FMCSA Safety Program Effectiveness Measurement: Intervention Model in Fiscal Year 2007

U.S. Department of Transportation
Federal Motor Carrier Safety Administration

April 2011

FOREWORD

This report presents results from the Federal Motor Carrier Safety Administration's Roadside Intervention Model for fiscal year 2007. The model estimates the number of crashes avoided, as well as injuries avoided and lives saved, as a result of the agency's roadside inspection program. The Roadside Intervention Model uses a risk-based approach to estimates the benefits of the roadside inspection program. With this approach, each violation detected at the roadside is assigned a crash risk. When these violations are corrected as a result of an inspection, the associated crash risks are removed and the number of crashes, fatalities, and injuries prevented can be estimated.

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16. Abstract **This report presents results from FMCSA's Roadside Intervention Model for fiscal year 2007. The model estimates the number of crashes avoided, as well as injuries avoided and lives saved, as a result of the Agency's roadside inspection program. The Roadside Intervention Model uses a risk-based approach to estimate the benefits of the roadside inspection program. With this approach, each violation detected at the roadside is assigned a crash risk. When these violations are corrected as a result of an inspection, the associated crash risks are removed and the number of crashes, fatalities, and injuries prevented can be estimated.**		
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SI* (MODERN METRIC) CONVERSION FACTORS

Table of APPROXIMATE CONVERSIONS TO SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
		LENGTH		
In	Inches	25.4	millimeters	mm
Ft	Feet	0.305	meters	m
Yd	Yards	0.914	meters	m
Mi	Miles	1.61	kilometers	km
		AREA		
in^2	square inches	645.2	square millimeters	mm^2
ft^2	square feet	0.093	square meters	m^2
yd^2	square yards	0.836	square meters	m^2
Ac	Acres	0.405	hectares	ha
mi^2	square miles	2.59	square kilometers	km^2
		VOLUME	Note: Volumes greater than 1000 L shall be shown in m^3	
fl oz	fluid ounces	29.57	milliliters	mL
Gal	Gallons	3.785	liters	L
ft^3	cubic feet	0.028	cubic meters	m^3
yd^3	cubic yards	0.765	cubic meters	m^3
		MASS		
Oz	Ounces	28.35	grams	g
Lb	Pounds	0.454	kilograms	kg
T	short tons (2000 lb)	0.907	megagrams (or "metric ton")	Mg (or "t")
		TEMPERATURE	Temperature is in exact degrees	
°F	Fahrenheit	5 × (F-32) ÷ 9 or (F-32) ÷ 1.8	Celsius	°C
		ILLUMINATION		
Fc	foot-candles	10.76	lux	lx
Fl	foot-Lamberts	3.426	candela/m^2	cd/m^2
		Force & Pressure or Stress		
Lbf	Poundforce	4.45	newtons	N
lbf/in^2	poundforce per square inch	6.89	kilopascals	kPa

Table of APPROXIMATE CONVERSIONS FROM SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
		LENGTH		
Mm	Millimeters	0.039	inches	in
M	Meters	3.28	feet	ft
M	Meters	1.09	yards	yd
Km	Kilometers	0.621	miles	mi
		AREA		
mm^2	square millimeters	0.0016	square inches	in^2
m^2	square meters	10.764	square feet	ft^2
m^2	square meters	1.195	square yards	yd^2
Ha	Hectares	2.47	acres	ac
km^2	square kilometers	0.386	square miles	mi^2
		VOLUME		
Ml	Milliliters	0.034	fluid ounces	fl oz
L	Liters	0.264	gallons	gal
m^3	cubic meters	35.314	cubic feet	ft^3
m^3	cubic meters	1.307	cubic yards	yd^3
		MASS		
G	Grams	0.035	ounces	oz
Kg	Kilograms	2.202	pounds	lb
Mg (or "t")	megagrams (or "metric ton")	1.103	short tons (2000 lb)	T
		TEMPERATURE	Temperature is in exact degrees	
°C	Celsius	1.8C + 32	Fahrenheit	°F
		ILLUMINATION		
Lx	Lux	0.0929	foot-candles	fc
cd/m^2	candela/m^2	0.2919	foot-Lamberts	fl
		Force & Pressure or Stress		
N	Newtons	0.225	poundforce	lbf
kPa	Kilopascals	0.145	poundforce per square inch	lbf/in^2

* SI is the symbol for the International System of Units. Appropriate rounding should be made to comply with Section 4 of ASTM E380.
(Revised March 2003, Section 508-accessible version September 2009)

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LIST OF ACRONYMS

CY	calendar year
FMCSA	Federal Motor Carrier Safety Administration
FY	fiscal year
MCMIS	Motor Carrier Management Information System
MCSAP	Motor Carrier Safety Assistance Program
VSAS	Violation Severity Assessment Study

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EXECUTIVE SUMMARY

INTRODUCTION

Roadside Inspection and Traffic Enforcement are two key Federal Motor Carrier Safety Administration (FMCSA) safety programs. Roadside inspections are performed by qualified safety inspectors following the guidelines of the North American Standard, which were developed by FMCSA and the Commercial Vehicle Safety Alliance. Most roadside inspections are conducted by the States under the Motor Carrier Safety Assistance Program (MCSAP). There are six levels of inspections that include a vehicle component, a driver component, or both. The traffic enforcement program has two distinct activities: a traffic stop as a result of a moving violation and a roadside inspection with at least one traffic violation.

