement violation. Additionally, several roadside violations were identified during the subsequent roadside inspection.

Table A-3. Classifying Intervention Violations with the VCRPP: Two Examples

	Violation Number (from Appendix B)	Violation Description	Violation Type (Roadside/Traffic)	OOS (Yes/No)	Risk Category (1-5)	Risk Prob. (Lower Bound)	Risk Prob. (Higher Bound)
Inspection A	392.5C	Operating a cmv while fatigued	Roadside	Yes	1	0.0083	0.0125
	393.9H	Inoperable head lamps	Roadside	Yes	1	0.0083	0.0125
	395.3A1	10 hour rule violation	Roadside	Yes	2	0.00083	0.00125
	392.14	Failed to use caution for hazardous condition	Roadside	Yes	2	0.00083	0.00125
	393.201B	Bolts securing cab broken	Roadside	Yes	2	0.00083	0.00125
	393.9T	Inoperable tail lamp	Roadside	No	2	0.0004167	0.000625
	393.60C	Use of vision reducing matter on windows	Roadside	No	2	0.0004167	0.000625
	392.9A3	Driver's view is obstructed	Roadside	No	2	0.0004167	0.000625
	393.77	Prohibited heaters	Roadside	No	2	0.0004167	0.000625
Inspection B	393.48A	Inoperative brakes	Roadside	Yes	1	0.0083	0.0125
	393.209D	Inoperative steering system component	Roadside	Yes	1	0.0083	0.0125
	393.17B	No deflective side marker	Roadside	No	2	0.0004167	0.000625
	392.9A	Failure to secure load	Roadside	No	2	0.0004167	0.000625
	392.5	Driver using or in possession of alcohol	Traffic	Yes	1	0.033	0.05
	392.2C	Failure to obey traffic control device	Traffic	Yes	2	0.0033	0.005
	392.2P	Improper passing	Traffic	Yes	2	0.0033	0.005

A.3.1.2. Occurrences per Risk Category

After the application of the VCRPP, the model aggregates violations occurring in a particular risk category. Table A-4 continues with the example interventions from Table A-3 by exhibiting the results of the aggregation.

Table A-4. Violation Occurrences per Risk Category: Two Examples[6]

Inspection	Roadside Inspection				Traffic Enforcement			
	Risk Category 1 Violations		Risk Category 2 Violations		Risk Category 1 Violations		Risk Category 2 Violations	
	OOS	Non-OOS	OOS	Non-OOS	OOS	Non-OOS	OOS	Non-OOS
A	2		3	4				
B	2			2	1		2	

A.3.2. Crashes Avoided per Intervention

To generate an intervention's crashes avoided, the number of violation occurrences per risk category is multiplied by the crash probability associated with that risk category. For instance, if four occurrences of roadside OOS violations in RC 1 were noted on an inspection report, then the model would multiply four by the roadside OOS RC 1 probability from the VCRPP. This would be done for all roadside OOS and non-OOS violations, along with all traffic OOS and non-OOS violations. Summing the products creates an initial crash risk reduction for the inspection's risk category being evaluated.

Initial Crash Risk Reduction per Risk Category

$$(v_{rs\text{-}rcOOS} \text{ X } P_{rs\text{-}rcOOS}) + (v_{rs\text{-}rcNON} \text{ X } P_{rs\text{-}rcNON}) + (v_{te\text{-}rcOOS} \text{ X } P_{te\text{-}rcOOS}) + (v_{te\text{-}rcNON} \text{ X } P_{te\text{-}rcNON}) = CRR_{rc\text{-}init} \quad \textbf{(A-1)}$$

where

$v_{rs\text{-}rcOOS}$ = the number of roadside out-of-service violations in a given risk category recorded during an inspection,

$v_{rs\text{-}rcNON}$ = the number of roadside non-out-of service violations in a given risk category recorded during an inspection,

$v_{te\text{-}rcOOS}$ = the number of traffic out-of-service violations in a given risk category recorded during an inspection,

$v_{te\text{-}rcNON}$ = the number of traffic non-out-of service violations in a given risk category recorded during an inspection,

$P_{rs\text{-}rcOOS}$ = crash risk probability for a given roadside out-of-service risk category,

$P_{rs\text{-}rcNON}$ = crash risk probability for a given roadside non-out-of-service risk category,

$P_{te\text{-}rcOOS}$ = crash risk probability for a given traffic out-of-service risk category,

$P_{te\text{-}rcNON}$ = crash risk probability for a given traffic non-out-of-service risk category, and

$CRR_{rc\text{-}init}$ = **initial**, calculated crash risk for a given risk category within an inspection.

Next, all violations recorded for a risk category during an intervention, roadside OOS and non-OOS and, if applicable, traffic OOS and non-OOS, are added together. Multiplying the total by

[6] To avoid needless complexity, the examples have been crafted using risk categories 1 and 2, rather than the entire range of risk categories 1 through 5.

the initial crash risk reduction calculated in Equation **(A-1)** produces the final crash risk reduction for a given risk category in a particular intervention. Equation **(A-2)** is designed to capture the growth in crash risk arising from the discovery and correction of numerous violations during a single intervention. The logic behind this is that, while each violation carries a certain degree of crash risk in isolation, additional violations occurring in tandem elevate the crash risk beyond the mere combined, additive, risk levels caused by each violation alone. In essence, the Final Crash Risk Reduction per Risk Category equation measures the multiplicative crash risk effect of compound safety defects.

Final Crash Risk Reduction per Risk Category

$$(v_{rs\text{-}rcOOS} + v_{rs\text{-}rcNON} + v_{te\text{-}rcOOS} + v_{te\text{-}rcNON}) \text{ X } CRR_{rc\text{-}init} = CRR_{RC} \qquad \textbf{(A-2)}$$

where

CRR_{RC} = **final**, calculated crash risk reduction for a given risk category within an inspection.

*Note: Equations **(A-1)** and **(A-2)** must be performed for each of the five risk categories.*

When all five risk categories have had their respective crash risk reductions determined, the model calculates the intervention's crashes avoided by adding the five CRR_{RC} numbers. A cap of 0.75 is placed on the outcome for each intervention, thus ensuring that the model never produces a crashes avoided total greater than one. Volpe Center analysts chose three-quarters of a crash avoided as a cap to maintain a more conservative tendency in the model, given the lack of empirical crash causation data.

Number of Crashes Avoided from an Intervention

$$CRR_{RC1} + CRR_{RC2} + \ldots + CRR_{RC5} = I_A \qquad \textbf{(A-3)}$$

where

I_A = calculated crashes avoided due to an inspection.

Repeating this process using both Higher Bound and Lower Bound probabilities yields the crashes avoided range for each intervention.

A.3.3. Examples

Example A: In Inspection A (see Table A-3), a vehicle given a roadside inspection is found to have two out-of-service violations in Risk Category 1, three out-of-service violations in Risk Category 2, and four non-out-of-service violations in Risk Category 2. The calculation of the total crashes avoided of this single inspection, using Higher Bound probabilities, appears below.

Multiplying the crash reduction probability for each risk category by the number of out-of-service violations in that risk category and adding it to the product of the risk reduction probability and the number of non-out-of-service violations gives the initial crash risk reduction.

Thus, $CRR_{rc\text{-}init}$ for each risk category, based on Equation **(A-1)**:

Higher Bound

Risk Category 1, $CRR_{rc1\text{-}init}$	(2 X .0125)	= .025
Risk Category 2, $CRR_{rc2\text{-}init}$	(3 X .00125) + (4 X .000625)	= .00625

Final crash risk reduction becomes known after multiplying the initial crash risk reduction for each risk category by the number of violations in that risk category. The model supplies total crashes avoided for the intervention by tallying the final crash risk reduction from each risk category.

Inspection A's total crashes avoided, based on Equations **(A-2)** and **(A-3)**:

Higher Bound

Risk Category 1, CRR_{RC1}	.05	=	.025	X 2
Risk Category 2, CRR_{RC2}	+ .04375	=	.00625	X 7
Total Crash Risk Reduction, I_A	.09375			

Therefore, Inspection A's range of crashes avoided begins at the Higher Bound result, 0.09375, and would extend to the Lower Bound output.

Example B: In Inspection B (see Table A-3), a traffic enforcement stop has resulted in both traffic enforcement violations and roadside inspection violations. The intervention involved one traffic enforcement out-of-service violation in Risk Category 1 and two out-of-service violations in Risk Category 2. In addition, the inspection involved two roadside out-of-service violations in Risk Category 1 and two non out-of-service violations in Risk Category 2. Inspection B's computations follow:

Higher Bound

	Roadside		Traffic		
Risk Category 1, $CRR_{rc1\text{-}init}$	(2 X .0125)	+	(1 X .05)	= .075	Using **(A-1)**
Risk Category 2, $CRR_{rc2\text{-}init}$	(2 X .000625)	+	(2 X .005)	= .01125	

To account for multiple violations, the model makes the following intensification adjustments to calculate the final crash risk reduction for each risk category:

Higher Bound

Risk Category 1, CRR_{RC1}	.225	= .075	X 3	Using **(A-2)**
Risk Category 2, CRR_{RC2}	+ .045	= .01125	X 4	and **(A-3)**
Total Crash Risk Reduction, I_A	.27			

The crashes avoided range for Inspection B starts at 0.27.

A.4. PROGRAM-LEVEL IMPACT

Measuring interventions at the program level is next. It is here, however, that the model follows two divergent paths, one measuring direct effects and the other measuring indirect effects. Direct effects, it should be remembered, are the immediate products of roadside inspections and traffic enforcement stops performed in a given year, while indirect effects are based on behavioral changes caused by program awareness.

A.4.1. Direct-Effect Approach

This section outlines the development of direct-effect crashes-avoided estimates. Figure A-1 shows the process used to determine the direct effects of the programs. First, there is a primary crashes avoided computation. Afterwards, a roadside allocation credits a portion of traffic enforcement crashes avoided to the roadside inspection program, recognizing the contribution to the traffic total made by the ensuing roadside inspection.

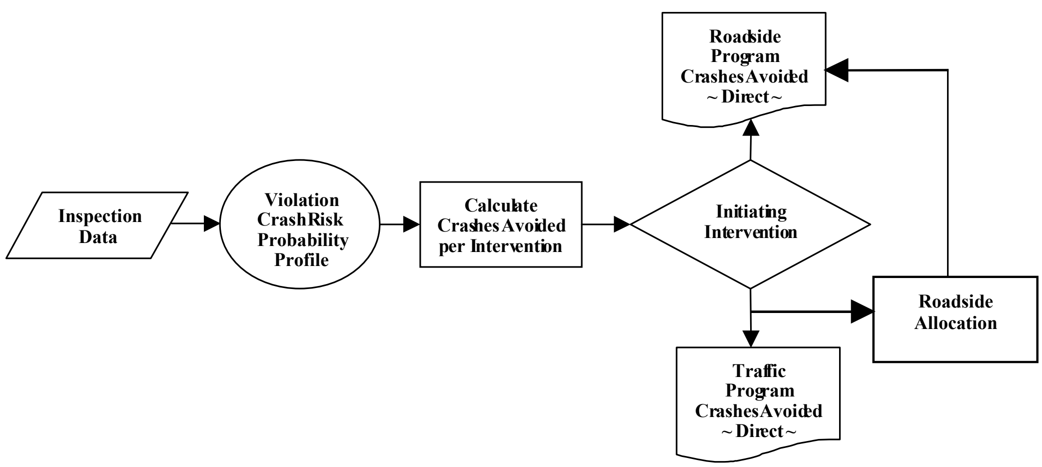

Figure A-1. Direct-Effect Approach with Roadside Allowance

A.4.1.1. Primary Determination

The model initially examines all inspections in a given year in terms of the numbers and types of violations associated with each individual inspection. Based on the VCRPP described above, inspection violations (both OOS and non-OOS) are matched with their respective crash risk reduction probabilities, to produce an estimated range of crashes avoided for that inspection. The model next segregates the complete set of inspections into two groups, depending on whether the initiating intervention was a roadside inspection or a traffic enforcement, and sums the estimated crashes-avoided ranges across all inspections in each group. Two overall estimates of crashes avoided emerge: one for the roadside inspection program and one for the traffic enforcement program.

Roadside Inspection-initiated crashes avoided $= I_{RS\text{-}A1} + I_{RS\text{-}A2} + \ldots + I_{RS\text{-}An}$, **(A-4)**

where

$I_{RS\text{-}A}$ = crashes avoided per roadside inspection for (1, 2, …, *n*) roadside-initiated inspections.

Likewise,
Traffic Enforcement-initiated crashes avoided $= I_{TE\text{-}A1} + I_{TE\text{-}A2} + \ldots + I_{TE\text{-}Am}$, **(A-5)**

where

$I_{TE\text{-}A}$ = crashes avoided per traffic enforcement for (1, 2, …, *m*) traffic-initiated inspections.

A.4.1.2. Roadside Allowance

The process, however, does not end with the primary determination. An additional allocation of crashes avoided is necessary. As stated above, when the traffic enforcement action is the initiating event for an inspection, it is appropriate to credit back to the roadside inspection program those crashes avoided due to the correcting of roadside inspection-related violations.

The model accomplishes the roadside allocation by using only the inspections initiated by traffic enforcement. *Violations* in this group are separated by type (roadside inspection-related and traffic enforcement-related) because two sets of crash risk reduction probabilities are required for each inspection. One set (A) is derived solely from traffic-related violations; the other (B) consists of the originally computed traffic enforcement crash risk reduction probabilities, using both types of violations. Dividing (A) by (B) provides the percentage of crashes avoided that need to be redistributed from the traffic enforcement program to the roadside inspection program.

$$Aadjust_{direct} = \frac{V_{TE}}{V_{TE+RS}} \quad \textbf{(A-6)}$$

where

V_{TE} = traffic enforcement-initiated crashes avoided from only traffic-related violations,

V_{TE+RS} = traffic enforcement-initiated crashes avoided from all violations, and

$Aadjust_{direct}$ = the percentage of traffic enforcement direct effect crashes avoided that will need to be allocated to the roadside inspection program.

The final direct-effect program totals are then:

$$RS_{A\text{-direct}} = A_{RS\text{-direct}} + [(1 - Aadjust_{direct}) \text{ X } A_{TE\text{-direct}}] \quad \textbf{(A-7)}$$

and

$$TE_{A\text{-direct}} = Aadjust_{direct} \text{ X } A_{TE\text{-direct}} \quad \textbf{(A-8)}$$

where

$A_{RS\text{-direct}}$ = the pre-allocation crashes avoided total for roadside inspections,

$A_{TE\text{-direct}}$ = the pre-allocation crashes avoided total for traffic enforcements,

$RS_{A\text{-direct}}$ = the post-allocation direct effect crashes avoided total for roadside inspections, and

$TE_{A\text{-direct}}$ = the post-allocation direct effect crashes avoided total for traffic enforcements.

