FMCSA Safety Program Effectiveness Measurement: Intervention Model Fiscal Year 2009

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

April 2013

FOREWORD

The Federal Motor Carrier Safety Administration (FMCSA), in cooperation with the researcher, has developed an analytic model to measure the effectiveness of roadside inspections and traffic enforcements in terms of crashes avoided, injuries avoided, and lives saved. Traffic enforcements and roadside inspections are considered interventions, and this analytic model is known as the Intervention Model. It provides FMCSA management with information to address 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. It also provides FMCSA and State safety program managers with a quantitative basis for optimizing the allocation of safety resources in the field.

NOTICE

Technical Report Documentation Page

1. Report No. **RRA-13-039**	2. Government Accession No.	3. Recipient's Catalog No.
4. Title and Subtitle **FMCSA Safety Program Effectiveness Measurement: Intervention Model Fiscal Year 2009**		5. Report Date **April 2013**
		6. Performing Organization Code
7. Author(s) **Gillham, Olivia; Horton, Suzanne; Schwenk, Judith**		8. Performing Organization Report No.
9. Performing Organization Name and Address **John A. Volpe National Transportation Systems Center** **Safety Management Systems Center of Innovation** **System Measurement and Analysis Division** **55 Broadway** **Cambridge, MA 02142**		10. Work Unit No. (TRAIS)
		11. Contract or Grant No.
12. Sponsoring Agency Name and Address **U.S. Department of Transportation** **Federal Motor Carrier Safety Administration** **Office of Analysis, Research, and Technology** **1200 New Jersey Ave., SE** **Washington, DC 20590**		13. Type of Report and Period Covered **Executive Summary**
		14. Sponsoring Agency Code **FMCSA**
15. Supplementary Notes **Contracting Officer's Technical Representative: Richard Gruberg**		

16. Abstract

The Federal Motor Carrier Safety Administration (FMCSA), in cooperation with the researcher, has developed an analytic model to measure the effectiveness of roadside inspections and traffic enforcements in terms of crashes avoided, injuries avoided, and lives saved. Traffic enforcements and roadside inspections are considered interventions and this analytic model is known as the Intervention Model. This model provides FMCSA management with information to address the requirements of the Government Performance and Results Act of 1993 (GRPA), 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.

17. Key Words **CMV, Commercial motor vehicle, crash avoidance, enforcement, inspections, intervention, roadside**	18. Distribution Statement **No restrictions**		
19. Security Classif. (of this report) **Unclassified**	20. Security Classif. (of this page) **Unclassified**	21. No. of Pages **48**	22. Price

Form DOT F 1700.7 (8-72) Reproduction of completed page authorized.

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	milometers	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	1,000 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 (2,000 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 and 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 (2,000 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.)

TABLE OF CONTENTS

LIST OF APPENDIXES

LIST OF FIGURES (AND FORMULAS)

LIST OF TABLES

ABBREVIATIONS AND ACRONYMS

Acronym	Definition
CRP	crash rate probability
CSA	Compliance, Safety, Accountability
CVSA	Commercial Vehicle Safety Alliance
CY	calendar year
FMCSA	Federal Motor Carrier Safety Administration
FY	fiscal year
GPRA	Government Performance and Results Act of 1993
MCMIS	Motor Carrier Management Information System
VSAS	Violation Severity Assessment Study

[This page intentionally left blank.]

EXECUTIVE SUMMARY

BACKGROUND

The Roadside Inspection and Traffic Enforcement Programs are two key Federal Motor Carrier Safety Administration (FMCSA) safety programs. The Roadside Inspection Program consists of roadside inspections performed by qualified safety inspectors following the guidelines of the North American Standard, developed by FMCSA and the Commercial Vehicle Safety Alliance (CVSA). Most roadside inspections are conducted by the States under the Motor Carrier Safety Assistance Program (MCSAP). This program has six levels of inspections, including a vehicle component, a driver component, or both. The Traffic Enforcement Program is composed of two distinct activities: a traffic stop as a result of a moving violation and a subsequent roadside inspection.

FMCSA developed an analytic model to measure the effectiveness of roadside inspections and traffic enforcements in terms of crashes avoided, injuries avoided, and lives saved. This model is known as the Intervention Model. In this model, traffic enforcements and roadside inspections are considered interventions.

The model is based on the premise that interventions resulting in the correction of vehicle and driver violations, specifically roadside inspections and traffic enforcements, contribute to a reduction in crashes. The model associates each violation of the Federal Motor Carrier Safety Regulations and Federal Hazardous Materials Regulations with a specific crash probability. Using these probabilities, the number of crashes avoided as a result of correcting these violations can be estimated.

Additionally, the Intervention Model provides FMCSA management with information to address the Government Performance and Results Act of 1993 (GPRA), which requires 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 model can be combined with the Compliance Review Effectiveness Model (http://ai.fmcsa.dot.gov/pe/CompliancePg.aspx) to provide a powerful performance measurement tool for assessing FMCSA's safety programs.

Since the occurrence of a single violation implies a certain degree of crash risk, each inspection that uncovers and corrects at least one violation can be interpreted as having reduced crash risk. The model expresses this risk reduction in terms of the elimination of specific crash probabilities associated with each violation corrected. For an individual intervention, the reduction in crash risk depends on the number and type of violations found. By summing the crash risk probabilities for all violations corrected over all inspections, the model estimates the number of crashes avoided as a result of the Roadside Inspection and Traffic Enforcement Programs.

One fiscal year (FY) (defined as October 1 of the previous year through September 30 of the FY referenced) of intervention data is extracted from the Motor Carrier Management Information

System (MCMIS) database. This database contains roadside inspection information compiled from Federal and State safety agencies, including violations (if any) cited during interventions. While inspections are not required to have violations associated with them, in practice, about two-thirds of all interventions do find one or more violations. The violation data are the key component in the model, as they represent the defects identified and subsequently corrected as a result of the two programs.

The model employs three estimates in developing the crash risk reduction probability for a violation group:

- The *crash risk* for violations in the group is defined as the likelihood that the unsafe behavior associated with the violation contributes to a crash during a commercial motor vehicle (CMV) daytrip. (A "daytrip" is defined as a CMV's travel during 1 day.)
- The *duration* of the reduction in crash risk when a violation in the group is identified at the roadside and corrected. The duration of the risk reduction varies according to the violation group to which the violation is assigned.
- The *correction rate* for violations in the group that are corrected as a result of the intervention.

A preliminary crash risk reduction for a violation group is calculated from the product of the crash rate probability (CRP) and the violation group's duration. The preliminary crash risk reduction is then multiplied by a violation correction rate to produce the final crash risk reduction for each violation in the violation group. The violation correction rate adjusts for the reality that not all violations are corrected within the required time period. Preliminary research indicates that only 69.9 percent of Vehicle Maintenance violations and 68.8 percent of Driver Fitness violations are corrected within the allotted time.[1] The violation correction rate thus decreases the magnitude of the crash risk reduction used in the model, to account for violations not corrected.

CALCULATION OF BENEFITS

To produce an estimate of the annual number of crashes avoided due to inspections, the model first determines the number of inspections for each violation group in which a violation was recorded during the FY. The inspection count is then multiplied by the final crash risk reduction associated with the violation group, yielding the estimate of annual crashes avoided. Lastly, the estimated crashes avoided are added up across all violation groups to produce an estimate of the total annual crashes avoided during the FY.

Once the number of crashes avoided is totaled for all inspections during the year, the model then computes the number of lives saved and injuries avoided as a result of those crashes avoided. Average numbers of fatalities per crash, injuries per crash, and injuries per fatal crash are

[1] See the SMS Factsheet for descriptions and examples of Vehicle Maintenance and Driver Fitness violations: http://csa.fmcsa.dot.gov/Documents/SMS_factsheet.pdf.

computed using MCMIS data for all crashes in the United States for the year. These averages are then multiplied by the number of crashes avoided to estimate the number of lives saved and injuries avoided due to the inspections.

FY 2009 INTERVENTION MODEL RESULTS

Total crashes avoided, total lives saved, and total injuries avoided as a result of roadside inspection and traffic enforcement activities performed during FY 2009 were estimated by the Intervention Model. The results are presented at the national and State levels. Beginning in FY 2006, the Intervention Model was implemented to estimate benefits from roadside interventions by fiscal year; previous years were implemented by calendar year (CY). As a result, estimates of benefits for years 2005 and earlier are shown by CY.

NATIONAL LEVEL ESTIMATES

Table 1 provides a breakdown of the program activity at the national level for the current analysis year (FY 2009) and the 2 years prior (FY 2007 and FY 2008). Program activity was higher in FY 2009 than in the 2 previous years. The number of interventions performed increased by about 1.1 percent from FY 2008, roadside inspections rose by 65,152 (2.4 percent), and traffic enforcements decreased by 25,253 (3.3 percent).

Table 1. Program Activity FY 2007–09

Interventions	FY 2007	FY 2008	FY 2009
Roadside Inspections	2,616,868	2,723,576	2,788,728
Traffic Enforcements	752,649	756,169	730,916
Total	***3,369,517***	***3,479,745***	***3,519,644***

Table 2 presents the estimated benefits of the two programs over the past 3 years. The model estimates that the Roadside Inspection Program prevented 8,149 crashes in FY 2009, while the Traffic Enforcement Program prevented 8,789, for a total of 16,939 crashes avoided. The number of crashes avoided decreased from FY 2008 to FY 2009, even as the total number of interventions increased, because the proportion of inspections resulting in no violations also increased (from 32 percent to 34 percent). Because more roadside inspections found no violations, the average number of violations per inspection decreased from 2.14 in 2008 to 2.07 in 2009. Traffic enforcement interventions are an exception: they prevented *more* crashes per intervention in FY 2009 than in FY 2008, but prevented fewer crashes overall because the total number of these interventions decreased.

Table 2. Program Effectiveness FY 2007–09 Using Intervention Model 3.0

Estimated Intervention Benefits	FY 2007	FY 2008	FY 2009
Crashes Avoided Due to Roadside Inspections	8,101	8,464	8,149
Crashes Avoided Due to Traffic Enforcements	8,769	9,053	8,789
Total Crashes Avoided	***16,870***	***17,517***	***16,939***
Injuries Avoided Due to Roadside Inspections	5,222	5,381	5,206
Injuries Avoided Due to Traffic Enforcements	5,652	5,755	5,615
Total Injuries Avoided	***10,874***	***11,136***	***10,821***
Lives Saved Due to Roadside Inspections	307	304	276
Lives Saved Due to Traffic Enforcements	332	325	297
Total Lives Saved	***639***	***629***	***573***

CONCLUSION

The Roadside Inspection and Traffic Enforcement Programs are two of the FMCSA's most powerful safety tools. By continually examining the results of these programs, FMCSA can ensure that they are being executed effectively and are producing the desired safety benefits. Results for individual States can be examined and compared to provide guidance on how to allocate safety resources. The total national results show the scale of Roadside Inspection and Traffic Enforcement Programs and the magnitude of their effects on highway safety: in 2009, 2,781,297 roadside inspections and 730,916 traffic enforcements were conducted. Together, it is estimated that in FY 2009, these interventions saved approximately 570 lives and prevented 10,800 injuries by averting almost 17,000 crashes. Over the past 9 years, it is estimated that these two programs have saved almost 6,000 lives.

