FMCSA Safety Program Effectiveness Measurement: Compliance Review Effectiveness Model Results for Carriers with Compliance Reviews in Fiscal Year 2007

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

August 2011

FOREWORD

This report documents the methodology and results from the Federal Motor Carrier Safety Administration's (FMCSA) Compliance Review (CR) Effectiveness Model. This model measures the effectiveness of one of the key safety programs of the FMCSA, the compliance review program. This work is part of an effort to assess the effectiveness of FMCSA's principal safety programs. The work also addresses the requirements of the Government Performance and Results Act (GPRA) of 1993, which obligates Federal agencies to measure the results of their programs as part of the budget cycle process.

The CR Effectiveness Model is one of two models that provide a baseline of the effectiveness of FMCSA safety programs through the use of standard safety performance measures. This baseline allows FMCSA to judge the relative performance of its programs on a periodic basis by reflecting the changes in benefits resulting from each program. The results of these analyses are also intended to provide a basis for FMCSA resource allocation and budgeting decisions that will more closely optimize the effectiveness and efficiency of its motor carrier safety programs.

NOTICE

Technical Report Documentation Page

1. Report No. **FMCSA-RRA-12-009**	2. Government Accession No.	3. Recipient's Catalog No.
4. Title and Subtitle **FMCSA Safety Program Effectiveness Measurement: Compliance Review Effectiveness Model Results for Carriers with Compliance Reviews in Fiscal Year 2007**		5. Report Date **August 2011** 6. Performing Organization Code
7. Author(s) **Jon M. Ohman**		8. Performing Organization Report No.
9. Performing Organization Name and Address **John A. Volpe National Transportation Systems Center** **Center for Safety Management Systems** **System Measurement and Analysis Division, RVT-33** **Kendall Square** **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 **Final Report** 14. Sponsoring Agency Code **FMCSA**
15. Supplementary Notes **Contracting Officer's Technical Representative: Richard Gruberg**		

16. Abstract

In FY 2007, Federal and State enforcement personnel conducted more than 15,000 CRs on individual motor carriers. It is intended that through education, heightened safety regulation awareness, and the enforcement effects of the CR, carriers will improve the safety of their commercial vehicle operations and, ultimately, reduce the number and severity of crashes in which they are involved.

The CR Effectiveness Model measures the direct impact of compliance reviews on carriers that received CRs. The model is based on the individual and cumulative "before and after" changes in the safety performance of carriers that received CRs in a given year. The model compares a motor carrier's crash rate in the 12 months following an onsite compliance review to its crash rate in the 12 months prior to that review. The model uses crash data reported by the States and power unit data reported by carriers or obtained during CRs to calculate both the before-CR and after-CR crash rates. This report documents the benefits derived from performing CRs on motor carriers in terms of crashes avoided, as well as lives saved and injuries prevented.

17. Key Words **CMV, Commercial motor vehicle, compliance reviews, CRs, crash avoidance, CREM, impact**	18. Distribution Statement **No restrictions**		
19. Security Classif. (of this report) **Unclassified**	20. Security Classif. (of this page) **Unclassified**	21. No. of Pages **34**	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	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	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 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 (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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ABBREVIATIONS, ACRONYMS, AND SYMBOLS

Acronym	Definition
CR	Compliance review
CY	Calendar year
FARS	Fatality Analysis Reporting System
FMCSA	Federal Motor Carrier Safety Administration
FMCSR	Federal Motor Carrier Safety Regulations
FHWA	Federal Highway Administration
FY	Fiscal year
GES	General Estimates System
GPRA	Government Performance and Results Act of 1993
MCMIS	Motor Carrier Management Information System
MCSAP	Motor Carrier Safety Assistance Program
NGA	National Governors' Association
NHTSA	National Highway Traffic Safety Administration
SafeStat	Motor Carrier Safety Status Measurement System
USDOT	U.S. Department of Transportation

See the FHWA Terminology and Acronyms supplement for a list of preferred acronyms.

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EXECUTIVE SUMMARY

BACKGROUND

This report documents the methodology and results from a model that measures the effectiveness of the compliance review (CR) program, one of the key safety programs of the Federal Motor Carrier Safety Administration (FMCSA). The work on the FMCSA Safety Program Effectiveness Measurement Project addresses the requirements of the Government Performance and Results Act (GPRA) of 1993, which obligates Federal agencies to measure the results of their programs as part of the budget cycle process.

This report describes the methodology of the Compliance Review Effectiveness Model and presents the results of the implementation of the model for carriers receiving CRs in fiscal year (FY) 2007. The benefits of the compliance review program are calculated in terms of crashes avoided, lives saved, and injuries avoided.

METHODOLOGY OF MODEL

The onsite compliance review is perhaps the single greatest resource-consuming activity of FMCSA. Thousands of CRs are conducted each year. In FY 2007, Federal and State enforcement personnel conducted more than 15,000 CRs on individual motor carriers. It is intended that through education, heightened safety regulation awareness, and the enforcement effects of the CR, carriers will improve the safety of their commercial vehicle operations and, ultimately, reduce the number and severity of crashes in which they are involved.

The CR Effectiveness Model was developed to determine the effectiveness of the CR program. The model measures the direct impact of compliance reviews on carriers that received CRs but not the "deterrent" effects (i.e., the "threat" of having a CR) on carriers that did not actually receive CRs. The model is based on the individual and cumulative "before and after" changes in the safety performance of carriers that received CRs in a given year. The model compares a motor carrier's crash rate in the 12 months following an onsite compliance review to its crash rate in the 12 months prior to that review. The model uses crash data reported by the States and power unit data reported by carriers or obtained during CRs to calculate both the before-CR and after-CR crash rates.

To eliminate the effects of changes in the average crash rate of the general carrier population, changes in crash reporting, and possibly other unknown factors, a control group of carriers that did not receive CRs was used. Any change in the average crash rate of the control group must be due to factors other than the effects of the CRs. Thus, the change in the average crash rate of the control group is calculated and then subtracted from the change in the average crash rate of the carriers that received CRs in the year in question, (i.e., the CR group). The difference resulting from this calculation represents the change in the average crash rate of the carriers that received CRs in the year in question that could be attributed to the CRs.

The FY 2007 CR effectiveness model used a control group that was based on carrier size and was generated from carriers that did not receive any CRs in FY 2007 or in the 4 years prior to FY 2007, (i.e., FY 2003–2006). The adoption of this control group is a refinement of the model as implemented for previous years.

The first three implementations of the model were on a calendar year (CY) basis. That is, the model was used to estimate benefits for carriers with CRs conducted in CY 2002, 2003, and 2004. Beginning with the report on carriers with CRs in FY 2005, the model has been implemented on a fiscal year basis to align the activities of the CR program with the program's funding cycle. It is now possible to link the results of the CRs conducted during a given fiscal year with the funding for the CR program for that fiscal year.