A.4.1.3. Examples

Continuing with the example interventions, the results of applying Equations **(A-5)** through **(A-8)** to Inspection A and Inspection B appear below.[7]

Equation **(A-5)**:

Higher Bound
Roadside Inspection-initiated crashes avoided = $I_{RS\text{-}A1}$ = 0.09375
Traffic Enforcement-initiated crashes avoided = $I_{TE\text{-}A1}$ = 0.27

Roadside Allowance, Equations **(A-1), (A-2), (A-3)**:
(Using Inspection B, the traffic enforcement-initiated intervention)

Traffic Violations Only, Equation **(A-1)**

Higher Bound
Risk Category 1, $CRR_{rc1\text{-}init}$ (1 X .05) = .05
Risk Category 2, $CRR_{rc2\text{-}init}$ (2 X .005) = .01

Traffic Violations Only, Equation **(A-2)**

Higher Bound
Risk Category 1, $CRR_{rc1\text{-}init}$ .05 X 1 = .05
Risk Category 2, $CRR_{rc2\text{-}init}$ .01 X 2 = .02

[7] Note: Since only two example interventions have been presented, one roadside-initiated (Inspection A) and the other traffic-initiated (Inspection B), Equation **(A-5)**'s example results are identical to the output of Equation **(A-3)**.

Traffic Violations Only, Equation **(A-3)**

Higher Bound	
Risk Category 1, CRR_{RC1}	.05
Risk Category 2, CRR_{RC2}	+ .02
Total Crash Risk Reduction, I_A	.07

The crashes avoided range for Inspection B, using only traffic violations begins at 0.07.

Applying Equation **(A-6)** gives the percentage of traffic enforcement-initiated crashes avoided that will be attributed to the traffic enforcement program.

Higher Bound

$$\frac{.07}{.27} = .259\text{, i.e., } 26\%$$

Final direct effects crashes avoided, Equations **(A-7)** and **(A-8)**.

Roadside Total	Traffic Total
Higher Bound	**Higher Bound**
.09375 + [(1 - .26) X .27] = .29355	.26 X .27 = .0702

Thus, the recalculated higher bound crashes-avoided of the roadside program is 0.29, and the recalculated higher bound crashes-avoided of the traffic program is 0.07.

A.4.2. Indirect-Effect Approach

The fundamental premise of the indirect-effect approach is that once carriers have been exposed to the combination of roadside inspection and traffic enforcement actions, a change in their behavior will be manifested by a reduction in crashes. This section presents a summary of the methods used in the model to arrive at the programs' indirect effects. As with the direct-effect approach, a primary determination and a roadside allowance make up the major part of the procedure. Figure A-2 provides a view of the processes involved in assessing the indirect effects of the model.

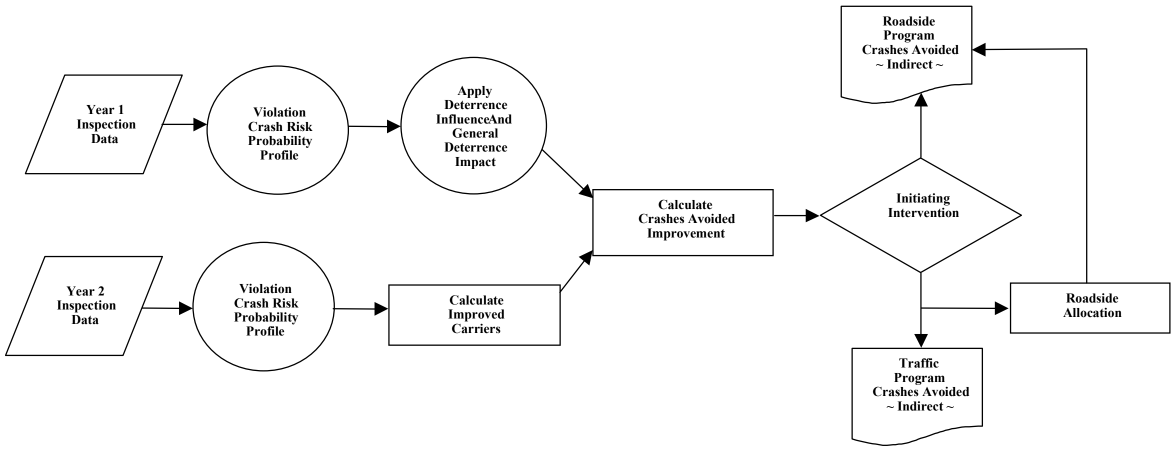

Figure A-2. Indirect-Effect Approach with Roadside Allowance

Indirect effects require means other than direct measurement to reveal their presence. For that reason, the model uses *changes* in the number of violations recorded during inspections to identify and evaluate the indirect effects. Specifically, the model's algorithm employs two successive years of inspection data to undertake this process.

To conduct a year-to-year comparison, it is necessary to identify and link the carriers who were inspected with the inspections each received during the two-year span. Only in this way can a cross-year evaluation discern the indirect influence (i.e., behavior modification) that causes a reduction in crashes. In contrast, this inspection-carrier link is not needed in the direct-effect approach.

A.4.2.1. Primary Determination

Gathered intervention data spanning two years is matched against the VCRPP, much in the manner laid out in the direct effects explanation. The model then organizes interventions by carriers. Intervention data from those carriers who have at least one intervention in both years are selected for preliminary analysis. The remaining Year One (Y1) intervention data, where a carrier match with Year Two (Y2) data was not able to be made, are set aside for later treatment. The nomenclature for the former group is *Selected*; the latter group is assigned the name *Remaining*.

A.4.2.1.1. Selected Set

For the Selected Set (S), the model determines each carrier's average crashes avoided in Y1, and again in Y2. The avoided crashes of each intervention from a given carrier in a given year (Equation **(A-9)**) are summed across the number of interventions the carrier had in that year (Equation **(A-10)**). Dividing the summation by all of the intervention actions conducted on the carrier for that year (Equation **(A-11)**) achieves the average crashes avoided. This provides Y1 and Y2 averages for each carrier in set S.

Improved carriers in set S[8] are those that have a decrease in average crashes avoided from Y1 to Y2. The *improved subset* designation applies to only those carriers with a lower Y2 figure.

A crashes-avoided estimate for carriers in the improved subset of set S can now be made by multiplying the number of interventions a carrier had in Y1 by the difference in average crashes avoided it experienced between Y1 and Y2 (Equation **(A-12)** for roadside and Equation **(A-13)** for traffic). The model reaches the entire improved subset's crashes avoided aggregate by adding the crashes avoided totals for all of the carriers within the subset. A parallel summation for both the roadside inspection-initiated (Equation **(A-14)**) and traffic enforcement-initiated (Equation **(A-15)**) interventions supplies each program with a crashes avoided total from the improved subset of set S.

Note: Calculate indirect effects separately, based on Higher Bound probabilities and Lower Bound probabilities.

Carrier Crashes Avoided per Year

Since every intervention has its own crashes avoided figure, summing the crashes avoided from each of the interventions a carrier received in a given year provides a crashes avoided total for that carrier.

$$\sum_{h=1}^{n} I_{Ah} \qquad \textbf{(A-9)}$$

Carrier Interventions per Year

Carrier interventions are the number of interventions a carrier had within a given year.

$$\sum_{h=1}^{n} I_{h} \qquad \textbf{(A-10)}$$

where

I = intervention, and

I_A = an intervention's crashes avoided for *h* (1, 2, …, *n*) interventions for a given carrier in a given year.

Carrier Average Crashes Avoided per Year

Using Equations **(A-9)** and **(A-10)**, a carrier's average crashes avoided in a given year is calculated by dividing a carrier's crashes avoided by its total number of interventions.

---

[8] An area for future investigation consists of motor carriers who registered no improvement in average crashes avoided.

$$C_{Aavg} = \frac{\sum_{h=1}^{n} I_{Ah}}{\sum_{h=1}^{n} I_{h}} \qquad \textbf{(A-11)}$$

where

C_{Aavg} = average crashes avoided for a given carrier in a given year.

Carrier Crashes Avoided

When a carrier's average crashes avoided diminishes in Y2, this is taken to be a positive indication of program indirect effects. Carriers who meet this condition are placed into an improved subset of set S called S′.

Roadside

The model determines an individual carrier's estimated number of roadside inspection crashes avoided resulting from indirect effects by taking the difference in its Y1 and Y2 average crashes avoided and multiplying the difference by the number of roadside inspections the carrier had in Y1. A modified version of Equation **(A-10)** that only counts roadside-initiated inspections from Y1 totals the number of roadside inspections.

$$A_{RS} = (C_{Aavg-Y1} - C_{Aavg-Y2}) \times \sum_{RS=1}^{n} I_{Y1\text{-}RS} \qquad \textbf{(A-12)}$$

where

$C_{Aavg-Y1}$ = carrier average crashes avoided in Y1,

$C_{Aavg-Y2}$ = carrier average crashes avoided in Y2,

$I_{Y1\text{-}RS}$ = Y1 roadside inspection,

A_{RS} = roadside inspection crashes avoided by a given carrier in subset S′ due to *RS* (1, 2, …, *n*) roadside inspections in Y1, and

the condition $C_{Aavg-Y1} > C_{Aavg-Y2}$, or subset S′, is met.

Traffic

The model calculates traffic enforcement crashes avoided in a similar manner.

$$A_{TE} = (C_{Aavg-Y1} - C_{Aavg)-Y2}) \text{ X } \sum_{TE=1}^{n} I_{Y1\text{-}TE} \qquad \textbf{(A-13)}$$

where

$C_{Aavg-Y1}$ = carrier average crashes avoided in Y1,

$C_{Aavg-Y2}$ = carrier average crashes avoided in Y2,

$I_{Y1\text{-}TE}$ = Y1 traffic enforcement,

A_{TE} = traffic enforcement crashes avoided by a given carrier in subset S′ due to *TE* (1, 2, …, *n*) traffic enforcements in Y1, and

the condition $C_{Aavg-Y1} > C_{Aavg-Y2}$, or subset S′, is met.

Set S Preliminary Crashes Avoided

Once Equations **(A-12)** and **(A-13)** have been used to create crashes avoided totals for each carrier in subset S′, preliminary program crashes avoided totals for set S are the aggregations of these totals.

Roadside.

$$A_{S'\text{-}RS} = \sum_{i=1}^{m} A_{RSi} \qquad \textbf{(A-14)}$$

where

$A_{S'\text{-}RS}$ = set S roadside inspection crashes avoided for i (1,2, …, *m*) carriers in subset S′.

Traffic

$$A_{S'\text{-}TE} = \sum_{i=1}^{m} A_{TEi} \qquad \textbf{(A-15)}$$

where

$A_{S'\text{-}TE}$ = set S traffic enforcement crashes avoided for i (1, 2, …, *m*) carriers in subset S′.

A.4.2.1.2. Remaining Set

Though crashes avoided have been calculated for the improved subset (S’), carrier and intervention data from the subset and its parent, set S, must still be used to impute crashes avoided totals to the Remaining Set (R). Because a definitive carrier-inspection link is absent over the course of Y1 and Y2, the R set requires estimations from general, intervention-related propositions. Therefore, two determinations are essential: the first is the ratio of interventions that are likely to be positively influenced by deterrence; the second characterizes the General Deterrence Impact of an intervention (described below).

Since not all carriers in set S showed an improvement in their average crashes avoided from Y1 to Y2, the model assumes only a certain proportion of all interventions performed in Y1 carry an indirect influence. Dividing the total number of interventions in the improved subset (S') by the total number of interventions in the entire set S approximates the deterrence-to-intervention influence.

The General Deterrence Impact (GDI) per intervention, on the other hand, attempts to quantify the portion of an avoided crash that is attributable to a single inspection, based again on the experience of the improved carrier subset. A unique GDI is calculated for each intervention type. The GDI for roadside inspections is the ratio of all improved subset roadside inspection crashes avoided divided by the total number of interventions in the subset, while the traffic enforcement GDI is the division of all improved subset traffic enforcement crashes avoided by the total number of interventions in the subset.

Having determined these percentages, set R calculations may proceed. The percentage of interventions likely to be influenced by deterrence is multiplied by the total number of interventions in set R. The outcome is the estimated number of R interventions that would register an improvement in average crashes avoided. Next, the model estimates the number of indirect influenced set R interventions by the General Deterrence Impact per roadside inspection. The product of this calculation is the estimated roadside inspection crashes avoided for set R. Lastly, using the General Deterrence Impact per traffic enforcement, the same procedure develops R set estimated crashes avoided for traffic enforcement.

The following equations, derived from Set S, provide the basis for estimating crashes avoided from Set R.

Positive Influence of Deterrence.

$$D = \frac{\sum_{j=1}^{l} I_j}{\sum_{k=1}^{q} I_k} \qquad \textbf{(A-16)}$$

where

D = percentage of interventions positively influenced by deterrence, and

I = inspection for j (1, 2, …, l) interventions in subset S′ and for k (1, 2, …, q) interventions in set S.

General Deterrence Impact

Roadside

The roadside inspection general deterrence impact is the ratio of all set S roadside inspection crashes avoided to the number of interventions (of either type) that are part of subset S′.

$$GDI_{RS} = \frac{A_{S'\text{-}RS}}{\sum_{j=1}^{l} I_j} \qquad \textbf{(A-17)}$$

where

GDI_{RS} = general deterrence impact per roadside inspection, and

$A_{S'\text{-}RS}$ = set S roadside inspection crashes avoided for j (1, 2, …, l) interventions in subset S′.

Traffic

The traffic enforcement general deterrence impact is the ratio of all set S traffic enforcement crashes avoided to the number of interventions (of either type) that are part of subset S′.

$$GDI_{TE} = \frac{A_{S'\text{-}TE}}{\sum_{j=1}^{l} I_j} \qquad \textbf{(A-18)}$$

where

GDI_{TE} = general deterrence impact per traffic enforcement, and

$A_{S'\text{-}TE}$ = set S traffic enforcement crashes avoided for j (1, 2, …, l) interventions in subset S′.

Set R Indirect-Influenced Interventions

With the results from Equation **(A-16)**, it is possible to estimate the number of set R interventions that would be influenced by deterrence by multiplying the number of interventions in set R by the positive influence of deterrence.

$$R_I = \sum_{g=1}^{r} I_g \ X \ D \qquad \textbf{(A-19)}$$

where

R_I = the number of set R interventions positively influenced by deterrence, and

D = the positive influence of deterrence for g (1, 2, …, r) interventions in set R.

Set R Preliminary Crashes Avoided.

Roadside

The number of roadside inspection crashes avoided for set R is calculated by multiplying the general deterrence impact of a roadside inspection by the number of set R interventions positively influenced by deterrence.

$$A_{R\text{-}RS} = R_I \text{ X } GDI_{RS} \quad \textbf{(A-20)}$$

where

$A_{R\text{-}RS}$ = set R crashes avoided from roadside inspections,

R_I = the number of set R interventions positively influenced by deterrence, and

GDI_{RS} = general deterrence impact per roadside inspection.

Traffic

The number of traffic enforcement crashes avoided for set R is calculated by multiplying the general deterrence impact of a traffic enforcement by the number of set R interventions positively influenced by deterrence.

$$A_{R\text{-}TE} = R_I \text{ X } GDI_{TE} \quad \textbf{(A-21)}$$

where

$A_{R\text{-}TE}$ = set R crashes avoided from traffic enforcements,

R_I = the number of set R interventions positively influenced by deterrence, and

GDI_{TE} = general deterrence impact per traffic enforcement.