1. INTRODUCTION

1.1 BACKGROUND

The Roadside Inspection and Traffic Enforcement Programs are two key Federal Motor Carrier Safety Administration (FMCSA) safety programs. The Roadside Inspection Program consists of roadside inspections performed by qualified safety inspectors following the guidelines of the North American Standard, developed by FMCSA and the Commercial Vehicle Safety Alliance (CVSA). Most roadside inspections are conducted by the States under the Motor Carrier Safety Assistance Program (MCSAP). This program has six levels of inspections, including a vehicle component, a driver component, or both. The Traffic Enforcement Program is composed of two distinct activities: a traffic stop as a result of a moving violation and a subsequent roadside inspection.

FMCSA developed an analytic model to measure the effectiveness of roadside inspections and traffic enforcements in terms of crashes avoided, injuries avoided, and lives saved. This model is known as the Intervention Model. In this model, traffic enforcements and roadside inspections are considered interventions.

The model is based on the premise that interventions resulting in the correction of vehicle and driver violations, specifically roadside inspections and traffic enforcements, contribute to a reduction in crashes. The model associates each violation of the Federal Motor Carrier Safety Regulations and Federal Hazardous Materials Regulations with a specific crash probability. Using these probabilities, the number of crashes avoided as a result of correcting these violations can be estimated.

Additionally, the Intervention Model provides FMCSA management with information to address the Government Performance and Results Act of 1993 (GPRA), which requires 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 model can be combined with the Compliance Review Effectiveness Model (http://ai.fmcsa.dot.gov/pe/CompliancePg.aspx) to provide a powerful performance measurement tool for assessing FMCSA's safety programs.

[This page intentionally left blank]

2. METHODOLOGY

The Intervention Model is based on the premise that the Roadside Inspection and Traffic Enforcement programs contribute to the reduction of crashes by discovering vehicle and/or driver violations during interventions (roadside inspections and traffic enforcements). When these violations are corrected as the result of interventions, it reduces the probability that the vehicles/drivers will be involved in subsequent crashes.

Since the occurrence of a single violation implies a certain degree of crash risk, each inspection that uncovers and corrects at least one violation can be interpreted as reducing crash risk. The model expresses this risk reduction in terms of the elimination of specific crash probabilities associated with each violation corrected. For an individual intervention, the reduction in crash risk depends on the number and type of violations found. By summing the crash risk probabilities for all violations corrected over all inspections, the model estimates the number of crashes avoided as a result of the Roadside Inspection and Traffic Enforcement Programs.

2.1 INPUT DATA SELECTION

One fiscal year (FY) (defined as October 1 of the previous year through September 30 of the FY referenced) of intervention data is extracted from the Motor Carrier Management Information System (MCMIS) database. This database contains roadside inspection information compiled from Federal and State safety agencies, including violations (if any) cited during interventions. While inspections are not required to have violations associated with them, in practice, about two-thirds of all interventions do find one or more violations. The violation data are the key component in the model, as they represent the defects identified and subsequently corrected as a result of the two programs.

2.2 ASSIGNMENT OF CRASH RISK REDUCTION PROBABILITIES

The model assumes that observed deficiencies (i.e., violations) discovered at the time of an 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.

An improved methodology was developed for determining the crash risk associated with violations in Intervention Model Version 3.0, and implemented in FY 2008. The improved methodology uses applicable results of related FMCSA research, including the Violation Severity Assessment Study (VSAS),[2] as well as research performed for the Agency's Compliance, Safety, Accountability (CSA) initiative. The revised methodology is based on sound safety data and statistical approaches, as well as input from subject matter experts when empirical data are not available.

[2] http://www.regulations.gov/#!documentDtail;D=FMCSA-2004-18898-0210.

The Version 3.0 methodology introduced the concept of a violation group as developed by the CSA initiative.[3] A violation group is defined as a set of violations similar in nature and having equal crash risks. The model assumes that correcting a violation associated with a particular violation group during an intervention reduces the risk of a subsequent crash by a finite amount, equal to the crash risk probability (CRP) associated with that group.

The model employs three estimates in developing the crash risk reduction probability for a violation group:

- The *crash risk* for violations in the group is defined as the likelihood that the unsafe behavior associated with the violation contributes to a crash during a commercial motor vehicle (CMV) daytrip. (A "daytrip" is defined as a CMV's travel during 1 day.)
- The *duration* of the reduction in crash risk when a violation in the group is identified at the roadside and corrected. The duration of the risk reduction varies according to the violation group to which the violation is assigned.
- The *correction rate* for violations in the group that are corrected as a result of the intervention.

A preliminary crash risk reduction for a violation group is calculated from the product of the CRP and the violation group's duration. The preliminary crash risk reduction is then multiplied by a violation correction rate to produce the final crash risk reduction for each violation in the violation group. The violation correction rate adjusts for the reality that not all violations are corrected within the required time period. Preliminary research indicates that only 69.9 percent of Vehicle Maintenance violations and 68.8 percent of Driver Fitness violations are corrected within the allotted time.[4] The violation correction rate thus decreases the magnitude of the crash risk reduction used in the model to account for violations not corrected.

For a more detailed discussion of crash risk, duration, and correction rates and their derivations, see Appendix A.

2.3 CALCULATION OF BENEFITS

To produce an estimate of the annual number of crashes avoided due to inspections, the model first determines the number of inspections for each violation group in which a violation was recorded during the FY. The inspection count is then multiplied by the final crash risk reduction associated with the violation group, yielding the estimate of annual crashes avoided. Lastly, the estimated crashes avoided are added up across all violation groups to produce an estimate of the total annual crashes avoided during the FY.

[3] For more information about how the CSA initiative groups safety violations, see the Safety Measurement System Methodology at http://csa.fmcsa.dot.gov/Documents/SMSMethodology.pdf.

[4] See the SMS Factsheet for descriptions and examples of Vehicle Maintenance and Driver Fitness violations: http://csa.fmcsa.dot.gov/Documents/SMS_factsheet.pdf.

Once the number of crashes avoided is totaled for all inspections during the year, the model then computes the number of lives saved and injuries avoided as a result of those crashes avoided. Average numbers of fatalities per crash, injuries per crash, and injuries per fatal crash are computed using MCMIS data for all crashes in the United States for the year. These averages are then multiplied by the number of crashes avoided to estimate the number of lives saved and injuries avoided due to the inspections.

[This page intentionally left blank]

3. FY 2009 INTERVENTION MODEL RESULTS

Total crashes avoided, total lives saved, and total injuries avoided as a result of roadside inspection and traffic enforcement activities performed during FY 2009 were estimated by the Intervention Model. The results are presented at the national and State levels. Beginning in FY 2006, the Intervention Model was implemented to estimate benefits from roadside interventions by FY; previous years were implemented by calendar year (CY). As a result, estimates of benefits for years 2005 and earlier are shown by CY.

3.1 NATIONAL LEVEL ESTIMATES

Table 3 provides a breakdown of the program activity at the national level for the current analysis year (FY 2009) and the 2 years prior (FY 2007 and FY 2008). Program activity was higher in FY 2009 than in the 2 previous years. The number of interventions performed increased by about 1.1 percent from FY 2008, roadside inspections rose by 65,152 (2.4 percent), and traffic enforcements decreased by 25,253 (3.3 percent).

Table 3. Program Activity FY 2007–09

Interventions	FY 2007	FY 2008	FY 2009
Roadside Inspections	2,616,868	2,723,576	2,788,728
Traffic Enforcements	752,649	756,169	730,916
Total	***3,369,517***	***3,479,745***	***3,519,644***

Table 4 presents the estimated benefits of the two programs over the past 3 years. The model estimates that the Roadside Inspection Program prevented 8,149 crashes in FY 2009, while the Traffic Enforcement Program prevented 8,789, for a total of 16,939 crashes avoided. The number of crashes avoided decreased from FY 2008 to FY 2009, even as the total number of interventions increased, because the proportion of inspections resulting in no violations also increased (from 32 percent to 34 percent). Because more roadside inspections found no violations, the average number of violations per inspection decreased from 2.14 in 2008 to 2.07 in 2009. Traffic enforcement interventions are an exception: they prevented *more* crashes per intervention in FY 2009 than in FY 2008, but prevented fewer crashes overall because the total number of these interventions decreased.

Table 4. Program Effectiveness FY 2007–09 Using Intervention Model 3.0

Estimated Intervention Benefits	FY 2007	FY 2008	FY 2009
Crashes Avoided Due to Roadside Inspections	8,101	8,464	8,149
Crashes Avoided Due to Traffic Enforcements	8,769	9,053	8,789
Total Crashes Avoided	***16,870***	***17,517***	***16,939***
Injuries Avoided Due to Roadside Inspections	5,222	5,381	5,206
Injuries Avoided Due to Traffic Enforcements	5,652	5,755	5,615
Total Injuries Avoided	***10,874***	***11,136***	***10,821***
Lives Saved Due to Roadside Inspections	307	304	276
Lives Saved Due to Traffic Enforcements	332	325	297
Total Lives Saved	***639***	***629***	***573***

Figure 1 shows the trends in estimated crashes avoided and lives saved from CY 2004 to FY 2009.[5] All estimates prior to FY 2009 were recalculated as necessary using the most recent Intervention Model (Version 3.0) to provide an historical time series compatible with FY 2009 estimates. In FY 2009, the number of lives saved decreased from the previous years, while the number of crashes avoided remained relatively unchanged. Complete Version 3.0 results from CY 2004 to FY 2009 are shown in Table 5.

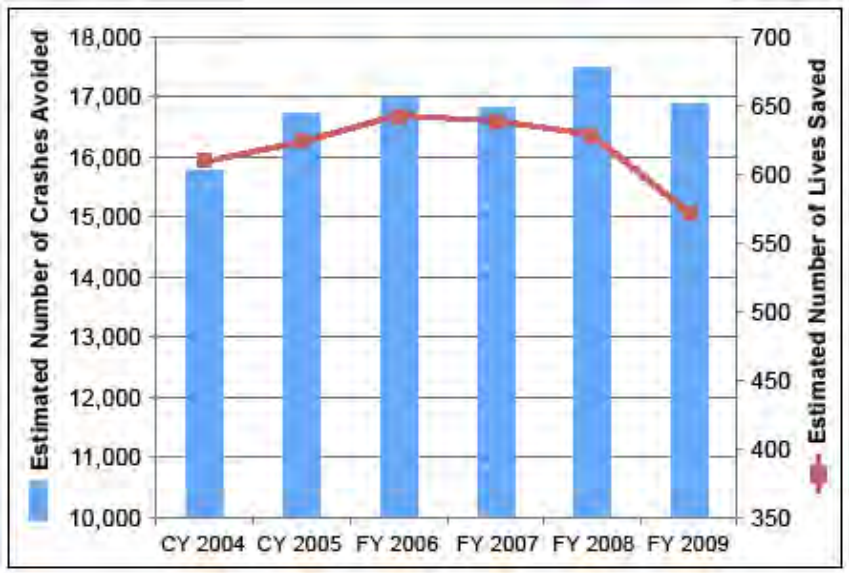


Figure 1. Estimated Number of Crashes Avoided and Lives Saved Trends, CY 2004–05 and FY 2006–09

[5] For 2004–05, data are only available by CY; from 2006 onward, data are organized by FY.