FMCSA has adopted an analytical model to measure the effectiveness of roadside inspections and traffic enforcements in terms of crashes avoided, injuries avoided, and lives saved. This analytical model is known as the Intervention Model. The model provides FMCSA management with information to address the requirements of the Government Performance and Results Act of 1993, which obligates Federal Agencies to measure the effectiveness of their programs as part of the budget cycle process. It also provides FMCSA and State safety program managers with a quantitative basis for optimizing the allocation of safety resources in the field.

The Intervention Model is based on the premise that interventions to correct vehicle and/or driver violations, discovered as a result of roadside inspections or by traffic enforcement activity (combined with an inspection), directly and indirectly contribute to a reduction in crashes. Direct effects are based on the assumption that vehicle and/or driver violations discovered and then corrected as the result of interventions reduce the probability that these vehicles/drivers will be involved in subsequent crashes. Indirect effects are the by-products of carriers' increased awareness of FMCSA intervention and enforcement programs and the potential consequences that the programs could impose, if steps are not taken to ensure and/or maintain higher levels of safety.

RESULTS

The Intervention Model measures the effectiveness of the Roadside Inspection and Traffic Enforcement programs. When combined with the Compliance Review Effectiveness Model (http://ai.fmcsa.dot.gov/CarrierResearchResults/PDFs/ProgramEffectiveness/CREM_O6.pdf), the resulting performance measurement capability plays a significant role in resource allocation decisions regarding FMCSA's safety programs.

Table 1 presents the benefits of the two programs in the current analysis year (FY 2007) as well as 2 years of historical results (CY 2005 and FY 2006). The number of crashes avoided and lives saved have all increased in FY 2007 relative to FY 2006, but injuries avoided have decreased slightly in FY 2007 relative to FY 2006.

Table 1. Program Effectiveness 2005–2007

Benefits Associated with Various Activities	CY 2005	FY 2006	FY 2007
Crashes Avoided—Roadside Inspection	9,256	9,614	10,210
Crashes Avoided—Traffic Enforcement	9,215	10,139	9,761
Total	**18,471**	**19,754***	**19,971**
Injuries Avoided—Roadside Inspection	6,418	6,445	6,581
Injuries Avoided—Traffic Enforcement	6,390	6,797	6,292
Total	**12,807***	**13,241***	**12,873**
Lives Saved—Roadside Inspection	344	364	387
Lives Saved—Traffic Enforcement	343	384	369
Total	**687**	**748**	**756**

*Total number is different due to rounding in the calculations.

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1. METHODOLOGY

The Intervention Model is based on the premise that the Roadside Inspection and Traffic Enforcement programs directly and indirectly contribute to the reduction of truck and bus crashes. As a result, the model includes two submodels to measure these different effects. Direct effects are based on the assumption that vehicle and/or driver violations discovered and then corrected as the result of interventions (roadside inspections and traffic enforcements) 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 impose, if steps are not taken to ensure and/or maintain high levels of safety. Figure 1 provides an overview of the Intervention Model.

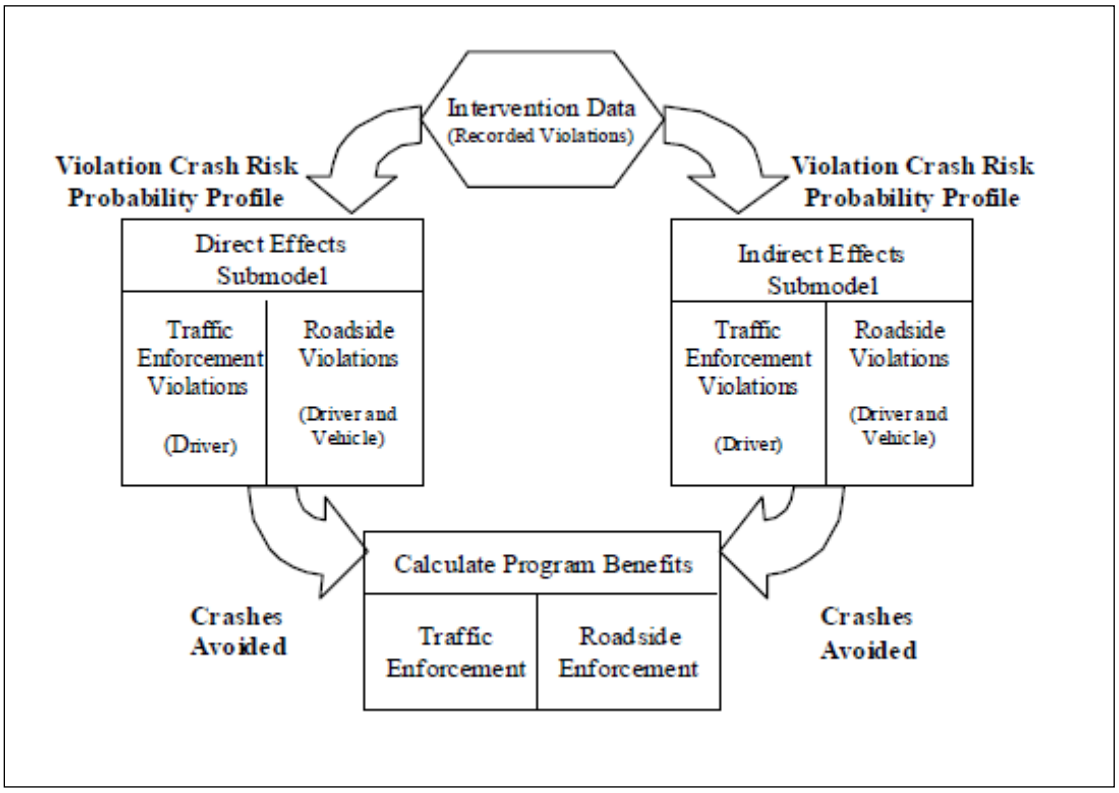

Figure 1. Overview of the Intervention Model

1.1 DIRECT EFFECTS SUBMODEL

This section describes the methodology employed to estimate the number of direct effect crashes avoided. Conceptually, the approach 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 may be interpreted as having reduced the risk associated 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 reduction in crash probability depends on the number and type of violations corrected. Multiple violations have a compounding effect that increases the likelihood of a 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, the Direct Effects Submodel estimates the number of crashes that have been avoided due to direct effects of the programs. The Direct Effects Submodel is composed of three major steps:

1. Input data selection.
2. Assignment of crash risk probabilities.
3. Calculation of direct results.

Input Data Selection. One fiscal year (defined as October 1 of the previous year through September 30 of the fiscal year referenced) of intervention data is extracted from the Motor Carrier Management Information System (MCMIS) database. This database contains roadside inspection and traffic enforcement information compiled from Federal and State safety agencies. These data also include the violations (if any) that were cited during the intervention. While interventions are not required to have violations associated with them, in practice about 70 percent of all interventions do have one or more violations.

These violation data are the key component in the model as they represent the problems that were identified and subsequently corrected as a part of the program. These data are also used in the determination of which interventions were conducted under the Traffic Enforcement program and which were conducted under the Roadside Inspection program. An inspection with a traffic enforcement violation is classified as traffic enforcement with a roadside inspection component. All other inspections are classified as entirely driver and/or vehicle roadside inspections.

Assignment of Crash Risk Probabilities. The model assumes that observed deficiencies (i.e., violations) discovered at the time of the intervention can be converted into crash risk probabilities. This assumption is based on the premise that detected violations represent varying degrees of mechanical or judgmental faults, and, further, that some are more likely than others to play a contributory role in motor carrier crashes. The assumption is that these deficiencies can be noted and ranked into discrete risk categories, each with a probability that quantifies the potential for a crash for all deficiencies in that category. The risk categories and their descriptions as defined by a 1998 study by Cycla Corp., are as follows:[(1)]

- Risk Category 1—The violation is the potential single, immediate factor leading to a crash.
- Risk Category 2—The violation is the potential single, eventual factor leading to a crash.
- Risk Category 3—The violation is a potential contributing factor leading to a crash.
- Risk Category 4—The violation is an unlikely potential contributing factor leading to a crash.
- Risk Category 5—The violation has little or no connection to crashes.

The risk categories were designed such that each category represents a different order of magnitude of likelihood of contributing to a crash. Using this information and the latest available data, crash risk probabilities were developed for each risk category by out-of-service indicator

and by violation type (driver or vehicle). Each probability is an estimate of the portion of a crash avoided when an inspection uncovers a particular violation or, conversely, the number of violations of that type that would need to be uncovered before one crash could be prevented. Crash risk probabilities are derived based on the premise that additional violations increase the risk of a crash by more than an additive risk factor.

Calculation of Direct Results. The likelihood of an inspection preventing a crash is calculated by using the crash reduction probabilities of each violation cited during the inspection. An inspection with multiple violations will have a greater likelihood of an avoided crash than will an inspection with a single violation, assuming all the violations are in the same risk category. This result reflects the belief that multiple violations compound the safety hazard posed from driver and/or vehicle deficiencies.

Once the number of crashes avoided for each inspection has been calculated, the next step is to compute the number of lives saved and injuries avoided as a result of those crashes avoided. This is done by first utilizing national historical data to determine the percentage of crashes that result in fatalities and injuries. The average number of fatalities per fatal crash, injuries per fatal crash, and injuries per injury crash are computed using MCMIS data. These averages are then multiplied by the number of fatal crashes avoided and injury crashes avoided, resulting in the number of lives saved and injuries avoided.

1.2 INDIRECT EFFECTS

The fundamental premise of the indirect effects approach is that once carriers have been exposed to interventions, 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 Indirect Effects Submodel follows a similar process 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 results 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 carrier performance in a base year to the year after in order to measure the effects of exposure to interventions in the base year on compliance. The estimate of crashes avoided is based on the number of interventions that record violations, so fewer violations recorded indicate reduced likelihood of a crash. The model uses changes in the number of violations recorded during inspections to identify and evaluate the indirect effects. Estimates of indirect effect crashes avoided are allocated to the program initiating the intervention: either the Roadside Inspection or Traffic Enforcement program. Figure 2 illustrates the processes involved in assessing the indirect effects of the model.