A.4.2.2. Roadside Allowance

Here too, the model allocates a portion of the crashes avoided derived from traffic enforcement actions back to the roadside program. Before doing so, overall indirect effect preliminary crashes avoided are obtained by adding the set S and R figures.

Roadside

$$A_{RS\text{-}indirect} = A_{S'\text{-}RS} + A_{R\text{-}RS} \quad \textbf{(A-22)}$$

where

$A_{RS\text{-}indirect}$ = the pre-allocation crashes avoided total for roadside inspections,

$A_{S'\text{-}RS}$ = set S roadside inspection crashes avoided, and

$A_{R\text{-}RS}$ = set R roadside inspection crashes avoided.

Traffic

$$A_{TE\text{-indirect}} = A_{S'\text{-TE}} + A_{R\text{-TE}} \quad \textbf{(A-23)}$$

where

$A_{TE\text{-indirect}}$ = the pre-allocation crashes avoided total for traffic enforcements,

$A_{S'\text{-TE}}$ = set S traffic enforcement crashes avoided, and

$A_{R\text{-TE}}$ = set R traffic enforcement crashes avoided.

Equations **(A-1)**, **(A-2)**, and **(A-3)** are used to calculated crashes avoided totals for each intervention of the improved subset, using only the traffic-related violations. Dividing this by the results from Equation **(A-15)** provides the percentage of traffic enforcement-initiated crashes avoided that will need to be allocated to the roadside inspection program.

$$Aadjustin_{direct} = \frac{V'_{TE}}{V'_{TE+RS}} \quad \textbf{(A-24)}$$

where

V'_{TE} = traffic enforcement-initiated crashes avoided from only traffic-related violations in subset S′,

V'_{TE+RS} = traffic enforcement-initiated crashes avoided from all violations in subset S′, and

$Aadjust_{indirect}$ = the percentage of indirect effect traffic enforcement crashes avoided that will need to be allocated to the roadside inspection program.

The final allocation of indirect effects is then:

Indirect-effect crashes avoided from roadside inspections

$$RS_{A\text{-indirect}} = A_{RS\text{-indirect}} + [(1 - Aadjust_{indirect}) \text{ X } A_{TE\text{-indirect}}] \quad \textbf{(A-25)}$$

and

Indirect effects crashes avoided from traffic enforcements

$$TE_{A\text{-indirect}} = Aadjust_{indirect} \text{ X } A_{TE\text{-indirect}} \quad \textbf{(A-26)}$$

where

$A_{RS\text{-indirect}}$ = the pre-allocation crashes avoided total for roadside inspections,

$A_{TE\text{-indirect}}$ = the pre-allocation crashes avoided total for traffic enforcements,

$RS_{A\text{-indirect}}$ = the post-allocation indirect effect crashes avoided total for roadside inspections, and

$TE_{A\text{-indirect}}$ = the post-allocation indirect effect crashes avoided total for traffic enforcements.

A.4.2.3. Examples

Because indirect effects require more than a single year of data, the previous example interventions will not suffice. Therefore, a new set of example data appears in Table A-5.

Table A-5. Indirect Effects Example Data

	Roadside Inspection										Traffic Enforcement									
	RC1		RC2		RC3		RC4		RC5		RC1		RC2		RC3		RC4		RC5	
Y/C	oos	n-oos	oos	n-oos	oos	n-oos	oos	n-oos	oos	n-oos	oos	n-oos	oos	n-oos	oos	n-oos	oos	n-oos	oos	n-oos
Y1																				
A			2	3		3		2		1										
A			1	7		7				4			1	1						
A										1				1						
A				6		2		4		3		1		2						
A				4	3	5		3		2										
B																1				
B				1																
B						2				2										
B								1		4					1					
B	1	1	2	1		1				1			1	1						
Y2																				
A				1				1						1						
A		1		2		2		1						1						
A				2		3		1						1						
A						5				2		1		1						

Y/C – Year/Carrier RC – Risk Category oos – out-of-service n-oos – non-out-of-service

The first column identifies intervention data by carrier (Carrier A and Carrier B) over a two-year period. Note that Carrier A has interventions in both years, while Carrier B has interventions in Y1 only. This does not necessarily indicate that Carrier B had no interventions in Y2. Instead, it reflects the fact that interventions are not always able to be associated with a particular carrier and the model requires a carrier match in Y1 and Y2. Based on the criteria outlined in Section A.4.2.1, Carrier A would fall into the Selected Set and Carrier B would make up the Remaining Set.

Equations **(A-1**) through **(A-3)** provide avoided crashes totals for each of the inspections in Table A-5. These figures form the input to the equations from the indirect-effect approach. Here, only the results created from the Higher Bound probabilities will be displayed. Lower Bound calculations follow the same steps.

Summing the crashes avoided for each carrier in each year (Equation **(A-9)**) yields:

Carrier A Crashes Avoided in Y1

	0.05033
	0.28487
	0.00500
	0.61023
+	0.05453
	1.00496

Carrier A Crashes Avoided in Y2

	0.00939
	0.07092
	0.02761
+	0.25032
	0.35824

The number of interventions per carrier per year, Equation **(A-10)**

Carrier A Number of Interventions in Y1 = 5

Carrier A Number of Interventions in Y2 = 4

Equation **(A-11)** supplies carrier average crashes avoided per carrier per year

$$\frac{\text{Carrier A Crashes Avoided in Y1}}{\text{Carrier A Number of Interventions in Y1}} = \frac{1.00496}{5} = 0.20099$$

$$\frac{\text{Carrier A Crashes Avoided in Y2}}{\text{Carrier A Number of Interventions in Y2}} = \frac{0.35824}{4} = 0.08956$$

Carrier A's average crashes avoided in Y2 is less than the average in Y1. Thus, it meets the criterion to be included in the Improved Subset of the Selected Set.

Indirect-effect roadside crashes avoided for Carrier A follow from Equation **(A-12)**.

(Carrier A Avg. Crashes Avoided in Y1 – Carrier A Avg. Crashes Avoided in Y2)

X (Carrier A Number of Roadside Inspections in Y1)

= (0.20099 – 0.08956) X 2

= 0.2229

Equation **(A-13)** supplies Carrier A's traffic crashes avoided.

(Carrier A Avg. Crashes Avoided in Y1 – Carrier A Avg. Crashes Avoided in Y2)
X (Carrier A Number of Traffic Enforcements in Y1)

= (0.20099 – 0.08956) X 3

= 0.3343

The output of Equations **(A-14)** and **(A-15)** is, in this example case, identical to **(A-12)** and **(A-13)**, respectively, because Carrier A is the sole carrier within the Selected set. Were other carriers present, the outputs of **(A-12)** would be added to arrive at Selected set roadside inspection crashes avoided. Traffic enforcement crashes avoided would be the summation of the outputs from **(A-13)**.

Positive Influence of Deterrence, Equation **(A-16)**

$$\frac{\text{Number of Interventions in the Improved Subset}}{\text{Number of Interventions in the Selected Set}} = \frac{4}{5} = 0.8$$

General Deterrence Impact for Roadside Inspections, Equation **(A-17)**

$$\frac{\text{Selected Set Roadside Crashes Avoided}}{\text{Number of Interventions in the Improved Subset}} = \frac{0.2229}{5} = 0.04457$$

General Deterrence Impact for Traffic Enforcements, Equation **(A-18)**

$$\frac{\text{Selected Set Traffic Crashes Avoided}}{\text{Number of Interventions in the Improved Subset}} = \frac{0.3343}{5} = 0.06686$$

The calculations for the Remaining Set are next.

Remaining Set Indirect-Influenced Interventions, Equation **(A-19)**

= Number of Interventions in the Remaining Set X Positive Influence of Deterrence

= 5 X 0.8

= 4

Remaining Set Preliminary Roadside Crashes Avoided, Equation **(A-20)**

= Remaining Set Indirect-Influenced Interventions X General Deterrence Impact for Roadside Inspections

= 4 X 0.04457

= 0.1783

Remaining Set Preliminary Traffic Crashes Avoided, Equation **(A-21)**

= Remaining Set Indirect-Influenced Interventions X General Deterrence Impact for Traffic Enforcements

= 4 X 0.06686

= 0.2674

Adding the Selected Set Crashes Avoided to the Remaining Set Crashes Avoided provides the pre-roadside allowance indirect-effects totals for each program.

Roadside Inspection Preliminary Indirect Effect Crashes Avoided, Equation **(A-22)**

0.2229 + 0.1783 = 0.40115

Traffic Enforcement Preliminary Indirect Effect Crashes Avoided, Equation **(A-23)**

0.3343 + 0.2674 = 0.60173

Roadside Allowance, Equation **(A-24)**

$$\frac{\text{Traffic Enforcement Crashes Avoided from only Traffic-Related Violations}}{\text{Traffic Enforcement Crashes Avoided from All Violations}}$$

$$= \frac{0.13163}{0.60173}$$

= 0.22

Indirect Effects Crashes Avoided from Roadside Inspections, **(A-25)**.

Roadside Inspection Preliminary Indirect Effect Crashes Avoided +
[(1 − Roadside Allowance)
X Traffic Enforcement Preliminary Indirect Effect Crashes Avoided]

= 0.40115 + [(1- 0.22) X 0.60173]

= 0.8705

Indirect Effects Crashes Avoided from Traffic Enforcements, **(A-26)**.

Roadside Allowance X
Traffic Enforcement Preliminary Indirect Effect Crashes Avoided

= 0.22 X 0.60173

= 0.1324

A.5. PROGRAM BENEFITS

Crash severity varies. Some crashes may result in no more than minor property damage, while others may result in bodily harm or loss of life. Of the many gradations possible, two classifications of crashes suffice for calculating program benefits, fatal crashes and injury crashes. Any motor carrier crash that results in at least one fatality is a fatal crash. A fatal crash may also involve injuries, but the fatality governs the crash's classification. Any motor carrier crash that results in at least one injury requiring transport for immediate medical attention but no fatalities, is an injury crash.

Statistics of fatal and injury crashes supply the basis for creating lives saved and injuries avoided figures. This follows NHTSA established practice, which expresses program benefits in terms of lives saved and injuries avoided. Fatal crashes avoided translate to lives saved and injury crashes avoided translate to injuries avoided.

Obtaining program benefits from estimated crashes-avoided figures requires two prior determinations, the first being a proportional identification of crashes by severity and the second being the average numbers of fatalities and injuries per crash. Fortunately, each has been completed elsewhere. According to a report[9] done for the Federal Highway Administration's (FHWA) Office of Motor Carriers (OMC),[10] of the trucks involved in crashes on U.S. roads in

[9] Center for National Truck Statistics, University of Michigan Transportation Research Institute, *Truck and Bus Crash Factbook 1995*, 1997.

[10] The Federal Highway Administration's (FHWA) Office of Motor Carriers (OMC) later became the Federal Motor Carrier Safety Administration (FMCSA).

1995, 3.6 percent were involved in fatal crashes, 40.0 percent were involved in injury crashes, and 56.4 percent were involved in towaway crashes.[11]

The average number of fatalities per fatal crash was calculated from data from the Fatality Analysis Reporting System (FARS), which is maintained by the NHTSA. For 1999 crashes involving large trucks or intercity buses, the ratio was 1.19 fatalities per fatal crash.

The number of injuries per crash involves fatal as well as injury crashes, since fatal crashes can also result in injuries. State-reported crash data in the MCMIS were used to compute the average numbers of injuries in fatal and injury crashes. For 1999 large truck and bus crashes, the averages were as follows:

- Fatal crashes: 1.26 injuries per crash
- Injury crashes: 1.60 injuries per crash

Figure A-3 shows the process used to calculate program benefits.

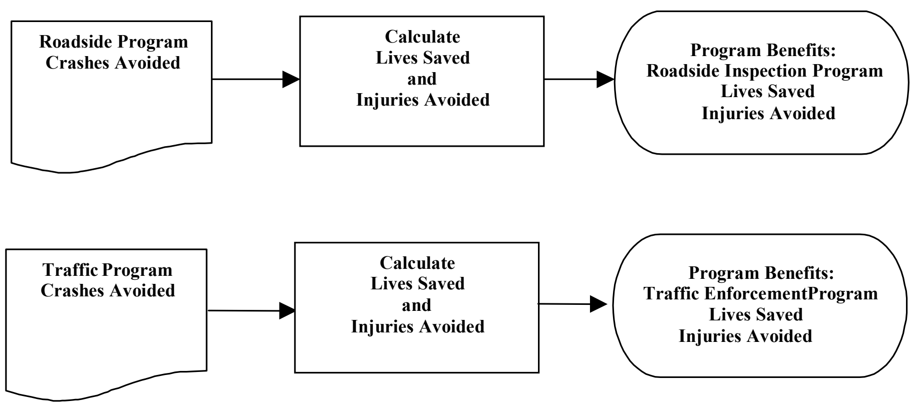

Figure A-3. Program Benefits Determination

Program Crashes Avoided (Direct and Indirect).
The input to the program benefits portion of the model requires the union of crashes avoided attributable to direct effects and indirect effects. The program benefits calculations use the output of Equations **(A-27)** and **(A-28)**. The calculations entail the development of estimated totals of crashes by severity as well as the final tally of lives saved and injuries avoided.

[11] A *towaway* crash results in no fatalities or injuries requiring transport for immediate medical attention, but in one or more motor vehicles incurring disabling damage as a result of the crash, requiring the vehicle(s) to be transported away from the scene by a tow truck or other motor vehicle.

Roadside

$RS_A = RS_{A\text{-direct}} + RS_{A\text{-indirect}}$ **(A-27)**

where

RS_A = roadside inspection crashes avoided from both direct and indirect effects,

$RS_{A\text{-direct}}$ = the post-allocation direct-effect crashes avoided total for roadside inspections, and

$RS_{A\text{-indirect}}$ = the post-allocation indirect-effect crashes avoided total for roadside inspections.

Traffic

$TE_A = TE_{A\text{-direct}} + TE_{A\text{-indirect}}$ **(A-28)**

where

TE_A = traffic enforcement crashes avoided from both direct and indirect effects,

$TE_{A\text{-direct}}$ = the post-allocation direct-effect crashes avoided total for traffic enforcements, and

$TE_{A\text{-indirect}}$ = the post-allocation indirect-effect crashes avoided total for traffic enforcements.

A.5.1. FATAL AND INJURY CRASHES AVOIDED

The model breaks out program crashes-avoided figures into the numbers of program crashes avoided by severity. The proportions from the Center for National Truck Statistics report (9) mentioned previously are used by the model to calculate estimates of the numbers of fatal crashes and injury crashes avoided due to the roadside inspection and traffic enforcement programs.

Roadside

Multiplying the roadside crashes avoided from Equation **(A-27)** and the proportion of all highway crashes that resulted in fatalities provides the roadside fatal crashes avoided. Roadside injury crashes avoided are calculated similarly, only substituting the injury proportion of all highway crashes in place of the fatality proportion.

$$RS_{A\text{-}Fatal} = RS_A \ X \ CSP_{Fatal} \qquad \textbf{(A-29)}$$

$$RS_{A\text{-}Injury} = RS_A \ X \ CSP_{Injury} \qquad \textbf{(A-30)}$$

where

$RS_{A\text{-}Fatal}$ = number of fatal crashes avoided due to the roadside inspection program,

$RS_{A\text{-}Injury}$ = number of injury crashes avoided due to the roadside inspection program,

RS_A = number of roadside inspection crashes avoided,

CSP_{Fatal} = proportion of all crash types that are fatal crashes, and

CSP_{Injury} = proportion of all crash types that are injury crashes.