The Compliance Review Effectiveness Model succeeded the Compliance Review Impact Analysis Model, which was used to estimate the benefits for carriers with CRs from CY 1998, to 2001. Reports documenting these results are available at ai.fmcsa.dot.gov/CarrierResearchResults/Archives.asp?p=24.

The results from the two models are not directly comparable because the models use different methodologies and different data sources.

IMPLEMENTATION OF MODEL FOR CARRIERS WITH COMPLIANCE REVIEWS IN FY 2007

The CR Effectiveness Model was implemented for carriers with CRs in FY 2007 to estimate the number of crashes (and associated fatalities and injuries) avoided in the first year following their reviews, i.e., FY 2007–2008.

Table 1 shows these benefits, as well as the benefits that were estimated to have occurred in:

- CY 2002–2003 for carriers with CRs in CY 2002.
- CY 2003–2004 for carriers with CRs in CY 2003.
- CY 2004–2005 for carriers with CRs in CY 2004
- FY 2005–2006 for carriers with CRs in FY 2005.
- FY 2006–2007 for carriers with CRs in FY 2006.

The estimates from the model implementation for carriers with CRs in FY 2007 were made using the control group based on carrier size, a change from previous models. To allow for comparisons, the model was rerun for carriers with CRs in CY 2002–2004 and FY 2005–2006 using this new control group. The analysis showed that the estimates of crashes avoided produced by the new (i.e., carrier size) control group were within 4 percent of the estimates produced by the old (i.e., all non-CR carriers) control group. Since the two sets of estimates are of the same magnitude and follow the same trends, they are comparable.

Table 1. Results of Implementation of Compliance Review Effectiveness Model for Carriers with Compliance Reviews in CY 2002–2004 and FY 2005–2007

Model Implementation for Motor Carriers with CRs	CY 2002	CY 2003	CY 2004	FY 2005	FY 2006	FY 2007
Compliance reviews conducted	12,139	11,086	10,671	11,431	14,426	15,530
Motor carriers that received compliance reviews and: • were interstate carriers or intrastate hazardous materials carriers, • were active in the 12 months before and after their CRs, • had one or more power units in the 12 months before and after their CRs, and • had crash and power unit data that passed edit checks designed to screen out erroneous data.	9,172	8,587	8,042	8,941	10,732	11,353
Estimated percentage reduction in average crash rate due to compliance reviews	12.6%	17.6%	21.1%	16.3%	18.6%	14.7%
Model Results (i.e., Benefits) Estimated for:	**CY 2002–2003**	**CY 2003–2004**	**CY 2004–2005**	**FY 2005–2006**	**FY 2006–2007**	**FY 2007–2008**
Crashes Avoided	1,426	2,276	2,720	2,306	2,860	2,175
Fatal crashes avoided	53	77	92	79	93	68
Injury crashes avoided	677	1,038	1,186	982	1,185	879
Towaway crashes avoided	696	1,161	1,442	1,245	1,582	1,228
Lives saved	62	90	107	92	109	79
Injuries avoided	1,087	1,651	1,889	1,561	1,866	1,399

ADDITIONAL ANALYSIS

To further assess the effectiveness of the CR program, the results of the implementation of the model were broken down by carrier size (i.e., number of power units) and by the planned course of action (i.e., enforcement or no enforcement) for the carrier following its CR.

- The breakdown of the results of the model implementation by carrier size showed that the carriers with one to five power units had the largest reduction in the average crash rate in the 12 months following their CRs.
- The results of the implementation by planned course of action showed that the carriers for which enforcement actions were planned had a smaller reduction in their average crash rate than did the carriers for which no enforcement actions were planned.

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1. INTRODUCTION

1.1 BACKGROUND

During the 1980s, Congress passed several acts intended to strengthen motor carrier safety regulations. This led to the implementation of safety-oriented programs at both the Federal and State levels. The Surface Transportation Assistance Act of 1982 established the Motor Carrier Safety Assistance Program (MCSAP), a grants-in-aid program to States to conduct roadside inspection and traffic enforcement programs aimed at commercial motor vehicles. The 1984 Motor Carrier Safety Act directed the U.S. Department of Transportation (USDOT) to establish safety fitness standards for carriers. The USDOT, in conjunction with the States, implemented the MCSAP to fund the roadside inspection and traffic enforcement programs and the safety fitness determination process and rating system (based on onsite safety audits called compliance reviews).

It is expected that a major benefit of these programs has been and will continue to be an improved level of safety in the operation of commercial motor vehicles. Previously, however, there was no means to measure the benefits and effectiveness of these programs. The Safety Program Effectiveness Measurement Project was established to identify major functions and operations (programs) associated with the Federal Motor Carrier Safety Administration (FMCSA) mission and to develop results-oriented performance measures for those functions and operations, as called for in the Government Performance and Results Act (GPRA) of 1993.

1.2 PROJECT OBJECTIVE

Program evaluation should be viewed as a continuous management process that encourages the organization to reflect periodically upon how it is implementing its programs. Program effectiveness should be reassessed in light of the mission, available resources, changing requirements, political climate, technological change, public demands, and costs. Periodic review of the results of the evaluations will ensure that the activities are working, i.e., that they are delivering what was promised. This report is intended to assess the effectiveness of one of FMCSA's motor carrier safety programs, the compliance review (CR) program. The immediate objective of this effort is to measure how much of an impact the safety program activities have on avoiding crashes involving motor carriers and reducing resulting injuries and fatalities.

One of the main objectives of the Safety Program Effectiveness Measurement Project is to provide a baseline of the effectiveness of the selected programs through the use of standard safety performance measures. This baseline allows the FMCSA to judge the relative performance of its programs on a periodic basis by reflecting the benefits resulting from each program. The results of these analyses are intended to provide a basis for FMCSA resource allocation and budgeting decisions that will more closely optimize the effectiveness and efficiency of its motor carrier safety programs.

1.3 PROJECT SCOPE

The scope of this overall effort is limited to the major identifiable operational FMCSA programs and their effectiveness in reducing crashes and avoiding injuries and fatalities. Currently, the Safety Program Effectiveness Measurement Project includes the compliance review, roadside inspection, and traffic enforcement activities and programs performed and supported by the FMCSA. Two models have been developed to estimate the benefits of these programs: the Compliance Review Effectiveness Model and the Intervention Model (for roadside inspections and traffic enforcements). The benefits of these programs are calculated in terms of crashes avoided, lives saved, and injuries avoided.