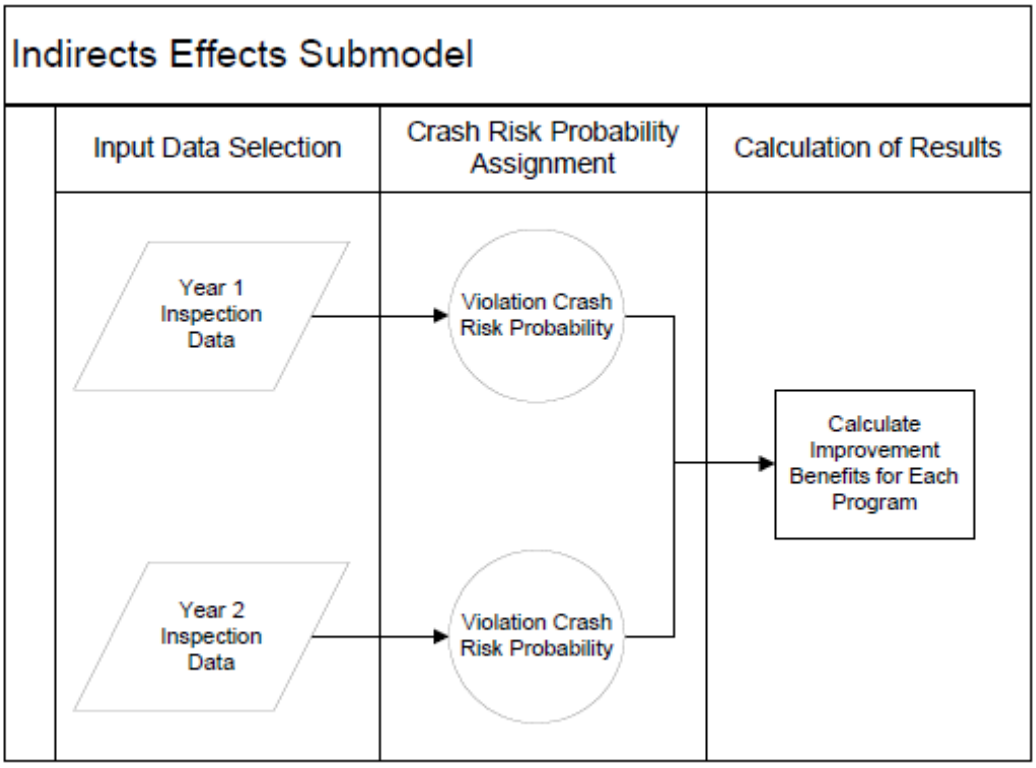

Figure 2. Indirect Effect Approach

Input Data Selection. Instead of 1 fiscal year of intervention data, like the Direct Effects Submodel, 2 fiscal years of intervention data are required. The first fiscal year of data selected is the base year. This is the year in which the effectiveness of the interventions will be estimated. The second fiscal year is the year after the base year and is used for comparison purposes in order to determine the change in carrier performance.

Crash Risk Probability Assignment. In this step, the 2 years of intervention data are analyzed and the violations are assigned to the appropriate risk categories.

Calculation of Results. The crashes avoided are calculated for both years of data by carrier for each program using the same algorithm as the Direct Effects Submodel. This is where the two submodels diverge in their approach. A standard set of filtering criteria is used to eliminate carriers with insufficient data for a comparison. Once the filtering is complete, the difference between the estimate of crashes avoided in the base year and the estimate of crashes avoided in the subsequent year is computed for each carrier and program. These carrier level results are then summed in order to arrive at program level results for the difference in crashes between the base year and the subsequent year. The change in crashes avoided is converted to a percentage difference and applied to the number of interventions conducted in the base year. The results of the computation are the estimated number of crashes avoided for each program. The determination of lives saved and injuries avoided is calculated the same way as it was for the direct effects. National averages of fatal and injury crash shares and number of fatalities per fatal crash, injuries per fatal crash, and injuries per injury crash are used to estimate lives saved and

injuries avoided. The safety benefits estimated by this part of the model represent the indirect effect of the intervention program activities conducted in the base year.

The only drawback to this method of calculating the indirect effects is that it requires an additional year of data after the activity year. For example, in order to compute the indirect effects for the fiscal year (FY) 2007 interventions requires FY 2008 intervention data as well. Instead of waiting until these data are available to release results, an average of the prior 2 years indirect effects benefits (as a percentage of the total benefits) is used to project the indirect effects. For example, to project the indirect benefits for the Roadside Inspection program for FY 2007 the percents of indirect benefits in the Roadside Inspection program for the previous 2 years are averaged. Once the additional year of activity data is available, the indirect effect benefits are updated and used in the subsequent years' calculations.

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2. FISCAL YEAR 2007 INTERVENTION MODEL RESULTS

The model was implemented to estimate the crashes avoided, lives saved, and injuries avoided as a result of activities performed during FY 2007 (October 1, 2006–September 30, 2007). The direct effects were calculated as described in the previous section. FY 2007 is the second year the Intervention Model was implemented to estimate benefits using the interventions performed by fiscal year; previous years were implemented by calendar year (CY). The indirect effects for each program were projected from an average of the indirect effects in FY 2005 and FY 2006, which accounted for 22.16 percent of the total Roadside Inspection program benefits and 16.29 percent of the total Traffic Enforcement program benefits. The direct and indirect results are combined and presented at two different levels, the National level and the State level.

2.1 NATIONAL LEVEL

Table 2 provides a comparison of the program activity level at the National level for the current analysis year (FY 2007) as well as 2 historical years (CY 2005 and FY 2006). Program exposure was higher in FY 2007 than in the previous 2 years. In FY 2007, roadside inspections rose approximately 10.29 percent and traffic enforcements decreased approximately 16.40 percent compared to FY 2006. Note that this table and many others throughout this document compare CY 2005 through FY 2006 with FY 2007.

Table 2. Program Exposure 2005–2007

Activity	CY 2005	FY 2006	FY 2007
Total Roadside Inspections	2,194,567	2,372,802	2,616,868
Total Traffic Enforcements	827,719	900,260	752,649
Total Interventions	**3,022,286**	**3,273,062**	**3,369,517**

Table 3 presents the benefits of the two programs in the current analysis year (FY 2007) as well as 2 years of historical results (CY 2005–FY 2006). The number of crashes avoided and lives saved have all increased in FY 2007 relative to FY 2006, but injuries avoided have decreased slightly in FY 2007 relative to FY 2006.