Traffic

Fatal crashes for the traffic enforcement flow from Equation **(A-28)**.

$$TE_{A\text{-}Fatal} = TE_A \ X \ CSP_{Fatal} \qquad \textbf{(A-31)}$$

$$TE_{A\text{-}Injury} = TE_A \ X \ CSP_{Injury} \qquad \textbf{(A-32)}$$

where

$TE_{A\text{-}Fatal}$ = number of fatal crashes avoided due to the traffic enforcement program,

$TE_{A\text{-}Injury}$ = number of injury crashes avoided due to the traffic enforcement program,

TE_A = number of traffic enforcement crashes avoided,

CSP_{Fatal} = proportion of all crash types that are fatal crashes, and

CSP_{Injury} = proportion of all crash types that are injury crashes.

A.5.2. LIVES SAVED

To calculate the number of lives saved, the number of fatal crashes avoided is multiplied by the average number of fatalities per fatal crash.

Roadside

$$LS_{RS} = RS_{A\text{-}Fatal} \ X \ FC_{Fatal} \quad \textbf{(A-33)}$$

where

LS_{RS} = lives saved due to the roadside inspection program,

$RS_{A\text{-}Fatal}$ = number of fatal crashes avoided due to the roadside inspection program, and

FC_{Fatal} = average fatalities per fatal crash.

Traffic

$$LS_{TE} = TE_{A\text{-}Fatal} \ X \ FC_{Fatal} \quad \textbf{(A-34)}$$

where,

LS_{TE} = lives saved due to the traffic enforcement program, and

$TE_{A\text{-}Fatal}$ = number of fatal crashes avoided due to the traffic enforcement program, and

FC_{Fatal} = average fatalities per fatal crash.

A.5.3. INJURIES AVOIDED

To calculate the number of injuries avoided, the number of fatal crashes avoided is multiplied by the average number of injuries per fatal crash, and the number of injury crashes avoided is multiplied by the average number of injuries per injury crash. The two products are then added to obtain the total number of injuries avoided.

Roadside

$$IA_{RS} = (RS_{A\text{-}Fatal} \ X \ FC_{Injury}) + (RS_{A\text{-}Injury} \ X \ IC_{Injury}) \quad \textbf{(A-35)}$$

where

IA_{RS} = number of injuries avoided due to roadside inspections,

$RS_{A\text{-}Fatal}$ = number of fatal crashes avoided due to the roadside inspection program,

$RS_{A\text{-}Injury}$ = number of injury crashes avoided due to the roadside inspection program,

FC_{Injury} = average injuries per fatal crash, and

IC_{Injury} = average injuries per fatal crash.

Traffic

$$IA_{TE} = (TE_{A\text{-}Fatal} \text{ X } FC_{Injury}) + (TE_{A\text{-}Injury} \text{ X } IC_{Injury}) \quad \textbf{(A-36)}$$

where

$TE_{A\text{-}Fatal}$ = number of fatal crashes avoided due to the traffic enforcement program,

$TE_{A\text{-}Injury}$ = number of injury crashes avoided due to the traffic enforcement program,

FC_{Injury} = average injuries per fatal crash, and

IC_{Injury} = average injuries per fatal crash.

A.5.4. EXAMPLES

Program Crashes Avoided

Roadside Program Crashes Avoided (Direct and Indirect), **(A-27)**

= Roadside Program Direct-Effect Crashes Avoided +
Roadside Program Indirect-Effect Crashes Avoided

= 0.9355 + 0.8705

= 1.806

Traffic Program Crashes Avoided (Direct and Indirect), **(A-28)**

= Traffic Program Direct-Effect Crashes Avoided +
Traffic Program Indirect-Effect Crashes Avoided

= 0.0702 + 0.1324

= 0.203

Fatal Crashes Avoided

Roadside Fatal Crashes Avoided, **(A-29)**

= Roadside Program Crashes Avoided (Direct and Indirect) X
Fatal proportion of truck crashes

= 1.806 X 0.036

= 0.065

Traffic Fatal Crashes Avoided, **(A-31)**

= Traffic Program Crashes Avoided (Direct and Indirect) X
Fatal proportion of truck crashes

= 0.203 X 0.036

= .0073

Injury Crashes Avoided

Roadside Injury Crashes Avoided, **(A-30)**

= Roadside Program Crashes Avoided (Direct and Indirect) X
Injury proportion of truck crashes

= 1.806 X 0.400

= 0.7224

Traffic Injury Crashes Avoided, **(A-32)**

= Traffic Program Crashes Avoided (Direct and Indirect) X
Injury proportion of truck crashes

= 0.203 X 0.400

= 0.0812

Lives Saved

Roadside Lives Saved, **(A-33)**

= Roadside Fatal Crashes Avoided X Average fatalities per fatal crash

= 0.065 X 1.19

= 0.0774

Traffic Lives Saved, **(A-34)**

= Traffic Fatal Crashes Avoided X Average fatalities per fatal crash

= 0.0073 X 1.19

= 0.0087

Injuries Avoided

Roadside Injuries Avoided, **(A-35)**

= (Roadside Fatal Crashes Avoided X Average fatalities per injury crash) + (Roadside Injury Crashes Avoided X Average. injuries per injury crash)

= (0.065 X 1.26) + (0.7224 X 1.60)

= 1.2377

Traffic Injuries Avoided, **(A-36)**

= (Traffic Fatal Crashes Avoided X Average. fatalities per injury crash) + (Traffic Injury Crashes Avoided X Average injuries per injury crash)

= (0.0073 X 1.26) + (0.0812 X 1.60)

= 0.1391

APPENDIX B – VIOLATIONS

Table B-1. Roadside Inspection Violations

Roadside Inspection Violations

Roadside - Driver Violations

Risk Category 1 Violation is the *potential single, immediate* factor leading to a crash or injuries/fatalities from a given crash.

Crash Reduction Probabilities

Higher Bound	OOS =	0.0125	Non OOS =	0.00625
Lower Bound	OOS =	0.00833	Non OOS =	0.004167

Source	Violation Code	Violation Description
C	392.5C2	Violating oos order pursuant to 392.5(a)/(b)
C	392.3	Operating a cmv while ill/fatigued
V	396.9C	Operating oos vehicle
C	396.9C2	Operating an out-of-service vehicle
C	398.4	Driving of veh-migrant workers

Roadside - Driver Violations

Risk Category 2 Violation is the *potential single, eventual* factor leading to a crash or injuries/fatalities from a given crash.

Crash Reduction Probabilities

Higher Bound	OOS =	0.00125	Non OOS =	0.000625
Lower Bound	OOS =	0.000833	Non OOS =	0.0004167

Source	Violation Code	Violation Description
C	395.8E	Fasle report of drivers of duty status
V	395.8	Log violations (general/form and manner)
C	395.8A	No drivers record of duty status
C	395.8K2	Driver failing to retain previous 7 days logs
V	395.8K3	Failed to retain 7 prev days
C	395.3A1	10 hour rule violation
C	395.3A2	15 hour rule violation
V	395.3E	15/20 hour rule viol (Alaska)
V	395.3E1	15 hour rule (Alaska)
V	395.3E2	20 hour rule (Alaska)
C	395.3B	60/70 hour rule violation
V	395.3E3	70 hour rule (Alaska)
C	395.1|1	15, 20, 70/80 hours of service violations (AK)
C	395.1|2	Adverse driving conditions violations (AK)
C	398.6	Violation of hours of service reg-migrant
C	383.51A	Driving a cmv (cdl) while disqualified
V	391.15	Driver disqualified
C	391.15A	Driving a cmv while disqualified

Table B-1. Roadside Inspection Violations (continued)

Roadside - Driver Violations
Risk Category 2 Violation is the *potential single, eventual* factor leading to a crash or injuries/fatalities from a given crash.

Crash Reduction Probabilities

Higher Bound	OOS =	0.00125	Non OOS =	0.000625
Lower Bound	OOS =	0.000833	Non OOS =	0.0004167

Source	Violation Code	Violation Description
C	392.14	Failed to use caution for hazardous condition
C	392.71A	Using or equiping a cmv with radar detector
V	383.23A	Operating a cmv without a valid cdl
C	383.23A2	Operating a cmv without a cdl
V	383.23A2C1	Operating on learner's permit w/o cdl holder
V	383.23C	Operating on learner's permit w/o cdl holder
C	383.23C1	Operating on learner's permit w/o cdl holder
V	391.11B4	Operating comm veh w/o corrective lenses
V	391.11B5	Not licensed for type vehicle being operated
C	391.11B6	Operating cmv w/o corrective lenses
C	391.11B7	No or invalide driver's license cmv
C	392.8	Failing to inspect/use emergency equipment
V	392.9	Driver load secure
V	392.9A	Failing to secure load
C	392.9A1	Failing to secure cargo/393.100-393.106
C	392.9A2	Failing to secure vehicle equipment
C	395.13D	Driving after being declared out-of-service
V	396.7	Unsafe operations forbidden
C	398.3B	Driver qualif-migrant workers

Roadside - Driver Violations
Risk Category 3 Violation is the *potential contributing* factor leading to a crash or injuries/fatalities from a given crash.

Crash Reduction Probabilities

Higher Bound	OOS =	0.000125	Non OOS =	0.0000625
Lower Bound	OOS =	0.0000833	Non OOS =	0.00004167

Source	Violation Code	Violation Description
V	391.41	No medical certificate
C	391.41A	No medical certificate on driver's possession
V	391.45	Expired medical exam
C	391.45B	Expired medical examiner's certificate
V	391.45B1	Expired medical examiner's certificate

Table B-1. Roadside Inspection Violations (continued)

Roadside - Driver Violations
Risk Category 3 Violation is the *potential contributing* factor leading to a crash or injuries/fatalities from a given crash.

Crash Reduction Probabilities

	OOS =		Non OOS =	
Higher Bound	OOS =	0.000125	Non OOS =	0.0000625
Lower Bound	OOS =	0.0000833	Non OOS =	0.00004167

Source	Violation Code	Violation Description
V	391.49	No medical waiver
V	391.49A	No valid medical waiver in possession
C	391.49J	No valid medical waiver in driver's possession
C	392.16	Failing to use seat belt while operating cmv
C	392.10A1	Failing to stop at railroad crossing-bus
C	392.10A2	Failing to stop at railroad crossing-chlorine
C	392.10A3	Failing to stop at railroad crossing-placard
C	392.10A4	Failing to stop at railroad crossing-hm cargo
V	392.12	Failing to stop at drawbridge-bus
V	392.15	Failing or improper use of turn signal
C	383.21A	Operating a cmv with more than 1 drv license
C	383.23C2	Oper on learner's permit w/o valid drv lic
C	383.91A	Operating a cmv with improper cdl group
C	383.93B1	No double/triple trailer endorsement on cdl
C	383.93B2	No passenger vehicle endorsement on cdl
C	383.93B3	No tank vehicle endorsement on cdl
C	383.93B4	No hazardous materials endorsement on cdl
C	383.95A	Violating airbrake restriction
C	391.11B1	Interstate driver under 21 years of age
C	391.11B2	Non-english speaking driver
C	392.15A	Failing or improper use of turn signal
C	392.15B	Failed to signal direction from parked position
C	392.15C	Failing to signal a lane change
V	392.52	Improper bus fueling
V	392.61	Unauthorized driver
V	392.62	Bus driver distracted
V	392.63	Pushing/towing a loaded bus
C	392.7	No pretrip inspection
V	397.1B	Driver/carrier must obey part 397
V	397.67	Hm vehicle routing violation (non ram)

Table B-1. Roadside Inspection Violations (continued)

Roadside - Driver Violations
Risk Category 3 Violation is the *potential contributing* factor leading to a crash or injuries/fatalities from a given crash.

Crash Reduction Probabilities

Higher Bound	OOS =	0.000125	Non OOS =	0.0000625
Lower Bound	OOS =	0.0000833	Non OOS =	0.00004167

Source	Violation Code	Violation Description
C	398.3B8	No doctor's certificate in possession

Roadside - Driver Violations
Risk Category 4 Violation is the *unlikely potential contributing* factor leading to a crash or injuries/fatalities from a given crash.

Crash Reduction Probabilities

Higher Bound	OOS =	0.0000125	Non OOS =	0.00000625
Lower Bound	OOS =	0.00000833	Non OOS =	0.000004167

Source	Violation Code	Violation Description
V	107.620B	No copy of US DOT hm registration number
V	139.01	Operating w/o proper motor carrier authority
V	139.06	Oper w/o proper insurance or other securities
V	387.403A	Freight forwarder-no evidence of insurance
C	392.9B	Hearing aid not worn while operating a cmv
V	392.9C1	Bus-standee forward of line
V	392.9C3	Bus-improper storage of baggage or freight

Roadside - Driver Violations
Risk Category 5 Violation has *little or no connection* to crashes or prevention of injuries/fatalities.

Crash Reduction Probabilities

Higher Bound	OOS =	0.00000125	Non OOS =	0.000000625
Lower Bound	OOS =	0.000000833	Non OOS =	0.0000004167

Source	Violation Code	Violation Description
C	391.43E	Improper medical exam form
V	391.43F	Improper medical certificate
C	391.43G	Improper medical examiner's certificate
C	395.8F1	Driver's record duty status no current
V	139.02C4B	Operating beyond geographical restrictions
V	387.301A	No evidence of public liab and prop dmg insur
V	387.301B	No evidence of cargo insurance
V	387.303B4	No copy of certificate of registration
V	387.307	Prop brkr-no evdn of bond or trust fund agrm
C	387.31F	No proof of financial resp-foreign passenger

Table B-1. Roadside Inspection Violations (continued)

Roadside - Driver Violations

Risk Category 5 Violation has *little or no connection* to crashes or prevention of injuries/fatalities.

Crash Reduction Probabilities

Higher Bound	OOS =	0.00000125	Non OOS =	0.000000625
Lower Bound	OOS =	0.000000833	Non OOS =	0.0000004167

Source	Violation Code	Violation Description
V	387.403B	Frt fwrd-no evdnce of pub liab & prop dmg ins
C	387.7F	No proof of financial responsibility-foreign
V	390.21	No DOT# marking and/or name/city/state
C	392.15D	Using trun signal to indicate disabled vehicle
C	392.15E	Using turn signal as a "do pass"
V	392.60	Unauthorized passenger on board cmv
C	392.60A	Unauthorized passenger on board cmv
C	396.11	Driver vehicle inspection report
V	396.11A	Driver vehicle inspection rpt
V	396.13A	Driver inspection
C	396.13C	No reviewing driver's signature on dvir

Roadside Inspection Violations

Roadside - Vehicle Violations

Risk Category 1 Violation is the *potential single, immediate* factor leading to a crash or injuries/fatalities from a given crash.