Table 5. Intervention Model Version 3.0 Estimated Program Benefits, CY 2004–FY 2009

Estimated Intervention Results	CY 2004	CY 2005	FY 2006	FY 2007	FY 2008	FY 2009
Number of Roadside Inspections	2,210,842	2,193,954	2,372,802	2,616,868	2,723,576	2,788,728
Number of Traffic Enforcements	802,798	826,951	900,260	752,649	756,169	730,916
Total Number of Interventions	***3,013,640***	***3,020,905***	***3,273,062***	***3,369,517***	***3,479,745***	***3,519,644***
Crashes Avoided Due to Roadside Inspections	7,353	7,575	7,593	8,101	8,464	8,149
Crashes Avoided Due to Traffic Enforcement	8,467	9,205	9,422	8,769	9,053	8,789
Total Crashes Avoided	***15,820***	***16,780***	***17,015***	***16,870***	***17,517***	***16,938***
Injuries Avoided Due to Roadside Inspections	5,362	5,252	5,090	5,222	5,381	5,206
Injuries Avoided Due to Traffic Enforcement	6,174	6,382	6,316	5,652	5,755	5,614
Total Injuries Avoided	***11,535***	***11,634***	***11,405***	***10,874***	***11,136***	***10,820***
Lives Saved Due to Roadside Inspections	284	282	287	307	304	275
Lives Saved Due to Traffic Enforcement	327	342	357	332	325	297
Total Lives Saved	***611***	***624***	***644***	***639***	***629***	***572***

3.2 STATE-LEVEL ESTIMATES

The model's flexibility makes it possible to examine the results with finer detail, such as benefits by reporting State or by carrier domicile State. State-level totals are presented by both reporting State and country of domicile (U.S. vs. non-U.S.).

3.2.1 Estimates by Country of Domicile (U.S. vs. Non-U.S.)

This section summarizes a comparison between carriers domiciled in the U.S. and those carriers domiciled outside the U.S.

Table 6 shows the number of roadside inspections and traffic enforcements performed on U.S. and non-U.S. domiciled carriers during FY 2009.

Table 6. Program Exposure: U.S. Domiciled vs. Non-U.S. Domiciled Carriers, FY 2009

Interventions	U.S. Domiciled	Non-U.S. Domiciled
Roadside Inspections	2,508,240	279,847
Traffic Enforcements	712,829	18,027
Total Interventions	***3,221,069***	***297,874***

Table 7 compares the effectiveness of interventions conducted in FY 2009 on carriers domiciled in the U.S. and non-U.S. domiciled carriers. Because the exposure for U.S. domiciled carriers is more than 10 times that for non-U.S. domiciled carriers, the U.S. carriers have many more inspections; as a result, their crashes avoided, injuries avoided, and lives saved are all much higher.

Table 7. Program Effectiveness: U.S. Domiciled vs. Non-U.S. Domiciled Carriers, FY 2009

Types of Benefits	Estimated Benefits: U.S.	Estimated Benefits: Non-U.S.	Estimated Benefits per 1,000 Interventions: U.S.	Estimated Benefits per 1,000 Interventions: Non-U.S.
Crashes Avoided Due to Roadside Inspections	6,768	1,375	2.70	4.91
Crashes Avoided Due to Traffic Enforcements	8587	201	12.05	11.13
Total Crashes Avoided	***15,355***	***1,576***	***4.77***	***5.29***
Injuries Avoided Due to Roadside Inspections	4,324	878	1.72	3.14
Injuries Avoided Due to Traffic Enforcements	5486	128	7.70	7.11
Total Injuries Avoided	***9,810***	***1,006***	***3.05***	***3.38***
Lives Saved Due to Roadside Inspections	229	47	0.09	0.17
Lives Saved Due to Traffic Enforcements	290	7	0.41	0.37
Total Lives Saved	***519***	***54***	***0.16***	***0.18***

To provide a more interesting basis for comparison between U.S. and non-U.S. domiciled carriers, Table 5 also includes the estimated program benefits per 1,000 interventions. From that analysis, it is clear that non-U.S. carriers had a somewhat higher rate of crashes avoided as a result of roadside inspections (4.91 compared to 2.70 crashes avoided per 1,000 roadside inspections), while the rates of crashes avoided per traffic enforcement are fairly similar for U.S. and non-U.S. carriers (12.05 and 11.13 crashes avoided per 1,000 traffic enforcements). This observation suggests that similar numbers and kinds of violations were found during traffic enforcement interventions on U.S. and non-U.S. domiciled carriers, but a roadside inspection on a non-U.S. domiciled carrier was likely to find more violations or more severe violations than one on a U.S. domiciled carrier.

3.2.2 Estimates by Reporting State

Table 8 provides roadside inspection results and Table 9 provides traffic enforcement results, by reporting State (as well as for Federal staff), for interventions conducted in all 50 States, the District of Columbia, and the U.S. territories (American Samoa, the Northern Mariana Islands, and Puerto Rico). Both tables provide intervention counts and total estimated benefits (crashes avoided, injuries avoided, lives saved).

Since activity levels vary widely from State to State, these tables include the number of benefits provided per 1,000 interventions (per 1,000 roadside inspections in Table 8; per 1,000 traffic enforcements in Table 9). This analysis can illuminate interesting trends about the effectiveness of interventions in different States. For example, while Texas has both a large number of roadside inspections and a large number of crashes avoided as a result of those inspections, the State also has highly effective inspections: its 5.33 crashes avoided per 1,000 inspections is nearly twice the national average of 2.94. Roadside inspections and traffic enforcements performed by Federal staff are likewise highly effective, with 5.59 crashes avoided per 1,000 roadside inspections and 20.41 crashes avoided per 1,000 traffic enforcements (compared to the national average of 12.02).

Table 8. Roadside Inspection Program Estimated Benefits by Reporting State, FY 2009

Reporting State	Total Interventions Initiated	Number of Roadside Inspections	Est. Crashes Avoided	Est. Injuries Avoided	Est. Lives Saved	Est. Crashes Avoided per 1,000 Inspections	Est. Injuries Avoided per 1,000 Inspections	Est. Lives Saved per 1,000 Inspections
Alabama	43,559	36,922	106.07	67.76	3.59	2.87	1.84	0.10
Alaska	9,926	8,626	19.14	12.23	0.65	2.22	1.42	0.08
Arizona	69,452	45,080	196.43	125.49	6.64	4.36	2.78	0.15
Arkansas	41,953	32,894	95.54	61.03	3.23	2.90	1.86	0.10
California	523,903	458,312	541.45	345.90	18.31	1.18	0.75	0.04
Colorado	56,458	44,782	175.07	111.84	5.92	3.91	2.50	0.13
Connecticut	18,796	12,403	63.92	40.83	2.16	5.15	3.29	0.17
Delaware	5,010	2,922	7.99	5.10	0.27	2.73	1.75	0.09
District of Columbia	6,725	4,746	4.49	2.87	0.15	0.95	0.60	0.03
Federal	**126,587**	**124,637**	**697.32**	**445.47**	**23.59**	**5.59**	**3.57**	**0.19**
Florida	101,735	81,053	199.25	127.29	6.74	2.46	1.57	0.08
Georgia	99,232	76,775	304.05	194.24	10.28	3.96	2.53	0.13
Hawaii	5,440	4,657	7.20	4.60	0.24	1.55	0.99	0.05
Idaho	12,903	6,155	24.79	15.84	0.84	4.03	2.57	0.14
Illinois	77,774	52,967	152.51	97.43	5.16	2.88	1.84	0.10
Indiana	95,524	39,953	144.96	92.61	4.90	3.63	2.32	0.12
Iowa	57,602	37,948	150.02	95.84	5.07	3.95	2.53	0.13
Kansas	52,303	43,293	106.04	67.74	3.59	2.45	1.56	0.08
Kentucky	87,760	61,680	111.46	71.20	3.77	1.81	1.15	0.06
Louisiana	50,929	33,530	130.63	83.45	4.42	3.90	2.49	0.13
Maine	23,814	20,403	55.00	35.14	1.86	2.70	1.72	0.09
Maryland	106,630	87,534	190.80	121.89	6.45	2.18	1.39	0.07
Massachusetts	18,477	8,157	25.06	16.01	0.85	3.07	1.96	0.10
Michigan	71,922	39,406	131.25	83.85	4.44	3.33	2.13	0.11
Minnesota	42,354	25,557	81.33	51.96	2.75	3.18	2.03	0.11
Mississippi	42,114	40,759	83.01	53.03	2.81	2.04	1.30	0.07
Missouri	85,001	58,144	152.63	97.51	5.16	2.63	1.68	0.09
Montana	45,152	41,469	81.17	51.85	2.75	1.96	1.25	0.07

Reporting State	Total Interventions Initiated	Number of Roadside Inspections	Est. Crashes Avoided	Est. Injuries Avoided	Est. Lives Saved	Est. Crashes Avoided per 1,000 Inspections	Est. Injuries Avoided per 1,000 Inspections	Est. Lives Saved per 1,000 Inspections
Nebraska	37,255	28,013	81.22	51.89	2.75	2.90	1.85	0.10
Nevada	32,097	23,536	64.62	41.28	2.19	2.75	1.75	0.09
New Hampshire	12,085	9,542	26.73	17.08	0.90	2.80	1.79	0.09
New Jersey	42,655	33,883	98.41	62.87	3.33	2.90	1.86	0.10
New Mexico	121,636	91,090	143.30	91.54	4.85	1.57	1.00	0.05
New York	111,725	97,587	238.60	152.43	8.07	2.44	1.56	0.08
North Carolina	90,610	73,020	124.18	79.33	4.20	1.70	1.09	0.06
North Dakota	14,706	13,210	19.42	12.41	0.66	1.47	0.94	0.05
Ohio	85,586	69,145	160.62	102.61	5.43	2.32	1.48	0.08
Oklahoma	29,562	18,734	56.21	35.91	1.90	3.00	1.92	0.10
Oregon	56,288	45,660	136.30	87.07	4.61	2.99	1.91	0.10
Pennsylvania	81,478	64,665	162.41	103.75	5.49	2.51	1.60	0.08
Rhode Island	2,662	1,613	7.16	4.57	0.24	4.44	2.83	0.15
South Carolina	52,261	39,035	124.62	79.61	4.22	3.19	2.04	0.11
South Dakota	29,212	24,480	61.46	39.26	2.08	2.51	1.60	0.08
Tennessee	69,586	51,346	82.12	52.46	2.78	1.60	1.02	0.05
Texas	370,667	356,375	1,900.54	1,214.13	64.28	5.33	3.41	0.18
Utah	40,642	32,700	103.85	66.34	3.51	3.18	2.03	0.11
Vermont	9,575	7,239	24.61	15.72	0.83	3.40	2.17	0.11
Virginia	43,711	32,497	97.34	62.18	3.29	3.00	1.91	0.10
Washington	108,113	77,492	191.85	122.56	6.49	2.48	1.58	0.08
West Virginia	33,735	23,099	43.11	27.54	1.46	1.87	1.19	0.06
Wisconsin	36,204	22,308	97.27	62.14	3.29	4.36	2.79	0.15
Wyoming	19,259	14,264	46.01	29.39	1.56	3.23	2.06	0.11
U.S. Territories	9,299	7,431	18.76	11.98	0.63	10.75	2.52	1.61
Total	***3,510,345***	***2,781,297***	***8,130.54***	***5,194.07***	***275.00***	***2.94***	***1.87***	***0.10***