Table 3. Program Effectiveness 2005–2007

Benefits Associated with Various Activities	CY 2005	FY 2006	FY 2007
Crashes Avoided—Roadside Inspection	9,256	9,614	10,210
Crashes Avoided—Traffic Enforcement	9,215	10,139	9,761
Total	**18,471**	**19,754***	**19,971**
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Total	**12,807***	**13,241***	**12,873**
Lives Saved—Roadside Inspection	344	364	387
Lives Saved—Traffic Enforcement	343	384	369
Total	**687**	**748**	**756**

*Total number is different due to rounding in the calculations.

Figure 3 displays the trends in estimated crashes avoided and lives saved, from CY 2000 to FY 2007. In FY 2007, the number of crashes avoided increased from the previous years, while the lives saved also increased slightly compared to most recent years.

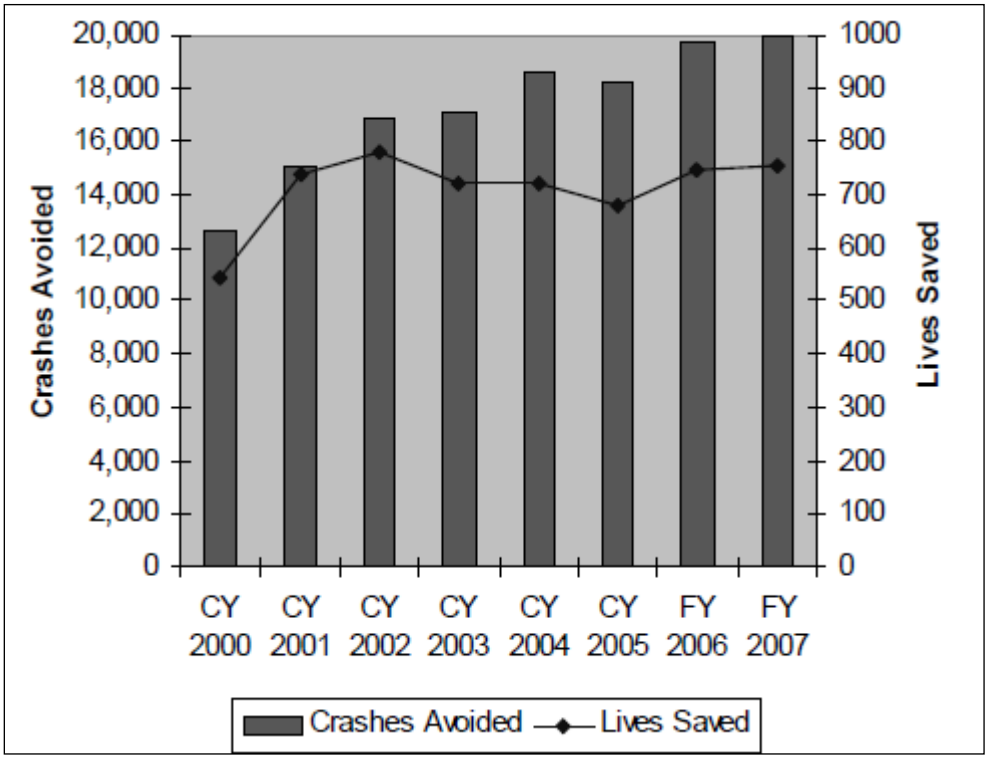

Figure 3. Crashes Avoided and Lives Saved Trends

2.2 ESTIMATES BY GEOGRAPHIC LOCATION

The model's flexibility lends itself to finer divisions of examination, such as scrutiny by report State or by carrier domicile State, which then can be used to guide the allocation of MCSAP resources and the design of State safety programs. State level totals are now available by both

report State and carrier domicile State. State level reporting is important because National totals may obscure State level trends.

Reporting State. Table 8 (Appendix A) provides detailed results organized by reporting State for interventions conducted:

- In all 50 States.
- In the District of Columbia, American Samoa, the Northern Mariana Islands.
- Puerto Rico.
- By Federal staff.

This table provide intervention counts, total estimated benefits (crashes avoided, injuries avoided, lives saved), and normalized estimated benefits (benefits per 1,000 interventions).

U.S. vs. Non-U.S. Locations. For the second year the Intervention Model compares program effectiveness between carriers domiciled in the United States and those carriers domiciled outside of the U.S.

Table 4 displays the number of roadside inspections and traffic enforcements performed on U.S. domiciled carriers to those domiciled outside of the United States for FY 2007.

Table 4. FY 2007 Program Exposure U.S. Domiciled vs. Non-U.S. Domiciled

Activity	U.S.	Non-U.S.
Roadside Inspections	2,334,813	282,055
Traffic Enforcements	726,901	25,748
Total Interventions	**3,061,714**	**307,803**

Table 5 compares the effectiveness of interventions conducted in FY 2007 on carriers domiciled in the U.S. to non-U.S. domiciled carriers. Since the exposure for U.S. domiciled carriers is almost 10 times that of non-U.S. domiciled carriers, the table also includes the estimated program benefits per 1,000 interventions.