An objective of the project is to continue to improve these models and update the results on a recurring basis. The models will serve the program-specific requirement to measure program effectiveness, as well as the broader function of supporting annual budget requirements and helping to determine the best resource allocation among program elements.

This report describes the methodology of the Compliance Review Effectiveness Model and presents the results of the implementation of the model for carriers receiving CRs in fiscal year (FY) 2007, including estimates of crashes avoided by carrier size and planned course of action.

The first three implementations of the model were on a calendar year (CY) basis. That is, the model was used to estimate benefits for carriers with CRs conducted in CY 2002, 2003, and 2004. Beginning with the report on carriers with CRs in FY 2005, the model has been implemented on a fiscal year basis to align the activities of the CR program with the program's funding cycle. It is now possible to link the results of the CRs conducted during a given fiscal year with the funding for the CR program for that fiscal year.

The Compliance Review Effectiveness Model succeeded the Compliance Review Impact Assessment Model, which was used to estimate the benefits for carriers with CRs in CY 1998, 1999, 2000, and 2001. (Reports documenting these results are available at ai.fmcsa.dot.gov/CarrierResearchResults/Archives.asp?p=24.) The results from the two models are not directly comparable because the models use different methodologies and different data sources.

2. COMPLIANCE REVIEW EFFECTIVENESS MODEL

2.1 COMPLIANCE REVIEWS

The onsite compliance review is perhaps FMCSA's single greatest resource-consuming activity. Thousands of CRs are conducted each year. In FY 2007, Federal and State enforcement personnel conducted more than 15,000 CRs on individual motor carriers.

When performing CRs, FMCSA and State safety investigators spend many hours examining the safety records of individual motor carriers to assess their compliance and safety performance. The investigators also discuss their findings with the carriers' safety managers to improve understanding of their safety programs. After a review is completed, the carrier is assigned a safety rating (i.e., satisfactory, conditional, or unsatisfactory). If serious violations are discovered, an enforcement case is initiated, and a fine may be imposed. The CR results are also incorporated, with other safety data (i.e., crashes, roadside inspection results, moving violations, and closed enforcement cases), into the Motor Carrier Safety Status Measurement System (SafeStat) to reassess the carrier's safety status. It is intended that through education, heightened safety regulation awareness, and the enforcement effects of the CR, carriers will improve the safety of their commercial vehicle operations, and, ultimately, reduce the number and severity of crashes in which they are involved.

2.2 METHODOLOGY OF THE MODEL

The CR Effectiveness Model was developed to determine the effectiveness of the CR program. The model measures the direct impact of compliance reviews on carriers that received CRs, but not the "deterrent" effects (i.e., the "threat" of having a CR) on carriers that did not actually receive CRs. In addition, the model was designed to estimate only the benefits that occur in the 12 months following a CR. The model is based on the individual and cumulative "before-and-after" changes in the safety performance of carriers that have received CRs. The model compares a motor carrier's crash rate in the 12 months following an onsite compliance review to its crash rate in the 12 months prior to that review. The model uses crash data reported by the States and power unit data obtained during CRs or from updated Form MCS-150 information submitted by carriers to calculate both the before-CR and after-CR crash rates. The data are stored in the FMCSA's Motor Carrier Management Information System (MCMIS).

2.3 RESULTS OF IMPLEMENTATION OF MODEL FOR CARRIERS WITH COMPLIANCE REVIEWS IN FISCAL YEAR 2007

A diagram of the CR Effectiveness Model, as implemented for carriers with CRs in FY 2007, is shown in Figure 1. The model estimates the number of crashes (and associated fatalities and injuries) avoided in the 12 months following the CRs. Thus, the benefits from the CRs conducted in FY 2007 occurred in both FY 2007 and FY 2008.

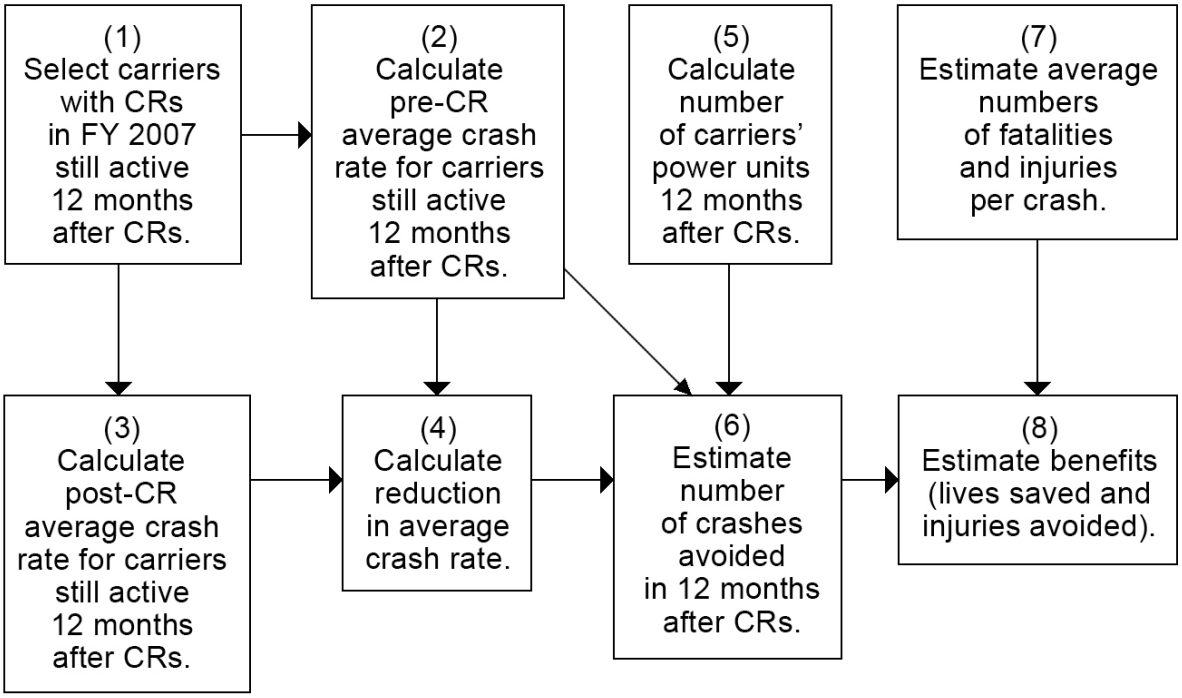

Figure 1. Compliance Review Effectiveness Model

A step-by-step description of the implementation procedure follows. The step numbers correspond to the numbers in the flowchart.

(1) Select carriers with one or more compliance reviews (CRs) in FY 2007 that were still active 12 months after their CRs.