Table 9. Traffic Enforcement Program Estimated Benefits by Reporting State, FY 2009

Reporting State	Total Initiating Interventions	Number Traffic Enforcements	Est. Crashes Avoided	Est. Injuries Avoided	Est. Lives Saved	Est. Crashes Avoided per 1,000 Enforcements	Est. Injuries Avoided per 1,000 Enforcements	Est. Lives Saved per 1,000 Enforcements
Alabama	43,559	6,637	82.04	52.41	2.77	12.36	7.90	0.42
Alaska	9,926	1,300	16.74	10.69	0.57	12.88	8.22	0.44
Arizona	69,452	24,372	345.46	220.69	11.68	14.17	9.06	0.48
Arkansas	41,953	9,059	110.93	70.87	3.75	12.25	7.82	0.41
California	523,903	65,591	485.67	310.26	16.43	7.40	4.73	0.25
Colorado	56,458	11,676	126.30	80.68	4.27	10.82	6.91	0.37
Connecticut	18,796	6,393	95.02	60.70	3.21	14.86	9.49	0.50
Delaware	5,010	2,088	19.08	12.19	0.65	9.14	5.84	0.31
District of Columbia	6,725	1,979	29.63	18.93	1.00	14.97	9.57	0.51
Federal	**126,587**	**1,950**	**39.79**	**25.42**	**1.35**	**20.41**	**13.04**	**0.69**
Florida	101,735	20,682	256.47	163.84	8.67	12.40	7.92	0.42
Georgia	99,232	22,457	317.29	202.70	10.73	14.13	9.03	0.48
Hawaii	5,440	783	7.09	4.53	0.24	9.05	5.79	0.31
Idaho	12,903	6,748	80.80	51.62	2.73	11.97	7.65	0.40
Illinois	77,774	24,807	241.62	154.36	8.17	9.74	6.22	0.33
Indiana	95,524	55,571	555.55	354.90	18.79	10.00	6.39	0.34
Iowa	57,602	19,654	315.28	201.41	10.66	16.04	10.25	0.54
Kansas	52,303	9,010	130.24	83.20	4.41	14.46	9.23	0.49
Kentucky	87,760	26,080	358.52	229.03	12.13	13.75	8.78	0.47
Louisiana	50,929	17,399	167.09	106.74	5.65	9.60	6.13	0.32
Maine	23,814	3,411	44.25	28.27	1.50	12.97	8.29	0.44
Maryland	106,630	19,096	254.79	162.77	8.62	13.34	8.52	0.45
Massachusetts	18,477	10,320	136.90	87.46	4.63	13.27	8.47	0.45
Michigan	71,922	32,516	393.92	251.65	13.32	12.11	7.74	0.41
Minnesota	42,354	16,797	294.35	188.04	9.96	17.52	11.19	0.59
Mississippi	42,114	1,355	18.98	12.13	0.64	14.01	8.95	0.47
Missouri	85,001	26,857	401.21	256.31	13.57	14.94	9.54	0.51
Montana	45,152	3,683	45.80	29.26	1.55	12.44	7.94	0.42

Reporting State	Total Initiating Interventions	Number Traffic Enforcements	Est. Crashes Avoided	Est. Injuries Avoided	Est. Lives Saved	Est. Crashes Avoided per 1,000 Enforcements	Est. Injuries Avoided per 1,000 Enforcements	Est. Lives Saved per 1,000 Enforcements
Nebraska	37,255	9,242	77.52	49.52	2.62	8.39	5.36	0.28
Nevada	32,097	8,561	89.37	57.09	3.02	10.44	6.67	0.35
New Hampshire	12,085	2,543	40.45	25.84	1.37	15.91	10.16	0.54
New Jersey	42,655	8,772	112.27	71.72	3.80	12.80	8.18	0.43
New Mexico	121,636	30,546	357.12	228.14	12.08	11.69	7.47	0.40
New York	111,725	14,138	173.41	110.78	5.87	12.27	7.84	0.42
North Carolina	90,610	17,590	287.48	183.65	9.72	16.34	10.44	0.55
North Dakota	14,706	1,496	16.51	10.55	0.56	11.04	7.05	0.37
Ohio	85,586	16,441	155.41	99.28	5.26	9.45	6.04	0.32
Oklahoma	29,562	10,828	127.11	81.20	4.30	11.74	7.50	0.40
Oregon	56,288	10,628	116.42	74.37	3.94	10.95	7.00	0.37
Pennsylvania	81,478	16,813	221.05	141.21	7.48	13.15	8.40	0.44
Rhode Island	2,662	1,049	16.39	10.47	0.55	15.62	9.98	0.52
South Carolina	52,261	13,226	185.96	118.80	6.29	14.06	8.98	0.48
South Dakota	29,212	4,732	65.53	41.86	2.22	13.85	8.85	0.47
Tennessee	69,586	18,240	206.99	132.23	7.00	11.35	7.25	0.38
Texas	370,667	14,292	143.35	91.58	4.85	10.03	6.41	0.34
Utah	40,642	7,942	119.08	76.07	4.03	14.99	9.58	0.51
Vermont	9,575	2,336	29.98	19.15	1.01	12.83	8.20	0.43
Virginia	43,711	11,214	145.48	92.94	4.92	12.97	8.29	0.44
Washington	108,113	30,621	381.37	243.63	12.90	12.45	7.96	0.42
West Virginia	33,735	10,636	97.11	62.04	3.28	9.13	5.83	0.31
Wisconsin	36,204	13,896	156.19	99.78	5.28	11.24	7.18	0.38
Wyoming	19,259	4,995	66.97	42.78	2.27	13.41	8.56	0.45
U.S. Territories	9,299	1,868	29.88	19.10	1.00	16.00	10.22	0.54
Total	***3,519,644***	***730,916***	***8789.21***	***5614.84***	***297.27***	***12.02***	***7.68***	***0.41***

3.2.3 Estimates by Carrier State of Domicile

Table 10 and Table 11 provide detailed roadside inspections and traffic enforcement results, respectively, organized by carrier domicile State for interventions conducted on carriers registered in all 50 States, the District of Columbia, and U.S. territories, as well as Canada, Mexico, and other countries. The number of benefits provided per 1,000 interventions (per 1,000 roadside inspections in Table 10; per 1,000 traffic enforcements in Table 11) is again included to provide a scale for comparison between States with different levels of activity.

Approximately 10 times as many roadside inspections were performed on carriers domiciled in Nebraska (41,075) as carriers domiciled in Delaware (4,104), but the benefits per 1,000 inspections performed on carriers from each State were similar: 2.61 crashes and 1.67 injuries were avoided, and 0.09 lives saved for every 1,000 inspections on Nebraska-domiciled carriers; for Delaware-domiciled carriers, these numbers were 2.63 crashes and 1.68 injuries avoided, and 0.09 lives saved.

It is also possible, in Table 10 and Table 11, to see more details of the effectiveness of roadside inspections and traffic enforcements on non-U.S. domiciled carriers. Table 11 confirms that the effectiveness of traffic enforcements is similar for U.S. and non-U.S. domiciled carriers. While the average for U.S. domiciled carriers was 12.05, carriers domiciled in Canada had 10.86 crashes avoided per 1,000 enforcements, and Mexico domiciled carriers had 11.84 crashes avoided per 1,000 enforcements. Non-North American carriers did have a noticeably higher rate of 17.09 crashes avoided per 1,000 enforcements. Table 10, on the other hand, shows some interesting differences in the results of roadside inspections on carriers domiciled in various non-U.S. countries. Canada has 10.52 crashes avoided per 1,000 inspections, and other non-North America countries average 6.10 crashes avoided per 1,000 inspections, which are greater than the U.S. domiciled average of 4.91 crashes avoided per 1,000 inspections. Mexico, on the other hand, has a much lower average number of crashes avoided per 1,000 inspections: 2.54.

Table 10. Roadside Inspection Program Estimated Benefits by Domicile State and Country, FY 2009

Carrier State	Total Initiating Interventions	Number Roadside Inspections	Est. Crashes Avoided	Est. Injuries Avoided	Est. Lives Saved	Est. Crashes Avoided per 1,000 Inspections	Est. Injuries Avoided per 1,000 Inspections	Est. Lives Saved per 1,000 Inspections
Alabama	54,479	43,754	126.14	80.58	4.27	2.88	1.84	0.10
Alaska	7,845	6,694	16.45	10.51	0.56	2.46	1.57	0.08
Arizona	90,526	71,728	165.44	105.69	5.60	2.31	1.47	0.08
Arkansas	60,419	47,069	115.40	73.72	3.90	2.45	1.57	0.08
California	436,014	362,682	549.41	350.98	18.58	1.51	0.97	0.05
Colorado	44,902	34,485	115.37	73.70	3.90	3.35	2.14	0.11
Connecticut	12,325	8,513	28.24	18.04	0.96	3.32	2.12	0.11
Delaware	5,413	4,104	10.79	6.89	0.36	2.63	1.68	0.09
District of Columbia	1,533	1,203	1.91	1.22	0.06	1.59	1.01	0.05
Florida	147,447	115,783	338.32	216.13	11.44	2.92	1.87	0.10
Georgia	100,395	75,379	256.13	163.62	8.66	3.40	2.17	0.11
Hawaii	4,837	4,131	6.82	4.36	0.23	1.65	1.06	0.06
Idaho	18,896	14,040	42.28	27.01	1.43	3.01	1.92	0.10
Illinois	127,303	91,703	252.27	161.16	8.53	2.75	1.76	0.09
Indiana	91,744	62,921	175.05	111.83	5.92	2.78	1.78	0.09
Iowa	69,335	49,615	125.31	80.05	4.24	2.53	1.61	0.09
Kansas	40,915	30,231	89.81	57.37	3.04	2.97	1.90	0.10
Kentucky	53,560	37,706	86.92	55.53	2.94	2.31	1.47	0.08
Louisiana	38,716	29,357	119.94	76.62	4.06	4.09	2.61	0.14
Maine	14,255	11,453	30.00	19.17	1.01	2.62	1.67	0.09
Maryland	53,874	43,218	94.57	60.41	3.20	2.19	1.40	0.07
Massachusetts	27,698	18,198	52.95	33.83	1.79	2.91	1.86	0.10
Michigan	85,465	57,475	177.17	113.18	5.99	3.08	1.97	0.10
Minnesota	74,971	51,594	121.72	77.76	4.12	2.36	1.51	0.08
Mississippi	28,290	22,655	66.92	42.75	2.26	2.95	1.89	0.10
Missouri	84,484	62,228	146.90	93.84	4.97	2.36	1.51	0.08
Montana	18,884	16,060	38.23	24.42	1.29	2.38	1.52	0.08
Nebraska	54,580	41,075	107.06	68.39	3.62	2.61	1.67	0.09
Nevada	14,524	11,866	35.16	22.46	1.19	2.96	1.89	0.10
New Hampshire	9,474	7,007	21.14	13.50	0.72	3.02	1.93	0.10