Table 5. FY 2007 Program Effectiveness U.S. Domiciled vs. Non-U.S. Domiciled

Benefits Associated with Various Activities	Total Benefits U.S.	Total Benefits Non-U.S.	Benefits per 1,000 Interventions U.S.	Benefits per 1,000 Interventions Non-U.S.
Crashes Avoided—Roadside Inspection	8,493	1,717	3.64	6.09
Crashes Avoided—Traffic Enforcement	9,555	206	13.14	8.00
Total	**18,048**	**1,923**	**5.89**	**6.25**
Injuries Avoided—Roadside Inspection	5,474	1,107	2.34	3.92
Injuries Avoided—Traffic Enforcement	6,159	133	8.47	5.17
Total	**11,633**	**1,240**	**3.80**	**4.03**
Lives Saved—Roadside Inspection	321	65	0.14	0.23
Lives Saved—Traffic Enforcement	362	8	0.50	0.31
Total	**683**	**73**	**0.22**	**0.24**

In comparison, U.S. carriers have many more inspections than non-U.S. domiciled carriers, and therefore the crashes avoided, injuries avoided, and lives saved are much higher. Comparing the estimated program benefits per 1,000 interventions, the non-U.S. carriers have a higher rate of crashes avoided for roadside inspections while the U.S. carriers have a much higher rate of crashes avoided per traffic enforcement. Overall, the benefit in terms of crashes avoided per 1,000 interventions is slightly larger for non-U.S. carriers at 6.25.

For more details on domicile State, Table 10 (Appendix A) provide detailed results organized by carrier domiciled outside of the U.S. for interventions conducted, specifically those registered in Canada, Mexico, and other countries. This table provides intervention counts, total estimated benefits (crashes avoided, injuries avoided, lives saved), and normalized estimated benefits (benefits per thousand interventions).

3. ANALYSIS

This section is devoted to the analysis of the model results. The number of interventions performed increased by about 3 percent in the current analysis year (FY 2007) as compared with the previous year (FY 2006). The increased interventions resulted in about a 1 percent increase in the number of crashes avoided from FY 2006. As previously discussed, the lives saved and injuries avoided are calculated directly from the crashes avoided. The lives saved increased by approximately 1 percent from FY 2006 while the injuries avoided decreased by about 2.8 percent. The reason for the differences is further explored in the following sections.

3.1 PROGRAM ACTIVITY

The activity data reveal that roadside inspections and traffic enforcements (Table 2) have changed in different ways. The number of roadside inspections increased by 244,066, 10.3 percent, and the number of traffic enforcements decreased by 147,611 (-16.40 percent), between FY 2006 and FY 2007. The crashes avoided due to roadside inspections in FY 2007 rose by 59 (6.20 percent), relative to FY 2006, while the crashes avoided due to traffic enforcement decreased by 378 (-3.73 percent) relative to FY 2006.

The Traffic Enforcement Program's declining contribution to the crashes avoided relative to the Roadside Inspection Program can be attributed to the changes in the traffic enforcement violation codes. In 2007, the violations assigned to the traffic enforcement category were significantly changed. A number of violations were removed from this category and a few new ones were added. While most of the changes had minimal influence in the overall number, one of the changes, the removal of violation code 392.2W (Size and Weight) made a significant impact. This change removed more than 300,000 violations that were considered traffic enforcement violations and assigned them as roadside inspection violations.

3.2 CRASH SEVERITY TRENDS

National averages of crash severity are used to determine the injuries avoided and lives saved as a result of crashes avoided. The number of lives saved in FY 2007 increased by about 1 percent, relative to FY 2006, while the injuries avoided decreased by about 3 percent. There is an overall decreasing trend in the percentage of fatal and injury crashes from CY 2002 to FY 2007. The percentage of injury crashes has shown a decrease in every year analyzed, with a greater than 7 percent decrease from CY 2002 to FY 2007. Meanwhile, the towaway crashes have shown a steady increase, which may be a result of safer roadways and vehicles or due to the FMCSA's emphasis on reporting these crashes.

An analysis of trends in the 2-year average of fatal, injury, and towaway crash shares show that the fatal crash share remained relatively unchanged. However, the towaway crash share increased while the injury crash share saw a large decrease.

Since 2002, there have also been declines in the number of fatalities per fatal crash, injuries per fatal crash, and injuries per injury crash. These metrics measure the severity of crashes with casualties. The trends in crash severity explain the decline of injuries avoided from FY 2006 to FY 2007. The injury crash severity share is decreasing, and there has been a decline in the number of injuries per crash. With both metrics declining, the overall number of injuries avoided also declines.

3.3 INDIRECT EFFECT TRENDS

The increase in the number of crashes avoided occurs in spite of the fluctuations in the contribution of indirect effects over the most recent years in the Roadside Inspection program. This helps explain why the increase in roadside inspections has not always carried over to a proportional increase in the number of crashes avoided from the Roadside Inspection program.

Table 6 compares the direct and indirect crashes avoided due to the Roadside Inspection program between FY 2005 and FY 2007. The crashes avoided due to the Direct Effects Submodel have been increasing, while the Indirect Effects Submodel shares have stayed relatively the same.

Table 6. Roadside Inspection Program Benefits FY 2005–FY 2007

Benefit	FY 2005 Crashes Avoided	FY 2005 % of Total	FY 2006 Crashes Avoided	FY 2006 % of Total	FY 2007 Crashes Avoided	FY 2007 % of Total
Direct	7,153	78.53%	7,505	77.16%	7,947	77.84%
Indirect	1,956	21.47%	2,222	22.84%	2,262	22.16%
Total	**9,109**	**–**	**9,727**	**–**	**10,210**	**–**

Table 7 compares the direct and indirect crashes avoided due to the Traffic Enforcement Program between FY 2005 and FY 2007.