Crash Reduction Probabilities

Higher Bound	OOS =	0.0125	Non OOS =	0.00625
Lower Bound	OOS =	0.00833	Non OOS =	0.004167

Source	Violation Code	Violation Description
C	393.42	No brakes as required
V	393.42A	No brakes on all wheels as required
V	393.42B	No/defective front wheel brakes as required
C	393.48A	Inoperative/defective brakes
C	393.70B2	Defective fifth wheel locking mechanism
C	393.70C	Defective coupling devices for full trailer
C	393.71	Improper coupling driveaway/towaway operation
C	393.9H	Inoperable head lamps
C	393.209D	Steering system components worn/welded/missing
C	393.207B	Adj axle locking pin missing/disengaged
C	393.75A	Flat tire or fabric exposed

Table B-1. Roadside Inspection Violations (continued)

Roadside - Vehicle Violations

Risk Category 1 Violation is the *potential single, immediate* factor leading to a crash or injuries/fatalities from a given crash.

Crash Reduction Probabilities

Higher Bound	OOS =	0.0125	Non OOS =	0.00625
Lower Bound	OOS =	0.00833	Non OOS =	0.004167

Source	Violation Code	Violation Description
C	393.75A1	Tire-ply or belt material exposed
C	393.75A2	Tire-tread and/or sidewall separation
C	393.75A3	Tire-flat and/or audible air leak
C	393.75A4	Tire-cut exposing ply and/or belt material
C	398.5	Parts/access-migrant workers

Roadside - Vehicle Violations

Risk Category 2 Violation is the *potential single, eventual* factor leading to a crash or injuries/fatalities from a given crash.

Crash Reduction Probabilities

Higher Bound	OOS =	0.00125	Non OOS =	0.000625
Lower Bound	OOS =	0.000833	Non OOS =	0.0004167

Source	Violation Code	Violation Description
C	393.40	Inadequate brake system on a cmv
C	393.47	Inadequate brake lining for safe stopping
C	393.70B	Defective/improper fifth wheel assemblies
C	393.71H	Towbar requirement violations
C	393.65C	Improper securement of fuel tank
C	393.67	Fuel tank requirement violations
V	393.201	All frame violations
C	393.201A	Frame cracked/broken/bent/loose
C	393.201B	Bolts securing cab broken/loose/missing
C	393.203B	Cab/body improperly secured to frame
C	392.33	Operating cmv with lamps/reflectors obscured
C	393.11	No/defective lighting devices/ref/projected
C	393.17	No/defective lamp/reflector-towaway operation
C	393.17A	No/defective lamps-towing unit-towaway operation
C	393.17B	No/defective side marker
C	393.19	No/defective turn/hazard lamp as required
C	393.24B	Non-compliance with headlamp requirements
C	393.25B	Lamps are not visible as required
V	393.25E	Lamp not steady burning

Table B-1. Roadside Inspection Violations (continued)

Roadside - Vehicle Violations

Risk Category 2 Violation is the *potential single, eventual* factor leading to a crash or injuries/fatalities from a given crash.

Crash Reduction Probabilities

Higher Bound	OOS =	0.00125	Non OOS =	0.000625
Lower Bound	OOS =	0.000833	Non OOS =	0.0004167

Source	Violation Code	Violation Description
C	393.25F	Stop lamp violations
V	393.26	Requirements for reflectors
C	393.9	Inoperable lamp (other than head/tail)
C	393.9T	Inoperable tail lamp
V	393.209	All steering violations
C	393.209A	Steering wheel not secured/broken
C	393.209B	Excessive steering wheel lash
C	393.209C	Loose steering column
V	393.207	All suspension violations
C	393.207A	Axle positioning parts defective/missing
C	393.207C	Leaf spring assembly defective/missing
C	393.207D	Coil spring cracked and/or broken
C	393.207E	Torsion bar cracked and/or broken
V	393.75F4	Flat tire
V	393.205	Wheel violations (general)
C	393.205A	Wheel/rim cracked or broken
C	393.205B	Stud/bolt holes elongated on wheels
C	393.205C	Wheel fasteners loose and/or missing
V	392.9	Driver load secure
V	393.100	No or improper load securement
C	393.100A	No or improper load securement
C	393.100E	Improper securement of intermodal containers
C	393.102	Improper securement system (tiedown assemblies)
C	393.102A	Improper securement syst (tiedown assemblies)
C	393.60C	Use of vision reducing matter on windows
V	393.95G	Hm-restricted emergency warning device
C	392.9A3	Driver's view/movement is obstructed
V	393.104	Improper blocking and/or bracing
C	393.104A	Improper blocking and/or bracing-longitudinal
C	393.104B	Improper blocking and/or bracing-lateral

Table B-1. Roadside Inspection Violations (continued)

Roadside - Vehicle Violations

Risk Category 2 Violation is the *potential single, eventual* factor leading to a crash or injuries/fatalities from a given crash.

Crash Reduction Probabilities

Higher Bound	OOS =	0.00125	Non OOS =	0.000625
Lower Bound	OOS =	0.000833	Non OOS =	0.0004167

Source	Violation Code	Violation Description
C	393.61A	Inadequate or missing truck side windows
C	393.77	Defective and/or prohibited heaters
C	393.80	No or defective rear-vision mirror

Roadside - Vehicle Violations

Risk Category 3 Violation is the *potential contributing* factor leading to a crash or injuries/fatalities from a given crash.

Crash Reduction Probabilities

Higher Bound	OOS =	0.000125	Non OOS =	0.0000625
Lower Bound	OOS =	0.0000833	Non OOS =	0.00004167

Source	Violation Code	Violation Description
C	396.3A1BA	Brake-out of adjustment
C	393.41	No or defective parking brake system on cmv
C	393.43	No/improper breakaway or emergency braking
C	393.43A	No/improper tractor protection valve
C	393.43D	No or defective automatic trailer brake
C	393.44	No/defective bus front brake line protection
C	393.45	Brake tubing aid hose adequacy
C	393.45A4	Brake hose/tubing chaffing and/or kinking
C	393.45A5	Brake hose/tubing contacting exhaust system
C	393.46	Brake hose/tube connection
C	393.46B	Brake connections with leaks/constrictions
C	393.50	Inadequate reservoir for air/vacuum brakes
C	393.50A	Failing to have sufficient air/vacuum reserve
C	393.50B	Failing to equip veh-prevent res air/vac leak
C	393.50C	No means to ensure operable check valve
C	393.51	No or defective brake warning device
C	396.3A1BA	Brakes (general)
C	396.3A1BC	Brake-air compressor violation
C	396.3A1BD	Brake-defective brake drum
V	396.3A1BH	Brake-hose/tube damaged and/or leaking
C	396.3A1BL	Brake-reserve system pressure loss

Table B-1. Roadside Inspection Violations (continued)

Roadside - Vehicle Violations

Risk Category 3 Violation is the *potential contributing* factor leading to a crash or injuries/fatalities from a given crash.

Crash Reduction Probabilities

Higher Bound	OOS =	0.000125	Non OOS =	0.0000625
Lower Bound	OOS =	0.0000833	Non OOS =	0.00004167

Source	Violation Code	Violation Description
V	393.70	Fifth wheel
C	393.70A	Defective coupling device-improper tracking
C	393.70D	No/improper safety chains/cables for full trl
C	393.71H10	No/improper safety chains/cables for towbar
V	393.65	Fuel system requirements
C	393.65B	Improper location of fuel system
C	393.65F	Improper fuel line protection
C	393.67C7	Fuel tank fill pipe cap missing
C	393.67C8	Improper fuel tank safety vent
V	393.77B11	Defective and/or prohibited heaters
C	393.201C	Frame rail flange improperly bent/cut/notched
C	393.201E	Prohibited holes drilled in frame rail flange
C	393.203A	Cab door missing/broken
C	393.203C	Hood not securely fastened
C	393.203D	Cab seats not securely mounted
C	393.203E	Cab front bumper missing/unsecured/protrude
C	393.209E	Power steering violations
C	393.207F	Air suspension pressure loss
V	393.75	Tires/tubes (general)
C	393.75B	Tire-front tread depth less than 4/32 of inch
C	393.75C	Tire-other tread depth less than 2/32 of inch
C	393.75D	Tire-bus regrooved/recap on front wheel
C	393.75E	Tire-regrooved on front of truck/truck-trac
C	393.75F	Tire-load weight rating/under inflated
V	393.75F1	Weight carried exceeds tire load limit
V	393.75F2	Tire - under-inflated
C	396.3A1T	Tires (general)
V	393.60	Windshield condition
C	393.78	Windshield wipers inoperative/defective
C	393.79	Defroster inoperative

Table B-1. Roadside Inspection Violations (continued)

Roadside - Vehicle Violations

Risk Category 3 Violation is the *potential contributing* factor leading to a crash or injuries/fatalities from a given crash.

Crash Reduction Probabilities

Higher Bound	OOS = 0.000125	Non OOS =	0.0000625
Lower Bound	OOS = 0.0000833	Non OOS =	0.00004167

Source	Violation Code	Violation Description
C	393.83B	Exhaust discharge fuel tank/filler tube
C	393.83C	Improper exhaust-bus (gasoline)
C	393.83D	Improper exhaust-bus (diesel)
C	393.83E	Improper exhaust discharge (not rear of cab)
C	393.83F	Improper exhaust system repair (patch/wrap)
C	393.83G	Exhaust leak under truck cab and/or sleeper
C	393.83H	Exhaust system not securely fastened
C	393.95F	Emergency warning devices not as required
C	393.61B	Buses-window escape inoperative/obstructed
V	393.61B1	Bus windows
C	393.61B2	No or defective bus emergency exits
C	393.61C	Buses-push out window requirements violation
V	393.61C1	Bus pushout window requirements violations
C	393.62	Window obstructed which would hinder escape
C	393.83A	Exhaust system location
C	393.86	No or improper rearend protection
C	393.87	No flag on projecting load
C	393.88	Improperly located tv receiver
C	393.89	Bus driveshaft not properly protected
V	393.93	Vehicle equipped seat belts
C	393.93A	Bus-not equipped with seat belt
C	393.93B	Truck not equipped with seat belt
V	396.5	Excessive oil leaks
V	396.5B	Oil and/or grease leak

Table B-1. Roadside Inspection Violations (continued)

Roadside - Vehicle Violations
Risk Category 4 Violation is the *unlikely potential contributing* factor leading to a crash or injuries/fatalities from a given crash.

Crash Reduction Probabilities

Higher Bound	OOS =	0.0000125	Non OOS =	0.00000625
Lower Bound	OOS =	0.00000833	Non OOS =	0.000004167

Source	Violation Code	Violation Description
C	393.48B1	Defective brake limiting device
C	393.201D	Frame accessories not bolted/riveted securely
C	393.20	No/improper mounting of clearance lamps
C	393.28	Improper or no wiring protection as required
C	393.30	Improper battery installation
C	393.32	Improper electrical connections
C	393.33	Improper wiring installations
C	393.60B	Damaged or discolored windshield
C	393.95A	No/discharged/unsecured fire extinguisher
V	392.9C	Buses-emerg exits inoper/obst
V	393.106	No/improper front end structure/headerboard
C	393.106A	No/improper front end structure/headerboard
C	393.63	No or inadequate bus escape window markings
C	393.81	Horn inoperative
C	393.84	Inadequate floor condition
C	393.91	Bus-improper aisle seats
C	393.92	Bus-no/improper emergency door marking
C	395.15G	On-board recording device info not available
V	396.3A	Vehicle maintenance (general)
C	396.3A1	Inspection/repair and maintenance
C	398.7	Inspect/maint mv-migrant workers

Table B-1. Roadside Inspection Violations (continued)

Roadside - Vehicle Violations

Risk Category 5 Violation has *little or no connection* to crashes or prevention of injuries/fatalities.

Crash Reduction Probabilities

Higher Bound	OOS =	0.00000125	Non OOS =	0.000000625
Lower Bound	OOS =	0.000000833	Non OOS =	0.0000004167

Source	**Violation Code**	**Violation Description**
V	392.30	Use of lamps as required
V	392.32	Dim headlights
C	393.95C	Spare fuses not as required
C	396.17C	Operating a cmv without periodic inspection
V	396.21	Periodic inspection
C	390.21A	No DOT# marking and/or name/city/state
C	393.76	Sleeper berth requirement violations
C	393.82	Speedometer inoperative
C	393.90	Bus-no or obscure standee line
C	399.207	Vehicle access requirements violations
C	399.211	Inadequate maintenance of driver access

Table B-2. Traffic Enforcement Violations

Traffic Enforcement Driver Violations

Risk Category 1 Violation is the *potential single, immediate* factor leading to a crash or injuries/fatalities from a given crash.

Crash Reduction Probabilities

Higher Bound	OOS =	0.05	Non OOS =	0.025
Lower Bound	OOS =	0.033	Non OOS =	0.0167

Source	Violation Code	Violation Description
V	392.4	Driver uses or is in possession of drugs
C	392.4A	Driver uses or is in possession of drugs
V	392.5	Driver uses or is in possession of alcohol
C	392.5A	Poss/use/under inflnce alcohol-4hr prio duty
C	392.2R	Local law/reckless driving
C	392.2Y	Local laws/failure to yield right of way
C	392.22A	Failing to use hazard warning flashers

Risk Category 2 Violation is the *potential single, eventual* factor leading to a crash or injuries/fatalities from a given crash.

Crash Reduction Probabilities

Higher Bound	OOS =	0.005	Non OOS =	0.0025
Lower Bound	OOS =	0.0033	Non OOS =	0.00167

Source	Violation Code	Violation Description
C	392.2C	Local laws/failure to obey traff cntl device
V	392.2D*	Local law/other driver violations
C	392.2FC	Local law/following too close
C	392.2LC	Local law/improper lane change
C	392.2OT	Local law/other moving violation
C	392.2P	Local law/improper passing
C	392.2S	Local law/speeding
C	392.2T	Local laws/improper turns
V	392.2V	Local law/other vehicle defects
V	392.2	Local laws (general)
C	392.22B	Failing/improper placement of warning devices

Risk Category 3 Violation is the *potential contributing* factor leading to a crash or injuries/fatalities from a given crash.

Crash Reduction Probabilities

Higher Bound	OOS =	0.0005	Non OOS =	0.00025
Lower Bound	OOS =	0.00033	Non OOS =	0.000167

Source	Violation Code	Violation Description
V	392.21	Stopped vehicle interfering with traffic
C	392.2W	Local laws/size and weight

Table B-2. Traffic Enforcement Violations (continued)

Risk Category 4 Violation is the *unlikely potential contributing* factor leading to a crash or injuries/fatalities from a given crash.

Crash Reduction Probabilities

Higher Bound	OOS =	0.00005	Non OOS =	0.000025
Lower Bound	OOS =	0.000033	Non OOS =	0.0000167

Source	Violation Code	Violation Description
C	392.20	Failing to properly secure parked vehicle

Risk Category 5 Violation has *little or no connection* to crashes or prevention of injuries/fatalities.

Crash Reduction Probabilities

Higher Bound	OOS =	0.000005	Non OOS =	0.0000025
Lower Bound	OOS =	0.0000033	Non OOS =	0.0000016700

Source	Violation Code	Violation Description
No violations in this Risk Category		

* Originally classified as Risk Category 1.