There were 11,353 carriers that received CRs in FY 2007, were still active 12 months after their CRs (i.e., throughout their post-CR periods), and met the following conditions:

- The carrier was either an interstate carrier or an intrastate hazardous materials carrier.
- The carrier was active throughout the pre-CR period (i.e., the 12 months before the CR).
- The carrier had one or more power units throughout the pre-CR and post-CR periods (i.e., the 12 months before and after the CR).
- If the carrier had more than one CR in FY 2007, the latest one was used.
- The carrier's crash and power unit data had to pass edit checks designed to screen out erroneous data (If the ratio of pre-CR to post-CR power units or the ratio of post-CR to pre-CR power units was greater than 100, then the carrier was excluded from the analysis. If either ratio was greater than 5, then the carrier's power unit and crash data were reviewed manually to determine their validity).

(2) Calculate the pre-CR average crash rate.

The 11,353 carriers that received CRs in FY 2007 and were still active 12 months after their CRs had a pre-CR average crash rate of 4.539 crashes per 100 power units. This average was obtained by dividing the total number of carriers' crashes in the 12 months before their FY 2007 CRs by their total number of power units and then multiplying by 100. In the rate calculation for each carrier, the power unit data were taken from the snapshot of MCMIS data used in the SafeStat run for the month following the carrier's CR. That way, the power unit data used in the rate calculation would reflect the power unit data collected during the CR.

(3) Calculate the post-CR average crash rate.

The 11,353 carriers that received CRs in FY 2007 and were still active 12 months after their CRs had a post-CR average crash rate of 3.872 crashes per 100 power units. This average was obtained by dividing the total number of carriers' crashes in the 12 months after their FY 2007 CRs by their total number of power units and then multiplying by 100. In the rate calculation for each carrier, the power unit data were taken from the snapshot of MCMIS data 1 year after the snapshot used to supply the carrier's pre-CR power unit data.

For example, if a carrier had a CR on August 15, 2007, then power unit data from the September 2007 MCMIS data snapshot would have been used to calculate its pre-CR average crash rate, and power unit data from the September 2008 MCMIS data snapshot would have been used to calculate its post-CR average crash rate. The carrier's pre-CR period (i.e., the 12 months prior to the CR) would have been August 15, 2006, to August 14, 2007, while its post-CR period (i.e., the 12 months after the CR) would have been August 16, 2007, to August 15, 2008. This information is shown in the timeline in Figure 2.

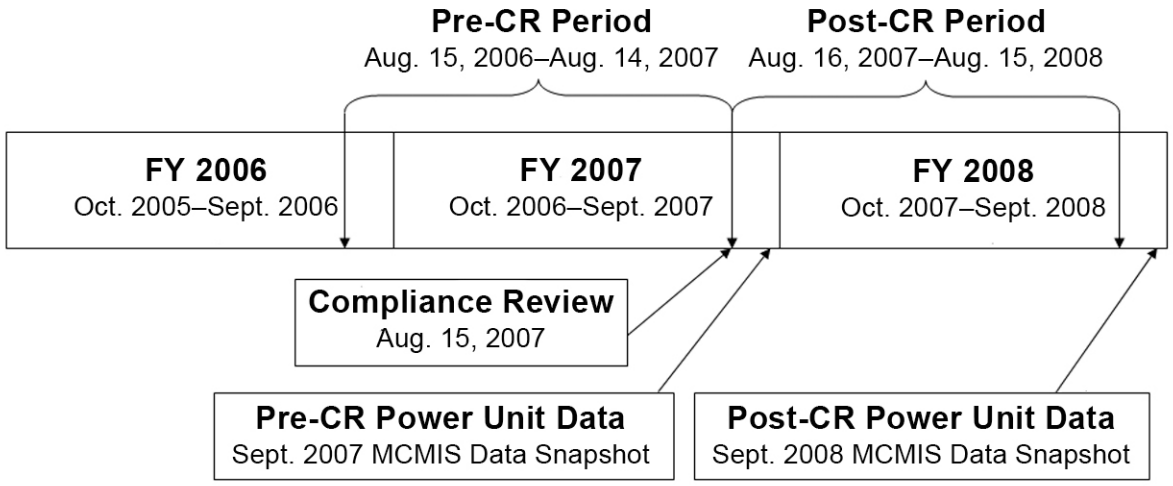

Figure 2. Timeline for a Carrier with a Compliance Review on August 15, 2007

(4) Calculate the reduction in the average crash rate.

(4a) Calculate the reduction using the data for the carriers with CRs in FY 2007.

The percentage change in the average crash rate of carriers with CRs in FY 2007 was calculated as follows:

$$\frac{\text{Post-CR Average Crash Rate - Pre-CR Average Crash Rate}}{\text{Pre-CR Average Crash Rate}} \times 100$$

$$= \frac{3.872 - 4.539}{4{,}539} \times 100 = -14.69\%$$

Figure 3. Formula to calculate the change in the average crash rate

(4b) Adjust the reduction for changes in the average crash rate of the general carrier population.

The change in the average crash rate of the carriers that received CRs (i.e., the CR group) calculated in Step 4a above is not adjusted for changes in the average crash rate of the general carrier population. For example, if the average crash rate of all carriers had decreased during the same period in which the CR group's average crash rate decreased, then the reduction in the CR group's average crash rate calculated in Step 4a would have been exaggerated. That is, not all of the reduction would have been the result of the CRs. Conversely, if the average crash rate of the general carrier population had increased during this period, then the reduction in the CR group's average crash rate calculated in Step 4a would have been less than the actual crash rate reduction due to the CRs.

Another factor that must be considered in the analysis of carriers that received CRs in FY 2007 is improved crash reporting. Over the past several years, the FMCSA has made a concerted effort to improve the timeliness and completeness of crash reporting by the states. As a result, crashes are being reported earlier and more completely. This improved crash reporting will tend to increase the post-CR average crash rate and produce a smaller crash rate reduction in the CR group's average crash rate than actually occurred.

To eliminate the effects of these factors, a control group of carriers was used. Any change in the average crash rate of the control group must have been due to factors other than the effects of the CRs. Thus, the change in the average crash rate of the control group was calculated and then subtracted from the change in the average crash rate of the carriers that received CRs in FY 2007. The difference resulting from this calculation represents the change in the average crash rate of the carriers that received CRs in FY 2007 that could be attributed to the CRs.

In the previous implementations of the CR Effectiveness Model, the control group consisted of all carriers that did not receive CRs in the year being analyzed. There was a concern, however, that the crash rate reduction shown by this control group might have been exaggerated, because the control group contained a higher proportion of small carriers than did the CR group. The model's results have consistently shown that small carriers that receive CRs have a higher level of crash rate reduction than do large carriers that receive CRs. The same relationship has also been found in the carriers that do not receive CRs.