Table 7. Traffic Enforcement Program Benefits FY 2005–FY 2007

Benefit	FY 2005 Crashes Avoided	FY 2005 % of Total	FY 2006 Crashes Avoided	FY 2006 % of Total	FY 2007 Crashes Avoided	FY 2007 % of Total
Direct	7,910	84.19%	8,746	83.24%	8,172	83.71%
Indirect	1,485	15.81%	1,761	16.76%	1,590	16.29%
Total	**9,395**	**–**	**10,507**	**–**	**9,761**	**–**

The 2-year average of indirect effects is used to project future indirect effects because this smoothes out any year-to-year fluctuations. To project indirect effects for FY 2007, a 2-year average of the indirect effects in FY 2005 and FY 2006 is calculated. Table 8 displays these 2-year averages for both programs.

Table 8. 2-Year Average of Indirect Benefits as a Percentage of Total Crashes

Activity	CY 2003–CY 2004	FY 2004–FY 2005	FY 2005–FY 2006
Roadside Inspections	22.72%	21.94%	22.16%
Traffic Enforcements	14.17%	13.74%	16.29%

Figure 4 displays the 2-year average contribution of indirect effect benefits of the Roadside Inspection and Traffic Enforcement Programs graphically.

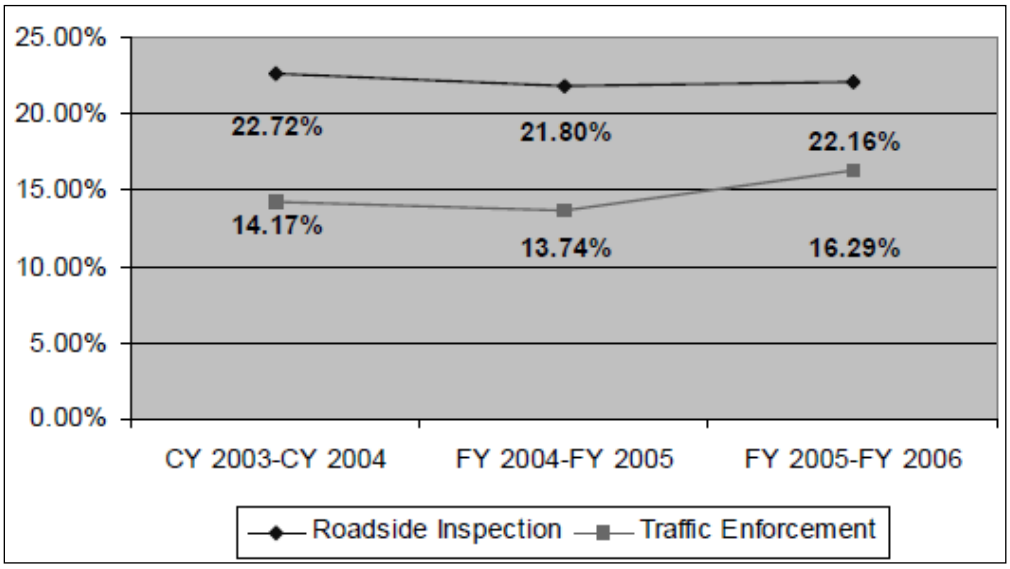

Figure 4. 2-Year Average of Indirect Benefits

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4. SUMMARY

The Intervention Model has shown an increase in the number and percentage of crashes avoided and lives saved, but also has shown a decrease in injuries avoided. The Roadside Inspection Program has shown a greater contribution than the Traffic Enforcement Program to crashes avoided, injuries avoided and lives saved, relative to other years. This is due to the increase in roadside inspection interventions, the increase in the marginal contribution of each roadside inspection to all factors, and the change in the violation code for Traffic Enforcement interventions. The number of injuries avoided overall is not as large as one would expect; that is a product of the decrease in the share of injury crashes as well as the reduced number of injuries per injury crash and injuries per fatal crash.

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5. FUTURE ENHANCEMENTS

Several enhancements are planned for future implementations of the Intervention Model. Currently, the model uses crash risk probabilities based on the Cycla study;[1] however, FMCSA has recently concluded the Violation Severity Assessment Study (VSAS), which uses data-driven statistical techniques to assess the crash risk of violations. The VSAS approach will be incorporated as appropriate into a revised methodology for determining crash risk probabilities for the Intervention Model to produce more realistic results.

Next, the effect of multiple violations cited in one intervention will be explored to determine the increased risk associated with the second, third, fourth, and additional violations to improve on the current method of handling interventions with multiple violations.

Lastly, the Intervention Model's assumption of a 100 percent violation correction rate will be examined, as it is unrealistic to believe that every violation found during an intervention is corrected immediately. In summary, the Intervention Model methodology may be enhanced by:

- Incorporating the VSAS approach to improve the crash risk probabilities
- Revising the current method of assigning additional risk when multiple violations are cited in the same intervention.
- Adopting a more realistic violation correction rate.