Carrier State	Total Initiating Interventions	Number Roadside Inspections	Est. Crashes Avoided	Est. Injuries Avoided	Est. Lives Saved	Est. Crashes Avoided per 1,000 Inspections	Est. Injuries Avoided per 1,000 Inspections	Est. Lives Saved per 1,000 Inspections
New Jersey	65,535	51,404	144.52	92.32	4.89	2.81	1.80	0.10
New Mexico	22,776	17,282	43.33	27.68	1.47	2.51	1.60	0.09
New York	75,357	60,621	179.53	114.69	6.07	2.96	1.89	0.10
North Carolina	88,890	68,228	154.25	98.54	5.22	2.26	1.44	0.08
North Dakota	13,390	10,796	26.56	16.97	0.90	2.46	1.57	0.08
Ohio	103,587	79,680	181.55	115.98	6.14	2.28	1.46	0.08
Oklahoma	43,109	32,391	109.65	70.05	3.71	3.39	2.16	0.11
Oregon	45,251	36,576	86.81	55.46	2.94	2.37	1.52	0.08
Pennsylvania	112,806	89,043	198.38	126.73	6.71	2.23	1.42	0.08
Rhode Island	3,846	2,574	9.60	6.13	0.32	3.73	2.38	0.12
South Carolina	44,350	33,457	113.93	72.78	3.85	3.41	2.18	0.12
South Dakota	15,574	11,670	33.94	21.68	1.15	2.91	1.86	0.10
Tennessee	88,541	67,428	148.65	94.96	5.03	2.20	1.41	0.07
Texas	329,289	292,716	1,266.55	809.12	42.84	4.33	2.76	0.15
Utah	47,523	36,258	95.59	61.07	3.23	2.64	1.68	0.09
Vermont	5,163	4,100	12.50	7.99	0.42	3.05	1.95	0.10
Virginia	44,966	33,719	85.75	54.78	2.90	2.54	1.62	0.09
Washington	84,145	64,094	160.57	102.58	5.43	2.51	1.60	0.08
West Virginia	20,267	15,005	31.60	20.19	1.07	2.11	1.35	0.07
Wisconsin	77,804	54,957	136.46	87.18	4.62	2.48	1.59	0.08
Wyoming	6,618	4,987	16.32	10.43	0.55	3.27	2.09	0.11
U.S. Territories	9,179	7,327	18.6	11.88	0.63	8.86	5.66	0.30
Canada	91,239	77,562	138.05	88.18	4.68	10.52	6.72	0.35
Mexico	205,566	201,350	1227.26	784.02	41.49	2.54	1.62	0.09
Non-North America	1,069	935	9.84	6.28	0.33	6.10	3.89	0.21
Unknown	701	641	5.68	3.63	0.19	1.78	1.14	0.06
Total	***3,457,320***	***2,788,728***	***8149.29***	***5,206.02***	***275.62***	***2.92***	***1.87***	***0.10***

Table 11. Traffic Enforcement Program Estimated Benefits by Domicile State and Country, FY 2009

Carrier State	Total Initiating Interventions	Number Traffic Enforcements	Est. Crashes Avoided	Est. Injuries Avoided	Est. Lives Saved	Est. Crashes Avoided per 1,000 Enforcements	Est. Injuries Avoided per 1,000 Enforcements	Est. Lives Saved per 1,000 Enforcements
Alabama	54,479	10,725	127.98	81.76	4.33	11.93	7.62	0.40
Alaska	7,845	1,151	15.16	9.68	0.51	13.17	8.41	0.44
Arizona	90,526	18,798	234.05	149.52	7.92	12.45	7.95	0.42
Arkansas	60,419	13,350	152.79	97.61	5.17	11.44	7.31	0.39
California	436,014	73,332	703.63	449.50	23.80	9.60	6.13	0.32
Colorado	44,902	10,417	123.33	78.79	4.17	11.84	7.56	0.40
Connecticut	12,325	3,812	51.18	32.70	1.73	13.43	8.58	0.45
Delaware	5,413	1,309	18.14	11.59	0.61	13.86	8.85	0.47
District of Columbia	1,533	330	4.46	2.85	0.15	13.52	8.64	0.45
Florida	147,447	31,664	403.95	258.06	13.66	12.76	8.15	0.43
Georgia	100,395	25,016	339.02	216.58	11.47	13.55	8.66	0.46
Hawaii	4,837	706	6.51	4.16	0.22	9.22	5.89	0.31
Idaho	18,896	4,856	65.02	41.54	2.20	13.39	8.55	0.45
Illinois	127,303	35,600	417.70	266.84	14.13	11.73	7.50	0.40
Indiana	91,744	28,823	328.98	210.16	11.13	11.41	7.29	0.39
Iowa	69,335	19,720	256.07	163.59	8.66	12.99	8.30	0.44
Kansas	40,915	10,684	133.67	85.39	4.52	12.51	7.99	0.42
Kentucky	53,560	15,854	202.45	129.33	6.85	12.77	8.16	0.43
Louisiana	38,716	9,359	107.65	68.77	3.64	11.50	7.35	0.39
Maine	14,255	2,802	32.21	20.58	1.09	11.50	7.34	0.39
Maryland	53,874	10,656	140.34	89.65	4.75	13.17	8.41	0.45
Massachusetts	27,698	9,500	139.32	89.00	4.71	14.67	9.37	0.50
Michigan	85,465	27,990	340.01	217.21	11.50	12.15	7.76	0.41
Minnesota	74,971	23,377	331.11	211.52	11.20	14.16	9.05	0.48
Mississippi	28,290	5,635	66.32	42.37	2.24	11.77	7.52	0.40
Missouri	84,484	22,256	273.69	174.84	9.26	12.30	7.86	0.42
Montana	18,884	2,824	35.15	22.46	1.19	12.45	7.95	0.42
Nebraska	54,580	13,505	133.33	85.18	4.51	9.87	6.31	0.33

Carrier State	Total Initiating Interventions	Number Traffic Enforcements	Est. Crashes Avoided	Est. Injuries Avoided	Est. Lives Saved	Est. Crashes Avoided per 1,000 Enforcements	Est. Injuries Avoided per 1,000 Enforcements	Est. Lives Saved per 1,000 Enforcements
Nevada	14,524	2,658	31.82	20.33	1.08	11.97	7.65	0.41
New Hampshire	9,474	2,467	37.52	23.97	1.27	15.21	9.72	0.51
New Jersey	65,535	14,131	177.25	113.23	6.00	12.54	8.01	0.42
New Mexico	22,776	5,494	64.00	40.89	2.16	11.65	7.44	0.39
New York	75,357	14,736	183.94	117.51	6.22	12.48	7.97	0.42
North Carolina	88,890	20,662	296.27	189.27	10.02	14.34	9.16	0.48
North Dakota	13,390	2,594	34.60	22.10	1.17	13.34	8.52	0.45
Ohio	103,587	23,907	261.94	167.34	8.86	10.96	7.00	0.37
Oklahoma	43,109	10,718	142.19	90.84	4.81	13.27	8.48	0.45
Oregon	45,251	8,675	100.36	64.11	3.39	11.57	7.39	0.39
Pennsylvania	112,806	23,763	272.31	173.96	9.21	11.46	7.32	0.39
Rhode Island	3,846	1,272	18.47	11.80	0.62	14.52	9.28	0.49
South Carolina	44,350	10,893	160.19	102.33	5.42	14.71	9.39	0.50
South Dakota	15,574	3,904	51.13	32.66	1.73	13.10	8.37	0.44
Tennessee	88,541	21,113	246.50	157.47	8.34	11.68	7.46	0.40
Texas	329,289	36,573	412.75	263.68	13.96	11.29	7.21	0.38
Utah	47,523	11,265	143.25	91.51	4.85	12.72	8.12	0.43
Vermont	5,163	1,063	13.89	8.87	0.47	13.07	8.34	0.44
Virginia	44,966	11,247	142.67	91.14	4.83	12.69	8.10	0.43
Washington	84,145	20,051	247.43	158.07	8.37	12.34	7.88	0.42
West Virginia	20,267	5,262	59.01	37.70	2.00	11.21	7.16	0.38
Wisconsin	77,804	22,847	254.83	162.79	8.62	11.15	7.13	0.38
Wyoming	6,618	1,631	22.07	14.10	0.75	13.53	8.65	0.46
U.S. Territories	9,179	1,852	29.78	19.03	1.00	16.08	10.28	0.54
Canada	91,239	13,677	148.50	94.85	5.01	10.86	6.94	0.37
Mexico	205,566	4,216	49.92	31.88	1.67	11.84	7.56	0.40
Non-North America	1,069	134	2.29	1.47	0.07	17.09	10.97	0.52
Unknown	701	60	1.14	0.73	0.04	19.00	12.17	0.67
Total	***3,519,644***	***730,916***	***8,789.24***	***5,614.86***	***297.26***	***12.02***	***7.68***	***0.41***

4. CONCLUSION

The Roadside Inspection and Traffic Enforcement Programs are two of the FMCSA's most powerful safety tools. By continually examining the results of these programs, FMCSA can ensure that they are executed effectively and are producing the desired safety benefits. Results for individual States can be examined and compared to provide guidance on how to allocate safety resources. The total national results show the scale of Roadside Inspection and Traffic Enforcement Programs and the magnitude of their effects on highway safety: in 2009, 2,781,297 roadside inspections and 730,916 traffic enforcements were conducted. Together, it is estimated that in FY 2009, these interventions saved approximately 570 lives and prevented 10,800 injuries by averting almost 17,000 crashes. Over the past 9 years, it is estimated that these two programs have saved almost 6,000 lives (Table 12).