Due to this concern, the control group was modified, beginning with the current model implementation (for carriers with CRs in FY 2007). Based on the results of an analysis, it was determined that a control group with characteristics similar to the CR group in terms of carrier size was appropriate. (This analysis will be documented in a separate report.)

A second concern with the control group was that, although the control group carriers did not have CRs in FY 2007, some of them may have had CRs in the years before FY 2007. As a result, these carriers may still have been exhibiting crash rate reduction in FY 2007. To address this concern, it was decided that the new control group would be generated from carriers that did not receive any CRs in FY 2007 or in the 4 years prior to FY 2007, i.e., FY 2003-2006.

These carriers were used to generate a control group consisting of 11,353 carriers, one for each carrier in the CR group. The process that was used to create the control group is described in Appendix A.

The 11,353 carriers in the control group had a pre-CR average crash rate of 1.623 crashes per 100 power units and a post-CR average crash rate of 1.623 crashes per 100 power units.

The percentage change in the average crash rate of the control group was calculated as follows:

$$\frac{1.623 - 1.623}{1.623} \times 100 = 0\% \text{ (i.e., no change)}$$

Figure 4. Percentage Change in the Control Group's Average Crash Rate

This zero change in the average crash rate of the control group is the sum of the effects of a change in the average crash rate of the general carrier population, changes in crash reporting, and possibly other unknown factors. To determine how much each element contributed to the zero change, a separate set of calculations was performed. The calculations showed that there was an estimated 1.50 percent decrease in the average crash rate of the general carrier population. Therefore, the estimated zero change in the average crash rate of the control group was the sum of an estimated 1.50 percent decrease in the crash rate of the general carrier population and an estimated 1.50 percent increase due to changes in crash reporting and possibly other unknown factors. These calculations are shown in Appendix B.

Therefore, the adjusted change in the average crash rate due to the CRs conducted in FY 2007 was the percentage change in the average crash rate of carrier with CRs in FY 2007 minus the percentage change in the average crash rate of the control group (i.e., -14.69 percent minus zero) equals -14.69 percent, or rounded off to a decrease of 14.7 percent.

(5) Calculate the number of post-CR power units, i.e., the number of power units 12 months after the CRs in FY 2007.

The 11,353 carriers that received CRs in FY 2007 and were still active 12 months after their CRs had a total of 325,907 power units 12 months after their CRs. This number was used to calculate the post-CR average crash rate in Step 3.

(6) Estimate the number of crashes avoided in FY 2007–2008 as a result of the CRs conducted in FY 2007.

The estimated number of crashes avoided in FY 2007–2008 by the 11,353 carriers that received CRs in FY 2007 and were still active 12 months after their CRs was calculated as 4.539 crashes per 100 power units, times 14.7 percent, times 325,907 power units equals 2,175 crashes.

Next, estimates were made for the number of crashes avoided in FY 2007–2008 by the carriers receiving CRs in FY 2007, by crash severity, i.e., fatal, injury, and towaway. (A *fatal* crash results in at least one fatality. An *injury* crash results in no fatalities but does result in bodily injury to at least one person who, as a result of the injury, immediately receives medical treatment away from the scene of the crash. A *towaway* crash results in no fatalities or injuries requiring transport for immediate medical attention, but in one or more motor vehicles incurring disabling damage as a result of the crash, requiring the vehicle(s) to be transported away from the scene by a tow truck or other motor vehicle.) State-reported crash data from the MCMIS Crash File were used to compute these proportions. Of the crashes involving large trucks or buses in FY 2007-2008, the period in which the benefits of the CRs conducted in FY 2007 would occur, 3.14 percent were fatal crashes, 40.40 percent were injury crashes, and 56.46 percent were towaway crashes.

Applying these proportions to the estimate of 2,175 crashes avoided produced the results shown in Table 2:

Table 2. Estimated Number of Crashes Avoided in FY 2007–2008

Fatal Crashes	2,175 × 3.14% = 68
Injury Crashes	2,175 × 40.40% = 879
Towaway Crashes	2,175 × 56.46% = 1,228

(7) Estimate the average numbers of fatalities and injuries per crash in FY 2007–2008.

The average number of fatalities per fatal crash was estimated from State-reported crash data from the MCMIS Crash File. For crashes in FY 2007-2008 involving large trucks or buses, the ratio was 1.16 fatalities per fatal crash.

The number of injuries per crash involves fatal as well as injury crashes, since fatal crashes can also result in injuries. State-reported crash data from the MCMIS Crash File were used to estimate the average numbers of injuries in fatal and injury crashes. For FY 2007–2008 large truck and bus crashes, the averages were as follows:

- Fatal crashes: 1.05 injuries per crash.
- Injury crashes: 1.51 injuries per crash.

(8) Estimate the benefits (i.e., lives saved and injuries avoided) that occurred in FY 2007–2008.

The estimated number of lives saved in the crashes avoided in FY 2007–2008 by the carriers with CRs in FY 2007 was calculated as number of fatal crashes avoided multiplied by the average number of fatalities per fatal crash, or 68 times 1.16 equals 79 lives saved.

The estimated number of injuries avoided in the crashes avoided in FY 2007–2008 by the carriers with CRs in FY 2007 was calculated as (the number of fatal crashes avoided multiplied by the average number of injuries per fatal crash), plus (the number of injury crashes avoided multiplied by the average number of injuries per injury crash), or (68 × 1.05) + (879 × 1.51) = 1,399 injuries avoided

Table 3 summarizes the estimated benefits that occurred in FY 2007–2008 as a result of the CRs conducted in FY 2007 on the 11,353 carriers that were still active 12 months after their CRs and met the additional criteria listed in the table. The table also shows the estimated benefits from the CRs conducted in CY 2002, CY 2003, CY 2004, FY 2005, and FY 2006 that occurred in CY 2002-2003, CY 2003-2004, CY 2004–2005, FY 2005–2006, and FY 2006–2007, respectively.