APPENDIX C – PROGRAM BENEFITS

C.1. NATIONAL PROGRAM BENEFITS

Table C-1a. National Program Benefits, 1998

Intervention Model -- Estimated Program Benefits During 1998

MCSAP Program	Crashes Avoided								
	Lower Bound			Higher Bound			Mean		
	Direct Effects	Indirect Effects	Combined Effects	Direct Effects	Indirect Effects	Combined Effects	Direct Effects	Indirect Effects	Combined Effects
Roadside Inspection Program	5,602	1,298	6,900	8,388	1,936	10,324	6,995	1,617	8,612
Traffic Enforcement Program	1,868	376	2,244	2,793	562	3,355	2,331	469	2,800

MCSAP Program	Lower Bound			Higher Bound			Mean		
	Combined Effects	Lives Saved	Injuries Avoided	Combined Effects	Lives Saved	Injuries Avoided	Combined Effects	Lives Saved	Injuries Avoided
Roadside Inspection Program	6,900	296	4,729	10,324	442	7,075	8,612	369	5,902
Traffic Enforcement Program	2,244	96	1,538	3,356	144	2,300	2,800	120	1,919

MCSAP Program	Initating Interventions	% of Total Interventions	Number with DR/VH Violations	% of Total Interventions
Roadside Inspection Program	1,700,522	76.7%	1,128,791	50.9%
Traffic Enforcement Program	516,048	23.3%	516,048	23.3%
Total	2,216,570			

Table C-1b. National Program Benefits, 1999

Intervention Model -- Estimated Program Benefits During 1999

MCSAP Program	Crashes Avoided								
	Lower Bound			Higher Bound			Mean		
	Direct Effects	Indirect Effects	Combined Effects	Direct Effects	Indirect Effects	Combined Effects	Direct Effects	Indirect Effects	Combined Effects
Roadside Inspection Program	5,971	1,335	7,306	8,938	1,994	10,932	7,455	1,665	9,119
Traffic Enforcement Program	2,010	410	2,420	3,009	613	3,622	2,510	512	3,021

MCSAP Program	Lower Bound			Higher Bound			Mean		
	Combined Effects	Lives Saved	Injuries Avoided	Combined Effects	Lives Saved	Injuries Avoided	Combined Effects	Lives Saved	Injuries Avoided
Roadside Inspection Program	7,306	313	5,007	10,932	468	7,492	9,119	391	6,250
Traffic Enforcement Program	2,420	104	1,659	3,622	155	2,482	3,021	129	2,070

MCSAP Program	Initating Interventions	% of Total Interventions	Number with DR/VH Violations	% of Total Interventions
Roadside Inspection Program	1,783,748	75.5%	1,161,786	49.2%
Traffic Enforcement Program	579,219	24.5%	579,219	24.5%
Total	2,362,967			

Table C-1c. National Program Benefits, 2000

Intervention Model -- Estimated Program Benefits During 2000

MCSAP Program	Crashes Avoided								
	Lower Bound			Higher Bound			Mean		
	Direct Effects	Indirect Effects	Combined Effects	Direct Effects	Indirect Effects	Combined Effects	Direct Effects	Indirect Effects	Combined Effects
Roadside Inspection Program	6,188	1,318	7,506	9,257	1,961	11,218	7,723	1,640	9,362
Traffic Enforcement Program	2,232	418	2,650	3,337	624	3,961	2,785	521	3,306

MCSAP Program	Lower Bound			Higher Bound			Mean		
	Combined Effects	Lives Saved	Injuries Avoided	Combined Effects	Lives Saved	Injuries Avoided	Combined Effects	Lives Saved	Injuries Avoided
Roadside Inspection Program	7,505	322	5,144	11,218	481	7,688	9,362	401	6,416
Traffic Enforcement Program	2,650	114	1,816	3,961	170	2,714	3,305	142	2,265

MCSAP Program	Initating Interventions	% of Total Interventions	Number with DR/VH Violations	% of Total Interventions
Roadside Inspection Program	1,832,988	74.7%	1,181,039	48.1%
Traffic Enforcement Program	620,226	25.3%	620,226	25.3%
Total	2,453,214			

C.2. ROADSIDE INSPECTION BENEFITS, BY STATE

Table C-2a. Mean Roadside Inspection Program Benefits by State, 1998

Intervention Model -- Estimated Mean Roadside Inspection Program Benefits During 1998

Report	Total Initiating	Roadside Inspections				Estimated Totals				Estimates per 1,000 Roadside Inspections			
State	Interventions	Number	% of Total	Number with DR/VH	% of Total	Crashes Avoided	Lives Saves	Injuries Avoided	Rank	Crashes Avoided	Lives Saves	Injuries Avoided	Rank
AK	2,269	1,926	84.9%	1,291	56.9%	13.20	0.57	9.05	50	6.86	0.29	4.70	20
AL	20,742	9,023	43.5%	8,035	38.7%	107.34	4.60	73.57	31	11.90	0.51	8.15	4
AR	41,243	26,881	65.2%	17,296	41.9%	121.19	5.19	83.06	26	4.51	0.19	3.09	38
AZ	42,253	23,908	56.6%	18,259	43.2%	306.43	13.13	210.02	6	12.82	0.55	8.78	3
CA	434,488	379,206	87.3%	200,650	46.2%	534.53	22.90	366.35	3	1.41	0.06	0.97	51
CO	42,882	38,199	89.1%	24,960	58.2%	213.16	9.13	146.09	18	5.58	0.24	3.82	31
CT	16,283	11,473	70.5%	10,275	63.1%	118.04	5.06	80.90	27	10.29	0.44	7.05	6
DC	2,596	2,293	88.3%	1,157	44.6%	4.17	0.18	2.86	51	1.82	0.08	1.25	50
DE	3,925	3,241	82.6%	2,413	61.5%	13.97	0.60	9.57	48	4.31	0.18	2.95	40
FL	63,015	45,012	71.4%	32,113	51.0%	239.43	10.26	164.10	12	5.32	0.23	3.65	33
GA	23,120	16,772	72.5%	13,948	60.3%	142.91	6.12	97.94	23	8.52	0.37	5.84	12
HI	8,054	6,657	82.7%	3,671	45.6%	26.22	1.12	17.97	45	3.94	0.17	2.70	44
IA	62,477	56,136	89.9%	43,268	69.3%	175.10	7.50	120.01	20	3.12	0.13	2.14	45
ID	5,672	3,833	67.6%	3,187	56.2%	39.61	1.70	27.14	42	10.33	0.44	7.08	5
IL	75,952	40,661	53.5%	19,370	25.5%	239.03	10.24	163.82	13	5.88	0.25	4.03	28
IN	52,777	25,862	49.0%	21,107	40.0%	248.13	10.63	170.06	11	9.59	0.41	6.58	9
KS	29,672	18,133	61.1%	13,401	45.2%	115.48	4.95	79.15	29	6.37	0.27	4.36	22
KY	70,566	62,590	88.7%	32,938	46.7%	249.80	10.70	171.20	10	3.99	0.17	2.74	43
LA	40,532	29,665	73.2%	27,397	67.6%	124.66	5.34	85.43	24	4.20	0.18	2.88	41
MA	26,064	14,191	54.4%	8,730	33.5%	110.85	4.75	75.97	30	7.81	0.33	5.35	18
MD	105,149	95,707	91.0%	49,247	46.8%	251.70	10.78	172.50	9	2.63	0.11	1.80	48
ME	5,655	5,426	96.0%	4,444	78.6%	33.70	1.44	23.10	44	6.21	0.27	4.26	24
MI	31,277	9,403	30.1%	7,199	23.0%	222.33	9.52	152.37	16	23.64	1.01	16.20	1
MN	34,384	18,900	55.0%	14,417	41.9%	297.74	12.76	204.06	7	15.75	0.67	10.80	2
MO	78,211	70,383	90.0%	56,996	72.9%	577.57	24.74	395.84	2	8.21	0.35	5.62	15
MS	28,478	27,889	97.9%	15,500	54.4%	83.13	3.56	56.97	35	2.98	0.13	2.04	47
MT	39,744	34,631	87.1%	16,825	42.3%	77.72	3.33	53.26	36	2.24	0.10	1.54	49
NC	27,102	17,387	64.2%	12,842	47.4%	101.39	4.34	69.49	32	5.83	0.25	4.00	29
ND	17,545	11,876	67.7%	4,758	27.1%	35.96	1.54	24.64	43	3.03	0.13	2.07	46
NE	18,096	13,222	73.1%	8,111	44.8%	52.87	2.26	36.23	40	4.00	0.17	2.74	42
NH	4,006	2,434	60.8%	2,020	50.4%	20.14	0.86	13.80	47	8.27	0.35	5.67	14
NJ	45,488	26,700	58.7%	18,696	41.1%	224.84	9.63	154.09	15	8.42	0.36	5.77	13
NM	35,138	27,404	78.0%	19,775	56.3%	122.27	5.24	83.80	25	4.46	0.19	3.06	39
NV	15,125	10,402	68.8%	7,990	52.8%	94.74	4.06	64.93	33	9.11	0.39	6.24	11
NY	48,517	41,872	86.3%	29,949	61.7%	210.83	9.03	144.49	19	5.04	0.22	3.45	35
OH	63,833	56,300	88.2%	41,691	65.3%	445.99	19.11	305.66	4	7.92	0.34	5.43	16
OK	18,565	12,165	65.5%	8,427	45.4%	70.75	3.03	48.49	38	5.82	0.25	3.99	30
OR	45,119	33,473	74.2%	22,679	50.3%	159.32	6.83	109.19	21	4.76	0.20	3.26	36
PA	46,226	35,968	77.8%	28,222	61.1%	220.70	9.45	151.26	17	6.14	0.26	4.21	25
RI	3,863	2,000	51.8%	1,480	38.3%	13.27	0.57	9.09	49	6.63	0.28	4.55	21
SC	33,564	15,889	47.3%	11,937	35.6%	155.57	6.66	106.62	22	9.79	0.42	6.71	7
SD	16,382	7,124	43.5%	6,307	38.5%	56.25	2.41	38.55	39	7.90	0.34	5.41	17
TN	52,493	25,035	47.7%	18,002	34.3%	237.82	10.19	162.99	14	9.50	0.41	6.51	10
TX	117,804	107,814	91.5%	92,177	78.2%	646.08	27.68	442.79	1	5.99	0.26	4.11	27
UT	14,002	9,110	65.1%	7,439	53.1%	88.72	3.80	60.81	34	9.74	0.42	6.67	8
VA	48,137	44,824	93.1%	33,775	70.2%	269.52	11.55	184.72	8	6.01	0.26	4.12	26
VT	5,120	3,154	61.6%	2,664	52.0%	23.63	1.01	16.20	46	7.49	0.32	5.14	19
WA	76,312	52,193	68.4%	37,584	49.3%	330.67	14.17	226.63	5	6.34	0.27	4.34	23
WI	24,977	22,292	89.3%	17,373	69.6%	116.93	5.01	80.14	28	5.25	0.22	3.59	34
WV	19,350	16,433	84.9%	9,741	50.3%	74.89	3.21	51.33	37	4.56	0.20	3.12	37
WY	12,626	8,364	66.2%	5,823	46.1%	46.66	2.00	31.98	41	5.58	0.24	3.82	32
Other	19,700	19,086	96.9%	11,235	57.0%	104.72	4.49	71.77	.	5.49	0.24	3.76	.
Totals	**2,216,570**	**1,700,522**	76.7%	**1,128,791**	50.9%	**8,612**	**369**	**5,902**		**353**	**15**	**242**	

Table C-2b. Mean Roadside Inspection Program Benefits by State, 1999

Intervention Model -- Estimated Mean Roadside Inspection Program Benefits During 1999