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APPENDIX A. DATA TABLES 9–10

Table 9. Roadside Inspection and Traffic Enforcement Program Benefits by Reporting State

Report State	Total Initiating Interventions	Number With Violations	% of Total	*Crashes Avoided	*Injuries Avoided	*Lives Saved	*Rank	†Crashes Avoided	†Injuries Avoided	†Lives Saved	†Rank
Alabama	33,649	26,270	78.07	188.78	121.69	7.15	33	5.61	3.62	0.21	26
Alaska	10,019	4,969	49.60	33.65	21.70	1.27	50	3.36	2.17	0.13	46
American Samoa	813	393	48.34	2.12	1.38	0.09	56	2.61	1.70	0.11	51
Arizona	62,126	50,656	81.54	802.65	517.38	30.38	3	12.92	8.33	0.49	6
Arkansas	43,884	30,007	68.38	318.71	205.45	12.07	25	7.26	4.68	0.28	17
California	495,641	256,848	51.82	1,099.36	708.64	41.60	2	2.22	1.43	0.08	55
Colorado	51,288	35,755	69.71	370.28	238.67	14.02	20	7.22	4.65	0.27	18
Connecticut	19,793	17,359	87.70	243.72	157.09	9.22	28	12.31	7.94	0.47	8
Delaware	6,245	4,745	75.98	38.79	25.02	1.48	48	6.21	4.01	0.24	21
District Of Columbia	6,893	3,955	57.38	30.88	19.90	1.18	52	4.48	2.89	0.17	37
Federal	114,214	76,253	66.76	388.97	250.71	14.71	18	3.41	2.20	0.13	47
Florida	101,113	74,208	73.39	636.26	410.14	24.08	8	6.29	4.06	0.24	22
Georgia	88,079	74,527	84.61	731.14	471.28	27.69	4	8.30	5.35	0.31	14
Guam	377	207	54.91	4.83	3.11	0.20	54	12.81	8.25	0.53	3
Hawaii	4,343	2,545	58.60	27.21	17.53	1.04	53	6.27	4.04	0.24	23
Idaho	9,985	8,632	86.45	152.07	98.02	5.77	36	15.23	9.82	0.58	2
Illinois	83,611	59,857	71.59	382.33	246.45	14.48	19	4.57	2.95	0.17	38
Indiana	71,751	63,528	88.54	403.18	259.89	15.27	17	5.62	3.62	0.21	27
Iowa	65,310	53,804	82.38	208.59	134.44	7.91	31	3.19	2.06	0.12	50
Kansas	47,303	32,823	69.39	241.84	155.88	9.17	29	5.11	3.30	0.19	32
Kentucky	83,078	45,667	54.97	357.39	230.37	13.54	22	4.30	2.77	0.16	43
Louisiana	51,754	44,486	85.96	231.01	148.90	8.74	30	4.46	2.88	0.17	39
Maine	20,750	13,838	66.69	101.63	65.51	3.84	40	4.90	3.16	0.19	33
Maryland	99,293	63,836	64.29	469.28	302.49	17.77	15	4.73	3.05	0.18	35
Massachusetts	21,471	16,655	77.57	138.39	89.20	5.24	38	6.45	4.15	0.24	24
Michigan	75,620	62,471	82.61	525.92	339.00	19.91	11	6.95	4.48	0.26	19

Report State	Total Initiating Interventions	Number With Violations	% of Total	*Crashes Avoided	*Injuries Avoided	*Lives Saved	*Rank	†Crashes Avoided	†Injuries Avoided	†Lives Saved	†Rank
Minnesota	50,305	31,113	61.85	690.93	445.35	26.16	7	13.73	8.85	0.52	4
Mississippi	55,276	28,257	51.12	189.85	122.37	7.18	32	3.43	2.21	0.13	48
Missouri	75,945	55,755	73.41	727.81	469.13	27.56	5	9.58	6.18	0.36	11
Montana	35,172	18,876	53.67	98.07	63.21	3.72	41	2.79	1.80	0.11	52
Nebraska	42,908	26,160	60.97	128.78	83.02	4.89	39	3.00	1.93	0.11	53
Nevada	30,958	21,226	68.56	170.83	110.11	6.48	35	5.52	3.56	0.21	28
New Hampshire	9,302	6,527	70.17	41.13	26.52	1.56	47	4.42	2.85	0.17	40

*Estimated Totals

†Estimated Totals/1,000 Inspections

Table 10. Roadside Inspection and Traffic Enforcement Benefits by Carrier Domicile Non-U.S. Country

Carrier State	Total Initiating Interventions	Number With Violations	% of Total	*Crashes Avoided	*Injuries Avoided	*Lives Saved	†Crashes Avoided	†Injuries Avoided	†Lives Saved
Panama	4	4	100.00	0.18	0.12	0.01	44.96	28.90	3.21
Nicaragua	10	7	70.00	0.14	0.09	0.00	13.95	8.90	0.00
Mexico	201,049	162,551	80.85	1,608.87	1,037.07	61.00	8.00	5.16	0.30
Honduras	29	29	100.00	0.53	0.34	0.03	18.39	11.84	0.89
Guatemala	476	441	92.65	6.24	4.02	0.24	13.10	8.44	0.51
El-Salvador	288	228	79.17	4.91	3.17	0.19	17.03	11.00	0.67
Costa Rico	21	21	100.00	0.28	0.19	0.01	13.29	9.05	0.61
Canada	104,690	63,419	60.58	285.05	183.77	10.82	2.72	1.76	0.10
Belize	33	32	96.97	0.85	0.55	0.04	25.81	16.58	1.17
Unknown	1,203	1,139	94.68	15.83	10.21	0.60	13.16	8.49	0.50
Total	**307,803**	**227,871**	**94.68**	**1,922.88**	**1,239.53**	**72.94**	**6.25**	**4.03**	**0.24**

*Estimated Totals

†Estimated Totals/1,000 Inspections

REFERENCES

1. Cycla Corporation. (1998). *Risk-based Evaluation of Commercial Motor Vehicle Roadside Violations: Process and Results*. Washington, DC: U.S. Department of Transportation, Federal Highway Administration, Office of Motor Carriers.