Table 3. Results of Implementation of Compliance Review Effectiveness Model for Carriers with Compliance Reviews in CY 2002–2004 and FY 2005–2007

Model Implementation for Motor Carriers with CRs	CY 2002	CY 2003	CY 2004	FY 2005	FY 2006	FY 2007
Compliance reviews conducted	12,139	11,086	10,671	11,431	14,426	15,530
Motor carriers that received compliance reviews and: • were interstate carriers or intrastate hazardous materials carriers, • were active in the 12 months before and after their CRs, • had 1 or more power units in the 12 months before and after their CRs, and • had crash and power unit data that passed edit checks designed to screen out erroneous data.	9,172	8,587	8,042	8,941	10,732	11,353
Estimated percentage reduction in average crash rate due to compliance reviews	12.6%	17.6%	21.1%	16.3%	18.6%	14.7%
Model Results (i.e., Benefits) Estimated for:	**CY 2002–2003**	**CY 2003–2004**	**CY 2004–2005**	**FY 2005–2006**	**FY 2006–2007**	**FY 2007–2008**
Crashes Avoided	1,426	2,276	2,720	2,306	2,860	2,175
Fatal crashes avoided	53	77	92	79	93	68
Injury crashes avoided	677	1,038	1,186	982	1,185	879
Towaway crashes avoided	696	1,161	1,442	1,245	1,582	1,228
Lives saved	62	90	107	92	109	79
Injuries avoided	1,087	1,651	1,889	1,561	1,866	1,399

The estimates from the model implementation for carriers with CRs in FY 2007 were made using the control group based on carrier size. The estimates from the previous model implementations were made using the control group consisting of all non-CR carriers. This change in methodology raises the question of whether the results of the implementation for FY 2007 are comparable with the results for the previous years. To answer this question, the model was rerun for carriers with CRs in CY 2002–2004 and FY 2005–2006 using the new control group based on carrier size. The analysis showed that the estimates of crashes avoided produced by the new (i.e., carrier size) control group were within 4 percent of the estimates produced by the old (i.e., all non-CR carriers) control group. Since the two sets of estimates are of the same magnitude and follow the same trends, they are comparable.

3. ADDITIONAL ANALYSIS

3.1 OVERVIEW

The safety benefits calculated by the model results were broken down by carrier size (i.e., number of pre-CR power units) and the planned course of action (i.e., enforcement or no enforcement) after the CR.

The results of these analyses reveal the types of carriers that will most likely respond positively to CRs. By focusing on carriers that are likely to respond positively to CRs, the effectiveness of the compliance review program may be improved. Alternative treatment approaches may be suggested for carriers that are at risk but will most likely not respond positively to CRs.

3.2 METHODOLOGY

The control group was broken down by size subgroup and planned course of action. (Each generated control group carrier was assigned the same size subgroup and planned course of action data values as its associated carrier in the CR group.) In each case, a different adjustment was made for each value of the attribute. Estimates were then combined where necessary in the planned course of action analysis.

The sum of the estimates of crashes avoided by each attribute (size and planned course of action) subgroup did not equal the estimate of 2,175 crashes avoided that was obtained in Section 2.3. (This result stems from the fact that both the pre-CR average crash rate and the percent reduction in the average crash rate were calculated separately for each attribute subgroup. If the product of these two parameters is not the same for each of the subgroups, then the safety benefits will not necessarily add up to the total benefits calculated in the original analysis.) Therefore, the estimates were prorated to sum to this number. For each attribute, the subgroup estimates of crashes avoided were summed to a total, which will be denoted as X. The subgroup estimates were prorated to the total of 2,175 by multiplying each subgroup estimate by the factor $(2{,}175 \div X)$. These prorated estimates were then used to derive the percent change in the average crash rate and the post-CR average crash rate for each subgroup.

The estimated numbers of crashes avoided, the adjusted post-CR average crash rates, and the adjusted percent changes in the average crash rates shown in Table 4 and Table 5 were both derived using this prorating procedure.

An additional change to the methodology was made beginning with the FY 2007 model implementation concerning “negative” crashes avoided. A negative estimate of crashes avoided in a carrier subgroup indicates that some of the carriers in that subgroup did not respond positively to the CRs that they received. The model, however, does not allow for the possibility that a CR could cause crashes to occur. Thus, if a subgroup of carriers showed a negative estimate of crashes avoided, the estimate for the subgroup was set to zero, and the total of 2,175 crashes avoided was prorated over the subgroups with positive estimates of crashes avoided. This

procedure does not change the estimate of the total number of crashes avoided, but only the distribution of the number of crashes avoided among the carrier subgroups.

3.3 CARRIER SIZE

The results of the implementation of the model were broken down by carrier size as measured by the number of power units at the time of the CR, i.e., the number of pre-CR power units.

Table 4 shows the results of the implementation of the model for the four size subgroups:

- 1–5 power units.
- 6–20 power units.
- 21–100 power units.
- 101 or more power units.

Table 4. Results of Implementation of Model by Carrier Size

Number of Pre-CR Power Units	Number of Carriers with CRs in FY 2007	Pre-CR Average Crash Rate*	Adjusted Post-CR Average Crash Rate*	Adjusted Percent Change in Average Crash Rate	Estimated Number of Crashes Avoided in FY 2007–2008
1–5	5,281	9.991	5.619	-43.8	632
6–20	3,875	7.047	5.010	-28.9	871
21–100	1,805	5.163	4.309	-16.5	672
≥101	392	3.334	–	–	0†
All Carriers	11,353	4.539	3.872	-14.7	2,175

* Crashes per 100 power units

† Negative estimate set to zero

Table 4 shows, for each size subgroup, the number of carriers in the group that received CRs in FY 2007, the pre-CR average crash rate, the adjusted post-CR average crash rate, and the adjusted percent change in the average crash rate after receiving the CRs. Table 4 also shows, for each size subgroup, the estimated number of crashes avoided as a result of the CRs.

The reduction in the average crash rate was inversely related to the size of the carrier, i.e., the larger the carrier, the smaller the crash rate reduction. The reductions in the average crash rate ranged from 43.8 percent for carriers with 1–5 power units to 16.5 percent for carriers with 21–100 power units. Carriers with 101 or more power units had an increase in their average crash rate and, thus, a negative estimate of crashes avoided. This estimate was set to zero in accordance with the methodology change discussed in Section 3.2.

Carriers with 6–20 power units had the largest number of crashes avoided due to the program (871), followed by carriers with 21–100 power units (672) and carriers with 1–5 power units (632).

The results of this analysis are consistent with the results of the analyses of data from the implementations of the model for carriers with CRs in CY 2002, CY 2003, CY 2004, FY 2005, and FY 2006. (Reports documenting these results are available at ai.fmcsa.dot.gov/CarrierResearchResults/Archives.asp?p=24.) They are also consistent with the results of analyses of data from the implementations of the previous model, the Compliance Review Impact Assessment Model. (A report documenting these results is available at ai.fmcsa.dot.gov/CarrierResearchResults/Archives.asp?p=24.)

3.4 PLANNED COURSE OF ACTION

The results of the implementation of the model were also broken down by the course of action planned by FMCSA for the carrier following its FY 2007 CR. A carrier with a prosecution, State prosecution, or out-of-service order indicated as the planned course of action was classified as an "enforcement" carrier. A carrier with only compliance monitoring indicated as the planned course of action was classified as a "non-enforcement" carrier. The results for the four courses of action were calculated. The results for prosecution, State prosecution, and out-of-service were then combined under "enforcement."