Report	Total Initiating	Roadside Inspections				Estimated Totals				Estimates per 1,000 Roadside Inspections			
State	Interventions	Number	% of Total	Number with DR/VH	% of Total	Crashes Avoided	Lives Saves	Injuries Avoided	Rank	Crashes Avoided	Lives Saves	Injuries Avoided	Rank
AK	3,500	3,027	86.5%	1,807	51.6%	13.74	0.59	9.41	49	4.54	0.19	3.11	37
AL	23,199	9,441	40.7%	8,318	35.9%	122.64	5.25	84.05	29	12.99	0.56	8.90	4
AR	47,216	31,900	67.6%	16,549	35.0%	107.72	4.61	73.83	33	3.38	0.14	2.31	44
AZ	45,410	22,785	50.2%	19,796	43.6%	353.56	15.15	242.32	5	15.52	0.66	10.63	2
CA	452,783	399,332	88.2%	201,732	44.6%	496.62	21.28	340.36	3	1.24	0.05	0.85	52
CO	46,510	40,578	87.2%	27,513	59.2%	284.41	12.19	194.93	6	7.01	0.30	4.80	18
CT	19,070	13,098	68.7%	11,594	60.8%	132.70	5.69	90.94	26	10.13	0.43	6.94	8
DC	3,493	2,750	78.7%	1,626	46.6%	8.65	0.37	5.93	52	3.14	0.13	2.15	46
DE	4,561	3,819	83.7%	2,225	48.8%	10.52	0.45	7.21	51	2.75	0.12	1.89	49
FL	55,280	36,648	66.3%	26,942	48.7%	232.68	9.97	159.47	15	6.35	0.27	4.35	25
GA	29,277	17,698	60.5%	15,105	51.6%	156.02	6.69	106.93	24	8.82	0.38	6.04	11
HI	7,477	5,911	79.1%	3,068	41.0%	22.79	0.98	15.62	47	3.85	0.16	2.64	40
IA	58,948	45,215	76.7%	35,305	59.9%	173.08	7.42	118.63	20	3.83	0.16	2.62	41
ID	5,417	3,462	63.9%	3,091	57.1%	44.44	1.91	30.46	43	12.84	0.55	8.80	5
IL	59,504	30,748	51.7%	13,337	22.4%	185.53	7.95	127.16	18	6.03	0.26	4.14	27
IN	50,359	23,339	46.3%	19,282	38.3%	246.63	10.57	169.04	13	10.57	0.45	7.24	7
KS	34,131	20,593	60.3%	14,842	43.5%	122.98	5.27	84.28	28	5.97	0.26	4.09	28
KY	83,181	69,874	84.0%	36,447	43.8%	264.72	11.34	181.43	11	3.79	0.16	2.60	43
LA	39,190	30,938	78.9%	21,661	55.3%	103.63	4.44	71.02	35	3.35	0.14	2.30	45
MA	21,445	13,739	64.1%	7,568	35.3%	90.56	3.88	62.07	37	6.59	0.28	4.52	23
MD	103,288	89,219	86.4%	49,406	47.8%	275.75	11.81	188.99	7	3.09	0.13	2.12	48
ME	7,845	7,220	92.0%	5,891	75.1%	40.88	1.75	28.02	44	5.66	0.24	3.88	30
MI	37,293	9,858	26.4%	7,747	20.8%	231.78	9.93	158.86	16	23.51	1.01	16.11	1
MN	34,998	19,822	56.6%	14,309	40.9%	269.39	11.54	184.63	9	13.59	0.58	9.31	3
MO	74,749	69,924	93.5%	56,653	75.8%	591.32	25.34	405.27	2	8.46	0.36	5.80	13
MS	26,268	24,844	94.6%	12,353	47.0%	77.90	3.34	53.39	38	3.14	0.13	2.15	47
MT	46,023	41,184	89.5%	19,975	43.4%	95.87	4.11	65.71	36	2.33	0.10	1.60	50
NC	67,387	45,628	67.7%	30,174	44.8%	173.62	7.44	119.00	19	3.81	0.16	2.61	42
ND	19,230	14,163	73.7%	5,294	27.5%	28.81	1.24	19.75	45	2.03	0.09	1.39	51
NE	19,941	14,682	73.6%	9,733	48.8%	66.36	2.84	45.48	40	4.52	0.19	3.10	38
NH	6,012	3,783	62.9%	2,896	48.2%	26.07	1.12	17.87	46	6.89	0.29	4.72	19
NJ	51,122	27,273	53.3%	17,472	34.2%	275.61	11.81	188.89	8	10.11	0.43	6.93	9
NM	48,527	33,412	68.9%	23,688	48.8%	161.08	6.90	110.40	22	4.82	0.21	3.30	36
NV	15,162	10,466	69.0%	8,276	54.6%	111.83	4.79	76.65	31	10.69	0.46	7.32	6
NY	60,899	52,256	85.8%	35,460	58.2%	267.65	11.47	183.43	10	5.12	0.22	3.51	35
OH	65,227	55,219	84.7%	41,376	63.4%	417.08	17.87	285.85	4	7.55	0.32	5.18	16
OK	16,808	10,012	59.6%	6,754	40.2%	67.36	2.89	46.17	39	6.73	0.29	4.61	22
OR	46,518	33,041	71.0%	22,251	47.8%	173.04	7.42	118.59	21	5.24	0.22	3.59	34
PA	44,473	34,555	77.7%	27,817	62.5%	235.88	10.11	161.66	14	6.83	0.29	4.68	21
RI	4,031	1,999	49.6%	1,559	38.7%	13.67	0.59	9.37	50	6.84	0.29	4.68	20
SC	30,728	13,921	45.3%	10,625	34.6%	140.38	6.02	96.22	25	10.08	0.43	6.91	10
SD	15,693	6,947	44.3%	6,224	39.7%	59.26	2.54	40.61	41	8.53	0.37	5.85	12
TN	64,304	31,368	48.8%	21,047	32.7%	262.60	11.25	179.98	12	8.37	0.36	5.74	14
TX	148,393	137,335	92.5%	117,598	79.2%	870.18	37.28	596.39	1	6.34	0.27	4.34	26
US	20,378	20,214	99.2%	17,541	86.1%	131.87	5.65	90.38	27	6.52	0.28	4.47	24
UT	19,257	14,186	73.7%	9,317	48.4%	116.91	5.01	80.13	30	8.24	0.35	5.65	15
VA	33,130	29,432	88.8%	20,646	62.3%	156.77	6.72	107.45	23	5.33	0.23	3.65	33
VT	3,454	2,049	59.3%	1,664	48.2%	14.44	0.62	9.90	48	7.05	0.30	4.83	17
WA	66,229	41,054	62.0%	29,386	44.4%	229.34	9.83	157.19	17	5.59	0.24	3.83	31
WI	21,205	18,188	85.8%	13,806	65.1%	105.94	4.54	72.61	34	5.82	0.25	3.99	29
WV	23,030	19,815	86.0%	12,193	52.9%	109.24	4.68	74.87	32	5.51	0.24	3.78	32
WY	17,570	12,384	70.5%	7,315	41.6%	49.24	2.11	33.75	42	3.98	0.17	2.72	39
Other	13,844	13,400	96.8%	7,532	54.4%	98.22	4.21	67.31	.	7.33	0.31	5.02	.
Totals	**2,362,967**	**1,783,748**	75.5%	**1,161,786**	49.2%	**9,119**	**391**	**6,250**		**362**	**16**	**248**	

Table C-2c. Mean Roadside Inspection Program Benefits by State, 2000

Intervention Model -- Estimated Mean Roadside Inspection Program Benefits During 2000

Report	Total Initiating	Roadside Inspections				Estimated Totals				Estimates per 1,000 Roadside Inspections			
State	Interventions	Number	% of Total	Number with DR/VH	% of Total	Crashes Avoided	Lives Saves	Injuries Avoided	Rank	Crashes Avoided	Lives Saves	Injuries Avoided	Rank
AK	4,972	4,420	88.9%	2,544	51.2%	17.24	0.74	11.82	47	3.90	0.17	2.67	38
AL	34,032	21,028	61.8%	13,484	39.6%	145.97	6.25	100.04	27	6.94	0.30	4.76	19
AR	62,719	43,638	69.6%	19,784	31.5%	124.13	5.32	85.07	30	2.84	0.12	1.95	49
AZ	47,215	24,181	51.2%	21,208	44.9%	363.21	15.56	248.93	5	15.02	0.64	10.29	2
CA	464,683	411,270	88.5%	200,749	43.2%	467.02	20.01	320.07	3	1.14	0.05	0.78	52
CO	52,680	44,175	83.9%	31,483	59.8%	263.05	11.27	180.28	9	5.95	0.26	4.08	27
CT	19,314	13,878	71.9%	11,979	62.0%	137.31	5.88	94.11	29	9.89	0.42	6.78	7
DC	3,196	2,827	88.5%	1,621	50.7%	10.15	0.43	6.95	52	3.59	0.15	2.46	43
DE	4,120	3,316	80.5%	2,144	52.0%	10.63	0.46	7.29	51	3.21	0.14	2.20	47
FL	49,228	28,603	58.1%	21,530	43.7%	197.46	8.46	135.33	18	6.90	0.30	4.73	20
GA	30,255	17,171	56.8%	15,055	49.8%	170.94	7.32	117.16	23	9.96	0.43	6.82	6
HI	7,099	5,718	80.5%	2,768	39.0%	21.96	0.94	15.05	46	3.84	0.16	2.63	39
IA	59,454	43,656	73.4%	34,094	57.3%	160.27	6.87	109.85	25	3.67	0.16	2.52	42
ID	7,121	4,154	58.3%	3,595	50.5%	50.98	2.18	34.94	43	12.27	0.53	8.41	4
IL	68,798	37,144	54.0%	16,677	24.2%	199.06	8.53	136.42	17	5.36	0.23	3.67	31
IN	51,626	23,038	44.6%	19,071	36.9%	245.59	10.52	168.32	12	10.66	0.46	7.31	5
KS	43,653	27,916	63.9%	19,021	43.6%	137.90	5.91	94.51	28	4.94	0.21	3.39	34
KY	75,013	60,682	80.9%	31,257	41.7%	228.93	9.81	156.90	13	3.77	0.16	2.59	40
LA	37,528	27,568	73.5%	17,246	46.0%	93.17	3.99	63.86	34	3.38	0.14	2.32	46
MA	16,620	10,441	62.8%	5,747	34.6%	65.25	2.80	44.72	39	6.25	0.27	4.28	25
MD	97,479	83,401	85.6%	47,953	49.2%	259.20	11.10	177.65	11	3.11	0.13	2.13	48
ME	6,723	5,420	80.6%	4,454	66.3%	34.37	1.47	23.56	44	6.34	0.27	4.35	22
MI	46,624	13,098	28.1%	10,477	22.5%	261.59	11.21	179.29	10	19.97	0.86	13.69	1
MN	35,652	20,190	56.6%	13,327	37.4%	289.68	12.41	198.54	7	14.35	0.61	9.83	3
MO	71,823	59,281	82.5%	46,146	64.2%	471.27	20.19	322.99	2	7.95	0.34	5.45	16
MS	30,017	28,504	95.0%	13,848	46.1%	99.15	4.25	67.95	33	3.48	0.15	2.38	45
MT	43,839	38,803	88.5%	18,026	41.1%	93.10	3.99	63.81	35	2.40	0.10	1.64	50
NC	70,339	50,634	72.0%	39,619	56.3%	188.86	8.09	129.44	19	3.73	0.16	2.56	41
ND	18,598	13,452	72.3%	4,533	24.4%	29.16	1.25	19.98	45	2.17	0.09	1.49	51
NE	18,382	14,198	77.2%	9,169	49.9%	60.54	2.59	41.49	40	4.26	0.18	2.92	36
NH	2,773	1,701	61.3%	1,319	47.6%	14.36	0.62	9.84	50	8.44	0.36	5.78	13
NJ	48,132	27,501	57.1%	17,907	37.2%	218.95	9.38	150.06	14	7.96	0.34	5.46	15
NM	55,233	38,821	70.3%	26,856	48.6%	184.43	7.90	126.40	21	4.75	0.20	3.26	35
NV	12,774	9,142	71.6%	7,014	54.9%	79.63	3.41	54.58	36	8.71	0.37	5.97	10
NY	65,865	56,156	85.3%	36,159	54.9%	284.10	12.17	194.71	8	5.06	0.22	3.47	32
OH	63,306	47,211	74.6%	37,747	59.6%	407.65	17.46	279.39	4	8.63	0.37	5.92	12
OK	15,450	9,078	58.8%	5,765	37.3%	57.35	2.46	39.31	41	6.32	0.27	4.33	23
OR	49,815	33,114	66.5%	22,396	45.0%	183.66	7.87	125.87	22	5.55	0.24	3.80	30
PA	65,460	50,758	77.5%	39,352	60.1%	318.88	13.66	218.55	6	6.28	0.27	4.31	24
RI	4,093	1,949	47.6%	1,509	36.9%	14.50	0.62	9.94	49	7.44	0.32	5.10	17
SC	32,788	17,766	54.2%	12,821	39.1%	146.93	6.29	100.70	26	8.27	0.35	5.67	14
SD	20,531	10,820	52.7%	9,612	46.8%	79.19	3.39	54.27	37	7.32	0.31	5.02	18
TN	56,854	22,557	39.7%	14,652	25.8%	207.29	8.88	142.07	16	9.19	0.39	6.30	8
TX	158,742	149,684	94.3%	126,613	79.8%	1296.38	55.54	888.49	1	8.66	0.37	5.94	11
US	33,347	33,198	99.6%	27,212	81.6%	187.30	8.02	128.37	20	5.64	0.24	3.87	28
UT	17,934	12,989	72.4%	9,569	53.4%	116.14	4.98	79.60	31	8.94	0.38	6.13	9
VA	37,299	34,289	91.9%	23,558	63.2%	170.61	7.31	116.93	24	4.98	0.21	3.41	33
VT	4,012	2,343	58.4%	1,932	48.2%	15.88	0.68	10.88	48	6.78	0.29	4.64	21
WA	63,801	37,023	58.0%	26,052	40.8%	207.72	8.90	142.37	15	5.61	0.24	3.85	29
WI	22,086	18,517	83.8%	13,723	62.1%	111.88	4.79	76.68	32	6.04	0.26	4.14	26
WV	22,036	19,576	88.8%	10,974	49.8%	69.86	2.99	47.88	38	3.57	0.15	2.45	44
WY	17,635	12,799	72.6%	7,301	41.4%	51.03	2.19	34.98	42	3.99	0.17	2.73	37
Other	4,446	4,191	94.3%	2,387	53.7%	40.77	1.75	27.94	.	9.73	0.42	6.67	.
Totals	**2,453,214**	**1,832,988**	74.7%	**1,181,039**	48.1%	**9,362**	**401**	**6,416**		**349**	**15**	**239**	

C.3. TRAFFIC ENFORCEMENT BENEFITS, BY STATE

Table C-3a. Mean Traffic Enforcement Program Benefits by State, 1998

Intervention Model -- Estimated Mean Traffic Enforcement Program Benefits During 1998

Report State	Total Initiating Interventions	Traffic Enforcements		Estimated Totals				Estimates per 1,000 Traffic Enforcements			
		Number	% of Total	Crashes Avoided	Lives Saves	Injuries Avoided	Rank	Crashes Avoided	Lives Saves	Injuries Avoided	Rank
AK	2,269	343	15.1%	4.34	0.19	2.98	48	12.66	0.54	8.68	2
AL	20,742	11,719	56.5%	60.01	2.57	41.13	16	5.12	0.22	3.51	24
AR	41,243	14,362	34.8%	51.29	2.20	35.15	20	3.57	0.15	2.45	46
AZ	42,253	18,345	43.4%	180.34	7.73	123.60	2	9.83	0.42	6.74	8
CA	434,488	55,282	12.7%	215.02	9.21	147.37	1	3.89	0.17	2.67	42
CO	42,882	4,683	10.9%	30.12	1.29	20.64	32	6.43	0.28	4.41	20
CT	16,283	4,810	29.5%	45.38	1.94	31.10	23	9.43	0.40	6.47	9
DC	2,596	303	11.7%	1.22	0.05	0.84	51	4.02	0.17	2.76	41
DE	3,925	684	17.4%	3.35	0.14	2.30	49	4.90	0.21	3.36	28
FL	63,015	18,003	28.6%	90.31	3.87	61.89	10	5.02	0.21	3.44	27
GA	23,120	6,348	27.5%	55.33	2.37	37.92	18	8.72	0.37	5.97	12
HI	8,054	1,397	17.3%	13.98	0.60	9.58	39	10.01	0.43	6.86	6
IA	62,477	6,341	10.1%	37.55	1.61	25.74	28	5.92	0.25	4.06	21
ID	5,672	1,839	32.4%	16.93	0.73	11.60	37	9.21	0.39	6.31	10
IL	75,952	35,291	46.5%	144.59	6.19	99.10	5	4.10	0.18	2.81	38
IN	52,777	26,915	51.0%	117.58	5.04	80.59	8	4.37	0.19	2.99	34
KS	29,672	11,539	38.9%	51.53	2.21	35.31	19	4.47	0.19	3.06	32
KY	70,566	7,976	11.3%	29.11	1.25	19.95	34	3.65	0.16	2.50	45
LA	40,532	10,867	26.8%	48.12	2.06	32.98	22	4.43	0.19	3.03	33
MA	26,064	11,873	45.6%	60.12	2.58	41.21	15	5.06	0.22	3.47	26
MD	105,149	9,442	9.0%	48.43	2.07	33.19	21	5.13	0.22	3.52	23
ME	5,655	229	4.0%	2.47	0.11	1.70	50	10.80	0.46	7.40	4
MI	31,277	21,874	69.9%	156.98	6.72	107.59	3	7.18	0.31	4.92	18
MN	34,384	15,484	45.0%	153.19	6.56	104.99	4	9.89	0.42	6.78	7
MO	78,211	7,828	10.0%	44.25	1.90	30.32	24	5.65	0.24	3.87	22
MS	28,478	589	2.1%	9.28	0.40	6.36	46	15.75	0.67	10.80	1
MT	39,744	5,113	12.9%	16.44	0.70	11.27	38	3.22	0.14	2.20	48
NC	27,102	9,715	35.8%	40.20	1.72	27.55	26	4.14	0.18	2.84	37
ND	17,545	5,669	32.3%	13.17	0.56	9.03	40	2.32	0.10	1.59	51
NE	18,096	4,874	26.9%	13.04	0.56	8.94	41	2.68	0.11	1.83	50
NH	4,006	1,572	39.2%	11.45	0.49	7.84	43	7.28	0.31	4.99	17
NJ	45,488	18,788	41.3%	140.82	6.03	96.51	6	7.50	0.32	5.14	15
NM	35,138	7,734	22.0%	35.33	1.51	24.21	31	4.57	0.20	3.13	30
NV	15,125	4,723	31.2%	41.25	1.77	28.27	25	8.73	0.37	5.99	11
NY	48,517	6,645	13.7%	56.35	2.41	38.62	17	8.48	0.36	5.81	14
OH	63,833	7,533	11.8%	77.59	3.32	53.18	12	10.30	0.44	7.06	5
OK	18,565	6,400	34.5%	28.71	1.23	19.68	35	4.49	0.19	3.07	31
OR	45,119	11,646	25.8%	35.33	1.51	24.22	30	3.03	0.13	2.08	49
PA	46,226	10,258	22.2%	87.95	3.77	60.28	11	8.57	0.37	5.88	13
RI	3,863	1,863	48.2%	6.87	0.29	4.71	47	3.69	0.16	2.53	44
SC	33,564	17,675	52.7%	71.12	3.05	48.74	13	4.02	0.17	2.76	40
SD	16,382	9,258	56.5%	29.89	1.28	20.48	33	3.23	0.14	2.21	47
TN	52,493	27,458	52.3%	118.73	5.09	81.37	7	4.32	0.19	2.96	35
TX	117,804	9,990	8.5%	66.06	2.83	45.27	14	6.61	0.28	4.53	19
UT	14,002	4,892	34.9%	35.76	1.53	24.51	29	7.31	0.31	5.01	16
VA	48,137	3,313	6.9%	39.23	1.68	26.88	27	11.84	0.51	8.11	3
VT	5,120	1,966	38.4%	10.06	0.43	6.89	45	5.12	0.22	3.51	25
WA	76,312	24,119	31.6%	102.65	4.40	70.35	9	4.26	0.18	2.92	36
WI	24,977	2,685	10.7%	12.93	0.55	8.86	42	4.82	0.21	3.30	29
WV	19,350	2,917	15.1%	10.89	0.47	7.46	44	3.73	0.16	2.56	43
WY	12,626	4,262	33.8%	17.38	0.74	11.91	36	4.08	0.17	2.80	39
Other	19,700	614	3.1%	9.94	0.43	6.81	.	16.19	0.69	11.09	.
Totals	**2,216,570**	**516,048**	**23.3%**	**2,800**	**120**	**1,919**		**334**	**14**	**229**	