Table 12. Historical Results for Intervention Model, CY 2001–05 and FY 2006–09

Intervention Results	CY 2001	CY 2002	CY 2003	CY 2004	CY 2005	FY 2006	FY 2007	FY 2008	FY 2009
Number of Roadside Inspections	2,050,786	2,253,070	2,215,669	2,210,842	2,193,954	2,372,802	2,616,868	2,723,576	2,788,728
Number of Traffic Enforcements	695,619	760,094	791,116	802,798	826,951	900,260	752,649	756,169	730,916
Total Number of Interventions	***2,746,405***	***3,013,164***	***3,006,785***	***3,013,640***	***3,020,905***	***3,273,062***	***3,369,517***	***3,479,745***	***3,519,644***
Crashes Avoided Due to Roadside Inspections	6,658	7,218	7,176	7,353	7,575	7,593	8,101	8,464	8,149
Crashes Avoided Due to Traffic Enforcement	7,263	8,115	8,251	8,467	9,205	9,422	8,769	9,053	8,789
Estimated Total Crashes Avoided	***13,921***	***15,333***	***15,427***	***15,820***	***16,780***	***17,015***	***16,870***	***17,517***	***16,938***
Injuries Avoided Due to Roadside Inspections	5,050	5,458	5,456	5,362	5,252	5,090	5,222	5,381	5,206
Injuries Avoided Due to Traffic Enforcement	5,509	6,136	6,274	6,174	6,382	6,316	5,652	5,755	5,614
Estimated Total Injuries Avoided	***10,559***	***11,594***	***11,730***	***11,535***	***11,634***	***11,405***	***10,874***	***11,136***	***10,820***
Lives Saved Due to Roadside Inspections	331	346	317	284	282	287	307	304	275
Lives Saved Due to Traffic Enforcement	361	389	364	327	342	357	332	325	297
Estimated Total Lives Saved	***691***	***735***	***681***	***611***	***624***	***644***	***639***	***629***	***572***

APPENDIX A: IMPROVEMENTS TO THE INTERVENTION MODEL METHODOLOGY

BACKGROUND

Development of the Intervention Model

The Intervention Model is part of FMCSA's efforts to address requirements of the GPRA, which requires Federal agencies to measure the effectiveness of their programs as part of the budget cycle process. Work on FMCSA Program Performance Measures resulted in an initial model for assessing the effectiveness of roadside inspections. After a review panel made recommendations for improvement in a 1998 Volpe Center report entitled "OMC Safety Program Performance Measures," the initial model evolved into Intervention Model 1.0 which produced estimates of crashes and injuries avoided and lives saved due to the Roadside Intervention and Traffic Enforcement programs for the years 1998, 1999, and 2000. Subsequently, several improvements to the 2001–07 model yielded Version 2.0, which was used to calculate benefits for CY 2001–05 and FY 2006–07. For FY 2008, Intervention Model 3.0 was developed in an effort to improve the methodology in several areas as described below.

Improvements to the Intervention Model

Ten years of experience with the Version 2.0 methodology revealed the need for updating the model. Intervention Model 3.0 includes improvements in four areas. The improvements are data-driven modifications, based on empirical data that provide a more realistic basis for estimating the effects of the intervention program:

- Addressed the fact that not all violations recorded during interventions are actually corrected.
- Eliminated the multiplicative factor that was applied when multiple violations were identified during an inspection.
- Implemented a new way of determining the crash risks associated with violations.
- Eliminated the calculation of indirect effects.[6]

[6] Indirect effects estimated in Intervention Model 2.0 were the byproducts of the carriers' increased awareness of FMCSA programs and their potential consequences if steps were not taken to ensure and/or maintain higher levels of safety. Indirect effects were essentially changes in carriers' safety behavior during the year following their exposure to the interventions. However, re-analysis of past years' data revealed that indirect effects probably were only a small fraction of direct effects, and that estimates of indirect effects by Version 2.0 were overstated. With the introduction of CSA and the revision of intervention program effectiveness models, it was determined that Intervention Model 3.0 would estimate only the immediate (direct) effects of Roadside Inspections and Traffic Enforcements, leaving the estimation of longer-term (indirect) effects to other CSA effectiveness models.

CORRECTION OF VIOLATIONS

Intervention Model 2.0 Approach

Intervention Model 2.0 assumed that all violations cited during an intervention were corrected either before the driver resumed operating the vehicle or shortly after the completion of the daytrip in which the intervention occurred. Therefore, Intervention Model 2.0 did not consider the possibility that non-correction of violations might lessen the crash risk reduction resulting from recording violations during interventions.

Intervention Model 3.0 Approach

Based on a study examining vehicles undergoing a second inspection within 7 days of the first, correction rates were determined for vehicle maintenance and driver fitness violations. The study did not support the assumption that 100 percent of these violations are corrected within the regulatory time period. On average only 69.94 percent of vehicle maintenance-related violations and 68.82 percent of driver fitness-related violations were corrected within the allotted time. Table 13 and Table 14 show the correction rates that are used in Intervention Model 3.0. In the Version 3.0 methodology, the overall estimates of the effectiveness of roadside inspections and traffic enforcements are multiplied by these factors to account for violations that are not corrected.

Table 13. Vehicle Maintenance Violation Correction Rates in Version 3.0

Violation Group ID	Violation Group Description	Correction Rate (%)
18	Brakes Out of Adjustment	70.30
19	Brakes, All Others	79.36
20	Coupling Devices	92.76
21	Exhaust Discharge	81.72
22	Fuel Systems	91.62
23	Lighting	60.81
24	Steering Mechanism	81.82
25	Suspension	88.77
26	Tires	66.56
27	Wheels, Studs, Clamps, Etc.	71.37
28	Windshield/Glass/Markings	73.16
29	Cab, Body, Frame	90.69
30	Inspection Reports	69.93
31	Vehicle Jumping OOS	95.45
32	Other Vehicle Defect	64.63
33	Emergency Equipment	74.49
34	Tire vs. Load	92.73
46	Clearance Identification Lamps/Other	57.18
Total	***All Violations***	***69.94***

Table 14. Driver Fitness Violation Correction Rates in Version 3.0

Violation Group ID	Violation Group Description	Correction Rate (%)
11	Driver Qualification	70.92
12	Endorsements & Vehicle Group	85.04
13	Medical Certificate	63.67
14	Physical	92.79
15	Multiple License	92.86
48	Fitness Jumping OOS	100.00
Total	***All Violations***	***68.82***

MULTIPLE VIOLATIONS PER INTERVENTION

Intervention Model 2.0 Approach

Intervention Model 2.0 used a multiplicative factor to augment avoided risk when multiple violations at the same risk level occurred in an inspection. For example, if a roadside inspection recorded three violations considered to be of equal risk, the model multiplied the CRP of each violation by a factor of three, and then totaled the augmented risks to produce the total risk avoided. If the three violations in the inspection did not have equal risk levels, then the multiplicative factor was not applied.

Intervention Model 3.0 Approach

An analysis was conducted to investigate whether multiple violations occurred more frequently in post-crash inspections than in non-crash inspections. It found that although the distribution of the number of violations per inspection in post-crash inspections was slightly skewed toward higher numbers of violations than in non-crash inspections, the differences were minimal. Figure 2 shows the two distributions.

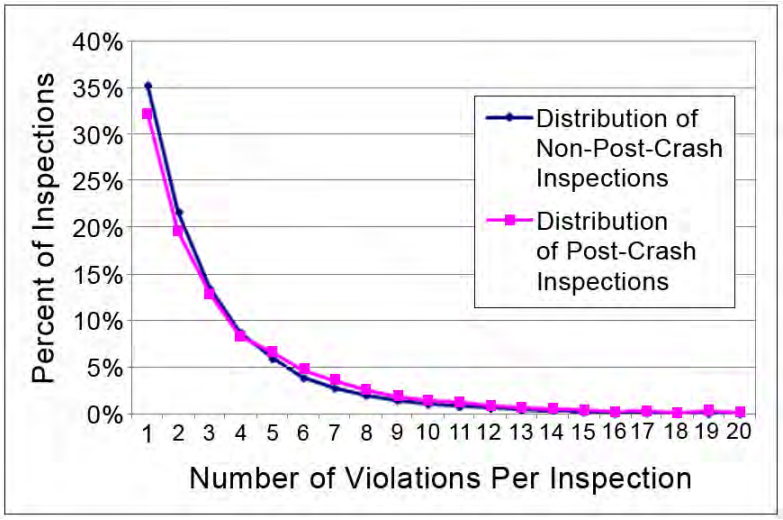


Figure 2. Distributions of Multiple Violations in Post-Crash and Non-Crash Inspections

This analysis does not justify the multiplicative factor used by Intervention Model 2.0 for multiple violations in the same risk category. Inspections with two to four violations are more likely to be non-crash inspections than post-crash inspections. The occurrence of two to four violations in an inspection does not indicate that it is more likely to be a post-crash inspection than not. (The mean number of violations per inspection is 2.3, and more than 85 percent of inspections have four or fewer violations.) A multiplicative factor designed to augment estimated crash risk would be inappropriate when four or fewer violations indicate no additional crash risk. Furthermore, inspections with five or more violations are only slightly more likely to be post-crash, so a multiplicative factor would be small and only appropriate for 15 percent of inspections. Thus, it was decided to eliminate the multiplicative factor from Intervention Model 3.0.

CRASH RISK REDUCTION ASSOCIATED WITH VIOLATIONS

Intervention Model 2.0 Approach

Intervention Model 2.0 assumed that recording a violation in a roadside inspection or traffic enforcement reduced the risk of a subsequent crash by a finite probability associated with the inherent potential of that violation to contribute to a CMV crash. The violations were grouped into five risk categories, each with a CRP representing the probability or likelihood that a violation would lead to a crash if left uncorrected. The relative weights were based on a 1998 study, *Risk-based Evaluation of Commercial Motor Vehicle Roadside Violations: Process and Results*.[7] Industry experts and the author's analysts converted these relative weights into crash risk reduction probabilities for use in the Intervention Model.

Intervention Model 3.0 Approach

An improved method was developed for determining the crash risk reduction associated with violations in Intervention Model 3.0. The improved methodology uses FMCSA research, including the VSAS, as well as research performed for the CSA initiative. The underlying revised methodology is based on sound safety data and statistical approaches, relying to the minimum degree possible on expert opinion and assumptions for data not readily available in useable form.

The Version 3.0 methodology assumes that recording a violation associated with a particular violation group during an intervention reduces the risk of a subsequent crash by a finite probability equal to the inherent potential of that violation group to contribute to a CMV crash, based on empirical data. The concept of a BASIC violation group was first developed by the VSAS. A violation group consists of similar violations thought to have equal crash risk. The violation groups are listed in Table 15.

[7] Cycla Corporation, Risk-based Evaluation of Commercial Motor Vehicle Roadside Violations: Process and Results, July 1998.

Table 15. Duration of Crash Risk Reduction by Violation Type

Violation Type	Duration
Unsafe Driving Fatigued Driving Improper Loading	30 days, based on several studies suggesting that a citation deters the behavior for 30–90 days.
Controlled Substance and Alcohol	90 days, length of license suspension for cited driver, assumes sober driver would replace him.
Vehicle Maintenance	Observable violation: 7 days. Non-observable violation: 37 days, recommended inspection interval by several vehicle maintenance organizations.
Driver Fitness	45 days, mean time between CVSA inspections, assumes driver could have violation immediately following CVSA inspection until the exemption period is up.

The model employs three estimates in developing the crash risk reduction probability for a violation group:

- The *crash risk* for violations in the group is defined as the likelihood that the unsafe behavior associated with the violation will contribute to a crash during a CMV daytrip (a "daytrip" is defined as a CMV's travel during 1 day). The crash risks for each violation group are calculated using data from the VSAS and CSA research, as well as the MCMIS database.
- The *duration* of the reduction in crash risk when a violation in the group is identified at the roadside and corrected. The duration of the risk reduction varies according to the violation group to which the violation is assigned.
- The *correction rate* for violations in the group that are corrected as a result of the intervention.

On any given day, there are CMVs on the road that exhibit unsafe behaviors associated with violation groups. Roadside inspections and traffic enforcements intercept "*non-crash daytrips*," revealing these unsafe behaviors and recording the associated violations. CMV daytrips that end in crashes ("*crash daytrips*") are frequently subjected to post-crash inspections, revealing violations that existed prior to the crash. Non-crash daytrips intercepted in roadside inspections and traffic enforcements and their violations are considered to be a representative sample of all non-crash daytrips, and crashes undergoing post-crash inspections and their violations are considered to be a representative sample of all crash daytrips.