These courses of action are the ones that were anticipated by FMCSA at the conclusions of the CRs that the carriers received in FY 2007 and may be different from the actions that were actually taken. The data in the MCMIS Compliance Review File do not indicate the actual actions taken after the CRs.

Table 5 shows, for each action type, the number of carriers that received CRs in FY 2007, the pre-CR average crash rate, the adjusted post-CR average crash rate, and the adjusted percent change in the average crash rate after receiving the CRs. Table 5 also shows, for each action type, the estimated number of crashes avoided as a result of the CRs.

Table 5 shows that it was anticipated that 3,298 (or 29.0 percent) of the 11,353 carriers that received CRs in FY 2007 would undergo enforcement actions. The "enforcement" carriers showed a crash rate reduction of 14.3 percent, compared to a 14.9 percent reduction for the "non-enforcement" carriers. The "enforcement" carriers accounted for 653, or 30.0 percent, of the 2,175 crashes avoided in FY 2007–2008.

Table 5. Results of Implementation of Model by Type of Planned Course of Action

Type of Planned Course of Action	Number of Carriers with CRs in FY 2007	Pre-CR Average Crash Rate*	Adjusted Post-CR Average Crash Rate*	Adjusted Percent Change in Average Crash Rate	Estimated Number of Crashes Avoided in FY 2007–2008
Enforcement	3,298	5.218	4.473	-14.3	653
Non-Enforcement	8,055	4.285	3.646	-14.9	1,522
Total	**11,353**	**4.539**	**3.872**	**-14.7**	**2,175**

* Crashes per 100 power units

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APPENDIX A—PROCESS USED TO CREATE THE CONTROL GROUP

OVERVIEW

This section describes the criteria used to create the control group. Since control-group carriers did not receive CRs, a protocol had to be developed for assigning their crashes and power unites to the pre- and post-CR time periods, which is also discussed below.

METHODOLOGY

To create this control group, the population of carriers that did not receive CRs in FY 2007 (i.e., non-CR carriers) was used. The control group was generated from non-CR carriers that met the following additional conditions:

- The carrier was either an interstate carrier or an intrastate hazardous materials carrier.
- The carrier must have been active throughout the pre-CR period (FY 2006–2007, i.e., October 2005–September 2007) and the post-CR period (FY 2007–2008, i.e., October 2006–September 2008).
- The carrier must have had one or more power units throughout the pre-CR and post-CR periods (i.e., October 2005–September 2008).
- The carrier must not have had any CRs in the 4 years prior to FY 2007, i.e., FY 2003, FY 2004, FY 2005, or FY 2006.
- The carrier's crash and power unit data had to pass various edit checks designed to screen out erroneous data.

The 495,269 carriers that met these criteria will be referred to as the eligible non-CR carrier population. These carriers were broken down into the four size subgroups (i.e., 1–5, 6–20, 21–100, and 101+ power units) used in the additional analysis in Section 3.3. The average numbers of pre-CR crashes, pre-CR power units, post-CR crashes, and post-CR power units per carrier per year were calculated for each of the subgroups. Each carrier in the CR group was matched with a "pseudo" control group carrier that had the average crash and power unit values for that carrier's size subgroup. The control group carrier was assigned the same size subgroup and planned course of action data values as the carrier in the CR group.

It is common practice to randomly select a carrier from the eligible non-CR carrier population that was in the same size subgroup as the corresponding carrier in the CR group. In this instance, however, since complete data were available for the entire eligible non-CR carrier population, it was decided to use subgroup averages in order to prevent the introduction of sampling error into the estimates.

CALCULATION OF SUBGROUP AVERAGES

The average numbers of pre-CR and post-CR crashes and power units per carrier per year were calculated for each size subgroup in the eligible non-CR carrier population. The formulas used are shown in this section.

Let *x* be a size subgroup in the eligible non-CR carrier population.

Let C_{xy} = the number of crashes in subgroup *x* in fiscal year *y*, and
P_{xy} = the number of power units in subgroup *x* in fiscal year *y*, and
N_x = the number of carriers in subgroup *x*.

The pre-CR period covers FY 2006 and FY 2007. Therefore, as shown in Figure 5, the average number of pre-CR crashes per carrier per year in subgroup *x* is defined as:

$$\frac{\frac{1}{2}\sum_{y=2006}^{2007}\sum_{n=1}^{N_x} C_{xy}}{N_x}$$

Figure 5. Equation to Define Average Number of Pre-CR Crashes per Carrier per Year

The post-CR period covers FY 2007 and FY 2008. Therefore, as shown in Figure 6, the average number of post-CR crashes per carrier per year in subgroup *x* is defined as:

$$\frac{\frac{1}{2}\sum_{y=2007}^{2008}\sum_{n=1}^{N_x} C_{xy}}{N_x}$$

Figure 6. Equation to Define Average Number of Post-CR Crashes per Carrier per Year

Similarly, Figure 7 shows the average number of pre-CR power units per carrier per year in subgroup *x* is defined as:

$$\frac{\frac{1}{2}\sum_{y=2006}^{2007}\sum_{n=1}^{N_x} P_{xy}}{N_x}$$

Figure 7. Equation to Define Average Number of Pre-CR Power Units per Carrier per Year

Figure 8 shows that the average number of post-CR power units per carrier per year in subgroup *x* is defined as:

$$\frac{\frac{1}{2}\sum_{y=2007}^{2008}\sum_{n=1}^{N_x} P_{xy}}{N_x}$$

Figure 8. Equation to Define Average Number of Post-CR Power Units per Carrier per Year

Table 6 shows the crash and power unit values that were assigned to the generated control group carriers. These values are the average numbers of pre-CR and post-CR crashes and power units per carrier per year in each size subgroup in the eligible non-CR carrier population. Table 6 also shows the resulting pre-CR and post-CR average crash rates for each size subgroup.

Table 6. Crash and Power Unit Values Assigned to Control Group Carriers

Size Subgroup†	Pre-CR Avg. No. of Crashes	Pre-CR Avg. No. of Power Units	Pre- CR Average Crash Rate*	Post-CR Avg. No. of Crashes	Post-CR Avg. No. of Power Units	Post-CR Average Crash Rate*
1	0.02574	1.7520	1.469	0.02551	1.7944	1.422
2	0.16138	9.7553	1.654	0.16358	9.9756	1.640
3	0.75032	40.0620	1.873	0.74753	40.9407	1.826
4	8.74691	566.8328	1.543	8.80472	564.1355	1.561

* Crashes per 100 power units

† Size Subgroup 1: 1–5 power units
Size Subgroup 2: 6–20 power units
Size Subgroup 3: 21–100 power units
Size Subgroup 4: 101 or more power units

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APPENDIX B—ALLOCATION OF CHANGE IN AVERAGE CRASH RATE OF CONTROL GROUP

The 11,353 carriers in the control group had a pre-CR average crash rate of 1.623 crashes per 100 power units and a post-CR average crash rate of 1.623 crashes per 100 power units.