Table C-3b. Mean Traffic Enforcement Program Benefits by State, 1999

Intervention Model -- Estimated Mean Traffic Enforcement Program Benefits During 1999

Report	Total Initiating	Traffic Enforcements		Estimated Totals				Estimates per 1,000 Traffic Enforcements			
State	Interventions	Number	% of Total	Crashes Avoided	Lives Saves	Injuries Avoided	Rank	Crashes Avoided	Lives Saves	Injuries Avoided	Rank
AK	3,500	473	13.5%	4.90	0.21	3.36	49	10.36	0.44	7.10	2
AL	23,199	13,758	59.3%	72.29	3.10	49.55	15	5.25	0.23	3.60	24
AR	47,216	15,316	32.4%	46.78	2.00	32.06	25	3.05	0.13	2.09	49
AZ	45,410	22,625	49.8%	210.68	9.03	144.39	1	9.31	0.40	6.38	6
CA	452,783	53,451	11.8%	199.47	8.55	136.71	2	3.73	0.16	2.56	40
CO	46,510	5,932	12.8%	32.83	1.41	22.50	33	5.53	0.24	3.79	23
CT	19,070	5,972	31.3%	49.18	2.11	33.71	24	8.23	0.35	5.64	13
DC	3,493	743	21.3%	1.99	0.09	1.36	52	2.68	0.11	1.83	51
DE	4,561	742	16.3%	3.01	0.13	2.06	51	4.06	0.17	2.78	36
FL	55,280	18,632	33.7%	87.14	3.74	59.72	10	4.68	0.20	3.21	28
GA	29,277	11,579	39.5%	68.77	2.95	47.14	17	5.94	0.25	4.07	22
HI	7,477	1,566	20.9%	12.54	0.54	8.60	44	8.01	0.34	5.49	14
IA	58,948	13,733	23.3%	50.08	2.15	34.32	23	3.65	0.16	2.50	41
ID	5,417	1,955	36.1%	16.95	0.73	11.62	38	8.67	0.37	5.94	10
IL	59,504	28,756	48.3%	119.67	5.13	82.02	8	4.16	0.18	2.85	34
IN	50,359	27,020	53.7%	126.71	5.43	86.84	7	4.69	0.20	3.21	27
KS	34,131	13,538	39.7%	56.33	2.41	38.60	20	4.16	0.18	2.85	35
KY	83,181	13,307	16.0%	38.60	1.66	26.46	31	2.90	0.12	1.99	50
LA	39,190	8,252	21.1%	39.24	1.69	26.89	30	4.76	0.20	3.26	26
MA	21,445	7,706	35.9%	51.60	2.21	35.37	22	6.70	0.29	4.59	19
MD	103,288	14,069	13.6%	68.13	2.92	46.69	18	4.84	0.21	3.32	25
ME	7,845	625	8.0%	4.46	0.19	3.05	50	7.13	0.30	4.88	18
MI	37,293	27,435	73.6%	164.05	7.03	112.43	4	5.98	0.26	4.10	21
MN	34,998	15,176	43.4%	142.01	6.08	97.33	5	9.36	0.40	6.41	4
MO	74,749	4,825	6.5%	44.67	1.91	30.62	27	9.26	0.40	6.35	7
MS	26,268	1,424	5.4%	12.69	0.55	8.70	43	8.91	0.38	6.11	9
MT	46,023	4,839	10.5%	18.24	0.78	12.50	37	3.77	0.16	2.58	38
NC	67,387	21,759	32.3%	76.74	3.29	52.60	14	3.53	0.15	2.42	44
ND	19,230	5,067	26.3%	10.34	0.44	7.09	45	2.04	0.09	1.40	52
NE	19,941	5,259	26.4%	16.45	0.71	11.28	39	3.13	0.13	2.14	48
NH	6,012	2,229	37.1%	14.63	0.63	10.03	40	6.56	0.28	4.50	20
NJ	51,122	23,849	46.7%	186.31	7.99	127.69	3	7.81	0.33	5.35	16
NM	48,527	15,115	31.1%	54.77	2.35	37.53	21	3.62	0.16	2.48	42
NV	15,162	4,696	31.0%	43.22	1.85	29.62	29	9.20	0.39	6.31	8
NY	60,899	8,643	14.2%	71.24	3.05	48.82	16	8.24	0.35	5.65	12
OH	65,227	10,008	15.3%	78.77	3.38	53.99	13	7.87	0.34	5.39	15
OK	16,808	6,796	40.4%	29.53	1.27	20.24	34	4.35	0.19	2.98	30
OR	46,518	13,477	29.0%	46.48	2.00	31.86	26	3.45	0.15	2.36	45
PA	44,473	9,918	22.3%	92.60	3.97	63.46	9	9.34	0.40	6.40	5
RI	4,031	2,032	50.4%	7.29	0.31	5.00	47	3.59	0.15	2.46	43
SC	30,728	16,807	54.7%	66.99	2.87	45.91	19	3.99	0.17	2.73	37
SD	15,693	8,746	55.7%	27.56	1.19	18.89	35	3.15	0.14	2.16	47
TN	64,304	32,936	51.2%	137.49	5.89	94.23	6	4.17	0.18	2.86	33
TX	148,393	11,058	7.5%	84.54	3.62	57.94	11	7.64	0.33	5.24	17
US	20,378	164	0.8%	7.80	0.34	5.35	46	47.56	2.04	32.59	1
UT	19,257	5,071	26.3%	43.57	1.87	29.86	28	8.59	0.37	5.89	11
VA	33,130	3,698	11.2%	37.67	1.61	25.82	32	10.19	0.44	6.98	3
VT	3,454	1,405	40.7%	5.91	0.25	4.05	48	4.21	0.18	2.88	32
WA	66,229	25,175	38.0%	83.19	3.57	57.01	12	3.30	0.14	2.26	46
WI	21,205	3,017	14.2%	13.79	0.59	9.45	41	4.57	0.20	3.13	29
WV	23,030	3,215	14.0%	13.75	0.59	9.43	42	4.28	0.18	2.93	31
WY	17,570	5,186	29.5%	19.39	0.83	13.29	36	3.74	0.16	2.56	39
Other	13,844	444	3.2%	7.91	0.34	5.42	.	17.80	0.77	12.20	.
Totals	**2,362,967**	**579,219**	**24.5%**	**3,021**	**129**	**2,070**		**356**	**15**	**244**	

Table C-3c. Mean Traffic Enforcement Program Benefits by State, 2000

Intervention Model -- Estimated Mean Traffic Enforcement Program Benefits During 2000

Report	Total Initiating	Traffic Enforcements		Estimated Totals				Estimates per 1,000 Traffic Enforcements			
State	Interventions	Number	% of Total	Crashes Avoided	Lives Saves	Injuries Avoided	Rank	Crashes Avoided	Lives Saves	Injuries Avoided	Rank
AK	4,972	552	11.1%	4.21	0.18	2.89	50	7.63	0.33	5.23	16
AL	34,032	13,004	38.2%	80.42	3.45	55.12	16	6.18	0.26	4.24	22
AR	62,719	19,081	30.4%	55.63	2.38	38.13	24	2.92	0.12	2.00	50
AZ	47,215	23,034	48.8%	224.52	9.62	153.88	1	9.75	0.42	6.68	6
CA	464,683	53,413	11.5%	193.12	8.27	132.36	2	3.62	0.15	2.48	45
CO	52,680	8,505	16.1%	42.90	1.84	29.40	29	5.04	0.22	3.46	26
CT	19,314	5,436	28.1%	48.28	2.07	33.09	25	8.88	0.38	6.09	12
DC	3,196	369	11.5%	2.43	0.10	1.66	52	6.58	0.28	4.51	19
DE	4,120	804	19.5%	3.52	0.15	2.41	51	4.37	0.19	3.00	34
FL	49,228	20,625	41.9%	86.88	3.72	59.55	14	4.21	0.18	2.89	35
GA	30,255	13,084	43.2%	80.24	3.44	54.99	17	6.13	0.26	4.20	23
HI	7,099	1,381	19.5%	12.62	0.54	8.65	42	9.14	0.39	6.26	8
IA	59,454	15,798	26.6%	46.86	2.01	32.12	26	2.97	0.13	2.03	49
ID	7,121	2,967	41.7%	23.62	1.01	16.19	36	7.96	0.34	5.46	15
IL	68,798	31,654	46.0%	132.99	5.70	91.15	7	4.20	0.18	2.88	36
IN	51,626	28,588	55.4%	131.03	5.61	89.80	8	4.58	0.20	3.14	29
KS	43,653	15,737	36.1%	63.50	2.72	43.52	22	4.03	0.17	2.77	40
KY	75,013	14,331	19.1%	40.00	1.71	27.41	31	2.79	0.12	1.91	51
LA	37,528	9,960	26.5%	43.90	1.88	30.09	28	4.41	0.19	3.02	32
MA	16,620	6,179	37.2%	40.32	1.73	27.63	30	6.52	0.28	4.47	20
MD	97,479	14,078	14.4%	68.38	2.93	46.87	20	4.86	0.21	3.33	27
ME	6,723	1,303	19.4%	8.38	0.36	5.74	48	6.43	0.28	4.41	21
MI	46,624	33,526	71.9%	188.03	8.06	128.87	3	5.61	0.24	3.84	24
MN	35,652	15,462	43.4%	184.30	7.90	126.31	4	11.92	0.51	8.17	2
MO	71,823	12,542	17.5%	83.55	3.58	57.26	15	6.66	0.29	4.57	18
MS	30,017	1,513	5.0%	16.34	0.70	11.20	39	10.80	0.46	7.40	5
MT	43,839	5,036	11.5%	18.22	0.78	12.49	38	3.62	0.15	2.48	44
NC	70,339	19,705	28.0%	73.28	3.14	50.22	18	3.72	0.16	2.55	42
ND	18,598	5,146	27.7%	10.20	0.44	6.99	45	1.98	0.08	1.36	52
NE	18,382	4,184	22.8%	13.72	0.59	9.40	41	3.28	0.14	2.25	48
NH	2,773	1,072	38.7%	8.60	0.37	5.90	47	8.02	0.34	5.50	14
NJ	48,132	20,631	42.9%	142.64	6.11	97.76	6	6.91	0.30	4.74	17
NM	55,233	16,412	29.7%	66.56	2.85	45.62	21	4.06	0.17	2.78	37
NV	12,774	3,632	28.4%	33.81	1.45	23.17	34	9.31	0.40	6.38	7
NY	65,865	9,709	14.7%	86.95	3.73	59.59	13	8.96	0.38	6.14	11
OH	63,306	16,095	25.4%	144.15	6.18	98.80	5	8.96	0.38	6.14	10
OK	15,450	6,372	41.2%	28.62	1.23	19.62	35	4.49	0.19	3.08	30
OR	49,815	16,701	33.5%	58.19	2.49	39.88	23	3.48	0.15	2.39	46
PA	65,460	14,702	22.5%	125.06	5.36	85.71	10	8.51	0.36	5.83	13
RI	4,093	2,144	52.4%	8.66	0.37	5.93	46	4.04	0.17	2.77	39
SC	32,788	15,022	45.8%	72.27	3.10	49.53	19	4.81	0.21	3.30	28
SD	20,531	9,711	47.3%	39.28	1.68	26.92	32	4.05	0.17	2.77	38
TN	56,854	34,297	60.3%	125.73	5.39	86.17	9	3.67	0.16	2.51	43
TX	158,742	9,058	5.7%	102.42	4.39	70.19	11	11.31	0.48	7.75	4
US	33,347	149	0.4%	11.75	0.50	8.05	44	78.83	3.38	54.03	1
UT	17,934	4,945	27.6%	44.73	1.92	30.65	27	9.04	0.39	6.20	9
VA	37,299	3,010	8.1%	34.05	1.46	23.34	33	11.31	0.48	7.75	3
VT	4,012	1,669	41.6%	7.36	0.32	5.04	49	4.41	0.19	3.02	33
WA	63,801	26,778	42.0%	91.25	3.91	62.54	12	3.41	0.15	2.34	47
WI	22,086	3,569	16.2%	15.74	0.67	10.79	40	4.41	0.19	3.02	31
WV	22,036	2,460	11.2%	12.44	0.53	8.53	43	5.06	0.22	3.47	25
WY	17,635	4,836	27.4%	19.18	0.82	13.15	37	3.97	0.17	2.72	41
Other	4,446	255	5.7%	4.48	0.19	3.07	.	17.55	0.75	12.03	.
Totals	**2,453,214**	**620,226**	**25.3%**	**3,305**	**142**	**2,265**		**399**	**17**	**274**	