Estimation of Crash Risk

To estimate the CRP for a particular violation group (*viol (j)*), the percent of daytrips with a violation in that violation group resulting in a crash is calculated as shown in Figure 3.

$$\frac{\text{\# Crashes With Violation (j)}}{\text{Total Trips With Violation (j)}} = \text{Likelihood of Crash With Violation (j)} = \text{CRP}$$

Figure 3. Violation Group Crash-Risk Probability Estimation Equation

Estimating the numerator of Figure 3 is straightforward, since all the data needed are in MCMIS. That calculation is shown in Figure 4.

$$\frac{\text{\# Post-Crash Inspections With Violation (j)}}{\text{\# Post-Crash Inspections Without Violation (j)}} \times \text{Total \# Crashes} = \text{\# Crashes With Violation (j)}$$

Figure 4. Equation to Estimate Numerator of Figure 3

Estimating the denominator of Figure 3 requires data in addition to that supplied by MCMIS, while the total number of non-crash daytrips is derived from other sources.[8] Figure 5 shows the equation for estimating the denominator.

$$\frac{\text{\# Non-Crash Inspections With Violation (j)}}{\text{\# Non-Crash Inspections Without Violation (j)}} \times \text{Total \# Non-Crash Trips} = \text{Total Non-Crash Trips With Violation (j)}$$

Figure 5. Denominator Determination Equation to Estimate CRP

[8] www.fhwa.dot.gov/policy/ohim/hs06/pdf/vm1.pdf and www.fmcsa.dot.gov/documents/tb99-002.pdf

Table 16. Crash Risk Reductions for Violation Groups in Intervention Model 3.0

Violation Group	Estimated Number of Non-Crash Daytrips (Denominator)	Estimated Number of Crashes (Numerator)	Estimated Likelihood of a Crash (N/D)	Duration of Crash Risk Reduction (Daytrips)	Crash Risk Reduction
Careless Driving	184,915,747	26,039.53	0.000141	30	0.004224
Reckless Driving	184,915,747	5,139.75	0.000028	30	0.000834
Speeding-Related	184,915,747	14,432.49	0.000078	30	0.002341
HM-Related	184,915,747	177.48	0.000001	30	0.000029
Other Driver Violations	184,915,747	74,228.28	0.000401	30	0.012038
392.2 Driver	184,915,747	96,931.23	0.000524	30	0.015718
Hours	135,147,842	14,113.03	0.000104	30	0.00312
False Log	45,214,552	9,569.60	0.000212	30	0.00636
Incomplete/Wrong Log	501,678,937	61,875.83	0.000123	30	0.00369
Jumping OOS/Driving Fatigued	799,215	4,614.42	0.005741	30	0.17223
EOBR-Related	521,501	63.89	0.000123	30	0.00369
Driver Qualification	30,223,328	6,311.11	0.000209	45	0.009405
Endorsements & Vehicle Group	50,894,361	9,072.66	0.000178	45	0.00801
Medical Certificate	212,070,741	31,378.06	0.000148	45	0.00666
Physical	6,308,906	582.13	0.000092	45	0.00414
Multiple License	712,945	184.58	0.000259	45	0.011655
Fitness Jumping OOS	4,847	7.1	0.001463	45	0.065835
Alcohol	3,976,205	3,464.37	0.000871	90	0.07839
Drugs	1,484,049	1,476.61	0.000994	90	0.08946
Alcohol Jumping OOS	75,608	42.59	0.000563	90	0.05067
Brakes Out of Adjustment	598,114,058	76,330.43	0.000128	37	0.004736
Brakes, All Others	1,273,227,151	98,405.12	0.000077	37	0.002849
Coupling Devices	32,839,240	8,194.14	0.000249	7	0.001743
Exhaust Discharge	210,994,572	12,245.08	0.000058	37	0.002146
Fuel Systems	64,210,788	8,085.10	0.000126	37	0.004662
Lighting	820,016,680	76,271.72	0.000093	7	0.000651
Steering Mechanism	137,599,046	10,576.05	0.000077	37	0.002849
Suspension	206,889,516	25,957.88	0.000125	37	0.004625

Violation Group	Estimated Number of Non-Crash Daytrips (Denominator)	Estimated Number of Crashes (Numerator)	Estimated Likelihood of a Crash (N/D)	Duration of Crash Risk Reduction (Daytrips)	Crash Risk Reduction
Tires	517,702,925	70,627.25	0.000136	7	0.000952
Wheels, Studs, Clamps, Etc.	612,694,671	60,948.60	0.000099	7	0.000693
Windshield/Glass/Markings	216,312,307	21,605.01	0.0001	7	0.0007
Cab, Body, Frame	151,690,832	23,567.58	0.000155	7	0.001085
Inspection Reports	237,913,373	36,928.13	0.000155	37	0.005735
Vehicle Jumping OOS	670,547	159.35	0.000238	37	0.008806
Other Vehicle Defect	536,736,891	72,589.81	0.000135	37	0.004995
Emergency Equipment	437,084,631	41,599.71	0.000095	37	0.003515
Tire vs. Load	39,856,664	3,967.07	0.0001	37	0.0037
Clearance Identification Lamps/Other	668,424,583	54,809.29	0.000082	7	0.000574
392.2 Vehicle	1,474,311,922	155,755.68	0.000106	37	0.003922
Load Securement	232,189,190	38,907.47	0.000168	30	0.00504
Other Cargo	78,886,501	12,454.75	0.000158	30	0.00474
Fire Hazard	525,171	41.94	0.00008	30	0.0024
Markings	28,696,023	1,593.54	0.000056	30	0.00168
Cargo Protection	3,131,643	478.06	0.000153	30	0.00459
Documentation	16,323,309	1,098.70	0.000067	30	0.00201
HM Route	169,000	25.16	0.000149	30	0.00447
Fraudulent Behavior	18,778	0	0	30	0
Package Integrity	5,248,076	436.13	0.000083	30	0.00249
HM Other	3,383,022	251.61	0.000074	30	0.00222
Package Testing	4,485,457	385.8	0.000086	30	0.00258
HM Shipper	27,526,351	1,710.96	0.000062	30	0.00186

Estimation of Duration

The recording of a violation group results in a risk reduction for a greater duration than the daytrip during which the intervention occurs. Studies have found evidence that drivers' behaviors are affected long after they are caught for unsafe driving practices. And vehicle safety deficiencies not discovered in inspections would have continued to exist on active CMVs for many more trips. The duration of the risk reduction varies according to the violation group to which the violation is assigned. The rationales for the reductions are described below.

For violations in the Unsafe Driving, Fatigued Driving, and Improper Loading categories, the corrected violation is assumed to remain corrected for 30 daytrips. These categories are treated similarly in the Intervention Model, since the same violation may occur independently on successive days. For example, a driver who improperly secured goods on one daytrip could improperly secure the next shipment of goods as well. Two recent studies[9] suggest that the effect of a traffic citation on a driver is to deter the driver from that behavior for the next 1–3 months. Assuming the same effect would occur when a CMV driver is given a violation in one of these three categories in a traffic enforcement or roadside inspection, a duration of 1 month (to be conservative) is applied when these violations occur in the Intervention Model.

For a drug- or alcohol-related violation, the crash reduction is assumed to be 90 daytrips. The minimum driver's license suspension in all States for such a violation is 90 days.[10] By using a 90-day duration in the Intervention Model, it is assumed that a sober replacement driver performs the trips the cited driver would have performed for the duration of the suspension.

For vehicle maintenance- or driver fitness-related violations, the crash reduction is assumed to last for more than one daytrip. The reasoning is that if the inspection revealing the vehicle maintenance or driver fitness violation had not occurred, then the vehicle or driver would have operated with that violation and its corresponding crash risk until another inspection or a crash occurred. For example, if an equipment violation, such as flawed brakes, had not been discovered during a roadside inspection, then the CMV would have continued to operate with the flawed brakes until the flaw was discovered during preventative maintenance or a roadside inspection, or until the brakes failed and caused a crash. In this case, the violation reduced the crash risk for a duration equal to the number of days between the time the flaw was detected at the roadside and the time it ultimately would have been discovered after one of these three latter events—assuming that the brakes remained fixed during this same time duration.

For a Vehicle Maintenance violation involving aspects of a vehicle that can be observed in a walkaround, the duration is assumed to be seven daytrips. For other Vehicle Maintenance violations that require a more thorough inspection, the duration is assumed to be 37 daytrips (8,000 miles at 216 miles per day on average for the U.S. CMV fleet). These durations represent inspection intervals recommended by vehicle maintenance groups, such as the Transportation

---

[9] Donald A Redelmeier, Robert J Tibshirani, Leonard Evans; "Traffic-law enforcement and risk of death from motor-vehicle crashes: case-crossover study," *The Lancet*, Vol 361, June 28, 2003, www.thelancet.com and "Traffic enforcement in Europe: effects, measures, needs and future," The "Escape Project," Technical Research Center of Finland, December 2002.

[10] Serenity Insurance, "DUI penalties State by State," http://www.serenitygroup.com/dui-penalties/

Services Division of Maryland's Department of Public Works and Transportation[11]; a vehicle buyers' service[12]; or a trucking resource center.[13]

The duration for driver fitness violations is assumed to be the mean time between CVSA inspections. CVSA issues decals to commercial vehicles that pass safety inspections according to FMCSA and CVSA criteria. These decals exempt a vehicle from additional inspections for the remainder of the quarter in which it was inspected, or an average of 45 days.[14] Assuming that a driver inspection would typically occur along with the vehicle inspection, a driver could operate for an average of 45 daytrips before a Driver Fitness violation that occurred immediately after an inspection was discovered in a subsequent inspection.

Table 15 (above) shows the durations of risk reduction used in the Intervention Model 3.0 for violation groups and the basis for their magnitudes.

Estimation of Crash Risk Reduction

Figure 6 shows the final calculation for the Risk Reduction (RR) for violation (j).

CRP for Violation (j) x Duration = RR for Violation (j)

Figure 6. Final Calculation of Risk Reduction for Violation (j) Equation

Table 16 (above) shows the crash risk reduction estimates using 4 years of MCMIS data (CY 2003–06).

INDIRECT EFFECTS

Intervention Model 2.0 Approach

The premise behind including indirect effects of interventions was that once carriers had been exposed to interventions, they would change their future behavior. Version 2.0 calculated indirect effects by comparing a carrier's performance in the base year to performance for the following year. Fewer violations per inspection in the following year compared to the base year would indicate improvement resulting from changed behavior. The Version 2.0 model translated the differences in the year-to-year violation rates into crashes avoided, using the same methodology as for the direct effects estimation, summing over all carriers that showed improvement and expressed as a percentage change from base year crashes avoided. This improvement rate was applied to those carriers for which there were insufficient inspection data as well. An overall estimate of indirect effect crashes avoided combined the results for both carriers with sufficient inspection data and carriers with insufficient inspection data.