Figure 9 shows the formula to determine the percentage change in the average crash rate of the control group.

$$\frac{\text{Post-CR Average Crash Rate - Pre-CR Average Crash Rate}}{\text{Pre-CR Average Crash Rate}} \times 100$$

$$\frac{1.623 - 1.623}{1.623} \times 100 = 0\% \text{ (i.e., No Change)}$$

Figure 9. Percentage Change in the Control Group's Average Crash Rate

This zero change in the average crash rate of the control group is the sum of the effects of a change in the average crash rate of the general carrier population, changes in crash reporting, and possibly other unknown factors. To determine how much each of these elements contributed to the zero change, an estimate of the change in the average crash rate of the general carrier population was calculated.

Data independent of the State-reported crash data used in the CR Effectiveness Model were used to calculate the large truck crash rates for the entire pre-CR and post-CR periods, i.e., FY 2006–2007 and FY 2007–2008, and the percent change in the two crash rates. This change represents the estimated change in the average crash rate of the general carrier population.

These crash rates were calculated using large truck crash data from the Fatality Analysis Reporting System (FARS) and the General Estimates System (GES), which are maintained by the National Highway Traffic Safety Administration (NHTSA). Counts of fatal crashes were obtained from FARS, which contains data on a census of fatal crashes. Counts of injury crashes and property-damage-only crashes were obtained from GES, which produces crash estimates from a national probability sample of all police-reported crashes. Crashes are included in the sample whether or not they are reported by the States to the FMCSA.

The NHTSA crash classification system differs from the National Governors' Association (NGA) standard used by the States to report crashes to the FMCSA. In both systems, a fatal crash is defined as a crash resulting in at least one fatality, but the NHTSA rule specifically requires that at least one death occur within 30 days of the crash. For non-fatal crashes, the differences are as follows:

The NGA categories of non-fatal crashes are *injury* and *towaway*:

- An *injury* crash is a crash that results in no fatalities but does result in bodily injury to at least one person who, as a result of the injury, immediately receives medical treatment away from the scene of the crash.
- A *towaway* crash is a crash that results in no fatalities or injuries requiring transport for immediate medical attention, but results in one or more motor vehicles incurring disabling damage as a result of the crash, requiring the vehicle(s) to be transported away from the scene by a tow truck or other motor vehicle.

The NHTSA categories of non-fatal crashes are *injury* and *property-damage-only*:

- An *injury* crash is a crash that results in no fatalities but in which one person was reported to have:
  - An incapacitating injury.
  - A visible but not incapacitating injury.
  - A possible but not visible injury.
  - An injury of unknown severity.
- A *property-damage-only* crash is a crash that results in no fatalities or injuries but does result in property damage.

The NHTSA non-fatal crash categories include many more crashes of lower severity than do the NGA non-fatal crash categories. Since it is the change in crash rates that is being measured, rather than the crash rates themselves, using the FARS and GES data provides a reasonable indication of the change in the NGA crash rate calculated using the FMCSA's MCMIS data.

While FARS data for FY 2006, 2007, and 2008 were obtained, GES data are not available by fiscal year. Thus, calendar year GES crash data were used in the calculations.

Power unit data were obtained from the Federal Highway Administration (FHWA). The FHWA collects truck registration data from the 50 States and the District of Columbia. The data obtained were the numbers of large trucks registered in the U.S. in CY 2006, 2007, and 2008. These CY numbers were used because they are the only national registration figure available, and some States report their data on a fiscal year basis. Therefore, the FHWA numbers are not pure calendar year numbers but are a mixture of calendar and fiscal year numbers.

The estimated change in the average crash rate of the general carrier population, as measured by the FARS and GES data, was calculated as shown in Figure 10:

$$\frac{\text{Post-CR Average Crash Rate - Pre-CR Average Crash Rate}}{\text{Pre-CR Average Crash Rate}} \times 100 = \text{Percent Change in Average Crash Rate}$$

Figure 10. Formula to Determine the Percent Change in the Average Crash Rate of the General Carrier Population

The pre-CR average crash rate is the average crash rate for the entire pre-CR period, i.e., FY 2006–2007, while the post-CR average crash rate is the average crash rate for the entire post-CR period, i.e., FY 2007–2008. The pre-CR and post-CR average crash rates were calculated as shown in Figure 11:

$$\frac{\text{Large Truck Crashes in FY06 + Large Truck Crashes in FY07}}{\text{Large Trucks Registered in CY06 + Large Trucks Registered in CY07}} \times 100 = \text{Pre-CR Average Crash Rate}$$

$$\frac{\text{Large Truck Crashes in FY07 + Large Truck Crashes in FY08}}{\text{Large Trucks Registered in CY07 + Large Trucks Registered in CY08}} \times 100 = \text{Post-CR Average Crash Rate}$$

Figure 11. Formulas to Determine the Pre-CR and Post-CR Average Crash Rates

The general carrier population had a pre-CR average crash rate of 4.268 crashes per 100 power units and a post-CR average crash rate of 4.204 crashes per 100 power units.

The estimated percentage change in the average crash rate of the general carrier population was calculated as shown in Figure 12:

$$\frac{4.204 - 4.268}{4.268} \times 100 = -1.50\% \text{ (i.e., a Decrease of 1.50 Percent)}$$

Figure 12. Formula Works Out the Math to Determine the Change in the Average Crash Rate of the General Carrier Population

Thus, the combined data from NHTSA and FHWA suggest that a more accurate estimate of the change in the crash rate of the general carrier population from FY 2006–2007 to FY 2007–2008 was a decrease of 1.50 percent.

Therefore, (see Figure 13), the percentage change in the crash rate of the control group caused by changes in crash reporting and possibly other unknown factors was:

Percentage in Average Crash Rate of Control Group (from State-Reported Data)
- Percentage Change in Average Crash Rate of General Carrier Population (from FARS and GES Data)
= 0 - (-1.50) = 1.50% (i.e., an Increase of 1.50 Percent)

Figure 13. Formula for Estimating the Difference in the Crash Rates of the Control Group Versus the General Carrier Population

Thus, the estimated zero change in the average crash rate of the control group was the sum of the estimated 1.50 percent decrease in the crash rate of the general carrier population and the estimated 1.50 percent increase due to changes in crash reporting and possibly other unknown factors.