[11] http://www.co.saint-marys.md.us/dpw/prevemaint.asp.
[12] edmunds.com, "How to Do a Maintenance Inspection," http://www.edmunds.com/how-to/how-to-do-a-maintenance-inspection.html?articleid=43792.
[13] Boom Truck Resource Center, "Maintenance Schedule," http://www.boomtruck.com/services/Resources/Maintenance-schedule.aspx
[14] Source: FMCSA Field Office personnel.

Intervention Model 3.0 Approach

It was determined that the estimation of indirect effects would be eliminated from Intervention Model 3.0, based on research that attempted to answer two analyses questions.

Did significantly more carriers improve or decline in their performance between the base and the following year?

The intent of this analysis was to determine whether random year-to-year fluctuations in carrier performance were being credited as indirect benefits of the program. The analysis looked at each 2-year period between 2004 and 2008 inclusive, and compared the number of carriers whose year-to-year performance improved and the number of carriers whose performance declined, their average number of violations corrected during interventions, and the resulting estimated crashes avoided. As shown in Table 17, the difference in the number of carriers that improved and declined and their performance was not significant in any of the periods. The Version 2.0 indirect effects estimation looked only at carriers that improved, and ignored those that declined in performance. If Version 2.0 had also considered those carriers with declining performance, there would have been much less net improvement, and a smaller indirect effect.

Table 17. Change in Carrier Performance (Estimated Crashes Avoided)

2-Year Period	Carriers That Improved	Average Improvement	Carriers That Declined	Average Decline
2004–05	23,717	1.01	25,280	-1.00
2005–06	25,507	1.02	25,877	-1.03
2006–07	29,463	1.02	24,521	-1.01
2007–08	28,015	0.99	26,959	-1.00

Did improvement in carrier performance last for more than 1 year?

Using 2004 as a baseline, the analysis determined how many carriers sustained improved performance over the next 3 years. The carriers were grouped according to the number of inspections they received during the base year. Improvement was measured in terms of crashes avoided per inspection. Table 18 shows the probability of sustained improvement over the 3 years by the number of inspections in 2004 and the degree of improvement. It can be seen that carriers with the greatest number of inspections in 2004 had the greatest likelihood of maintaining improved performance during the next 3 years.

Table 18. Probability of a Carrier Sustaining Improved Performance for 3 Years by the Number of Inspections in 2004

Crashes Avoided	5–20 Inspections	21–35 Inspections	36–70 Inspections	70+ Inspections
0–0.25	12%	19%	21%	30%
0.25–5	18%	32%	38%	49%
0.5–75	24%	39%	50%	53%
0.75–1	29%	48%	58%	65%
1–2	41%	55%	65%	71%
2–3	50%	76%	76%	83%
3–4	57%	82%	100%	100%
4–5	70%	96%	100%	100%
5+	81%	97%	100%	100%

If Version 2.0 had considered fluctuating performance by a carrier during the 3-year period after the base to indicate a random response to its intervention experience, and had considered only those carriers that sustained their improvements over 3 years to represent actual behavioral changes, then the probabilities in Table 18 would represent the proportion of carriers in each category that experienced indirect effects of interventions. When these probabilities are applied to CY 2004–07, Table 19 shows the corresponding indirect effects estimates, which are on average about 10 percent of the indirect effects generated from Version 2.0. These estimates are within the range of the direct effects estimates.

Table 19. Indirect Effects Estimates Based on Sustained Improvement by Carriers

Year	Crashes Avoided	Number of Carriers with Sustained Improvement	Crashes Avoided per Carrier
CY 2004	246	8,286	0.030
CY 2005	279	7,929	0.035
CY 2006	536	9,065	0.059
CY 2007	517	8,742	0.059

Consideration of Duration in Version 3.0 Crash Risk Reduction Estimation

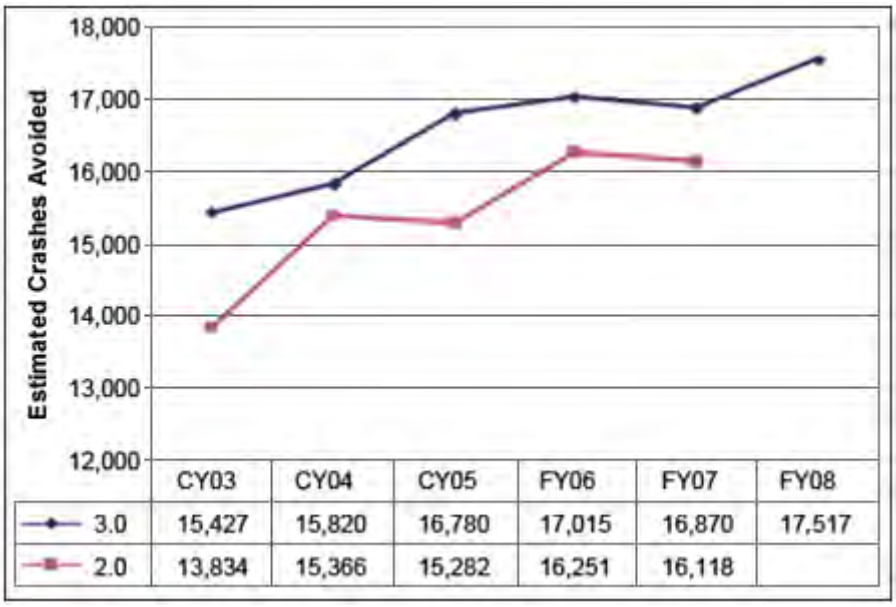
The improved crash risk reduction method for Intervention Model 3.0 encompasses indirect effects of interventions to some degree by including the concept of the duration of the crash risk reductions. Recall that correcting a violation results in a risk reduction for a greater duration than the daytrip during which the intervention occurs. This, in a sense, is an indirect effect. The durations in Table 15 can be considered measures of indirect effects of interventions that are much more straightforward and accountable than those produced by the Version 2.0 estimation method.

COMPARISON OF RESULTS BETWEEN INTERVENTION MODELS 3.0 AND 2.0

Due to the changes to the methodology introduced to Intervention Model 3.0 in FY 2008, one cannot directly compare FY 2008 results with estimates for previous years based on Version 2.0.

Most significantly, the method for determining the crash risk associated with violations in Version 3.0 is completely different from that used in previous versions. To provide a consistent time series of annual estimates for analytic purposes, Model 3.0 was run for several prior years, and the differences between results from the two models were compared.

Figure 7 shows that Version 3.0 direct effects estimates are consistently larger than those of Version 2.0, ranging from 3 to 12 percent.



	CY03	CY04	CY05	FY06	FY07	FY08
3.0	15,427	15,820	16,780	17,015	16,870	17,517
2.0	13,834	15,366	15,282	16,251	16,118	

Figure 7. Intervention Model: Direct Effects Versions 3.0 and 2.0

Figure 8 shows the magnitude of indirect effects as estimated by Version 2.0. As discussed in the previous section, recent analysis has shown these to have been inflated. Hence they were eliminated from Version 3.0.

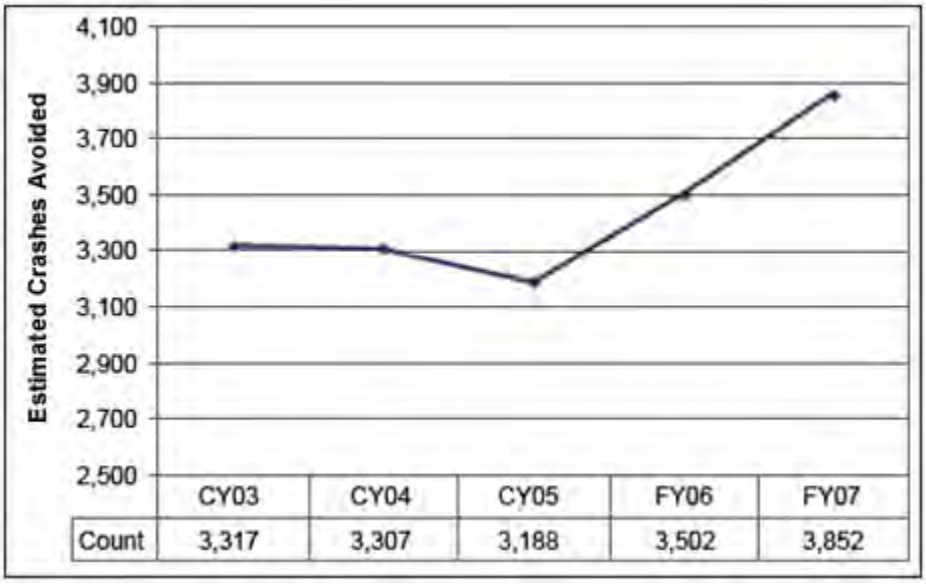


Figure 8. Intervention Model: Indirect Effects Version 2.0

Finally, Figure 9 shows a comparison of the overall results of Intervention Models 2.0 and 3.0. Because indirect effects are not estimated in Version 3.0, Version 3.0 estimates are consistently lower than those of Version 2.0, ranging from 84 to 91 percent of the latter. The elimination of indirect effects estimates and the implementation of the other modifications in Version 3.0 yield results that are based on a sounder and more defensible statistical footing.

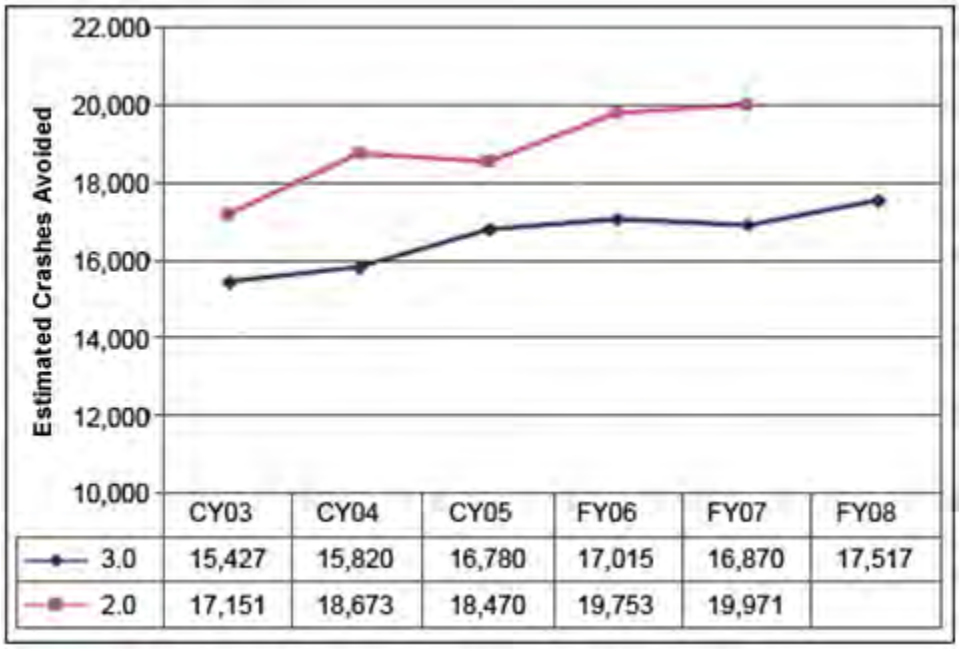


Figure 9. Intervention Model Results: Comparison of Versions 3.0 and 2.0