FMCSA Safety Program Effectiveness Measurement: Compliance Review Effectiveness Model Results for Carriers with Compliance Reviews in FY 2008

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

September 2012

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 CR program. The model was developed for the FMCSA by the Research and Innovative Technology Administration's John A. Volpe National Transportation Systems Center (the Volpe Center) in Cambridge, MA. 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-12-010**	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 FY 2008**		5. Report Date **September 2012** 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 and Period Covered **Final Report** 14. Sponsoring Agency Code **FMCSA**
15. Supplementary Notes **Contracting Officer's Technical Representative: Richard Gruberg**		

16. Abstract

In FY 2008, Federal and State enforcement personnel conducted 14,906 compliance reviews (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 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. 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	18. Distribution Statement
Commercial motor vehicle, compliance review, CR, CREM, FY 2008, effectiveness, safety, safety programs	**No restrictions**

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	**Unclassified**	**36**	

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 (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).

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ABBREVIATIONS, ACRONYMS, AND SYMBOLS

Acronym	Definition
CR	compliance review
CSA	Compliance, Safety, Accountability
CY	calendar year
FARS	Fatality Analysis Reporting System
FHWA	Federal Highway Administration
FMCSA	Federal Motor Carrier Safety Administration
FMCSR	Federal Motor Carrier Safety Regulation
FY	fiscal year
GES	General Estimate System
GPRA	Government Performance and Results Act
HM	hazardous material
MCSAP	Motor Carrier Safety Assistance Program
MCMIS	Motor Carrier Management Information System
NGA	National Governors' Association
NHTSA	National Highway Traffic Safety Administration
SMS	Safety Measurement System
USDOT	U.S. Department of Transportation

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EXECUTIVE SUMMARY

BACKGROUND

This report documents the methodology and results from a model that measures the effectiveness of one of the key safety programs of the Federal Motor Carrier Safety Administration (FMCSA), the compliance review (CR) program. The research was conducted by the Research and Innovative Technology Administration's John A. Volpe National Transportation Systems Center (Volpe Center) in Cambridge, MA, under an interagency agreement with 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 CR Effectiveness Model and presents the results of the implementation of the model for carriers receiving CRs in fiscal year (FY) 2008. The benefits of the CR program are calculated in terms of crashes avoided, lives saved, and injuries avoided.

METHODOLOGY OF MODEL

The onsite CR is perhaps the single greatest resource-consuming activity of FMCSA. Thousands of CRs are conducted each year. In FY 2008, Federal and State enforcement personnel conducted nearly 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 CRs 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 CR 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 and changes in crash reporting and possibly other unknown factors, a control group of carriers 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 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 FY 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 FY with the funding for the CR program for that FY.

The CR Effectiveness Model succeeded the CR Impact Analysis Model, which was used to estimate the benefits for carriers with CRs in CY 1998, 1999, 2000, and 2001.[1] 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 CRs IN FY 2008

The CR Effectiveness Model was implemented for carriers with CRs in FY 2008 to estimate the number of crashes (and associated fatalities and injuries) avoided in the first year following the reviews, i.e., FY 2008–09. Table 1 shows these benefits, as well as the benefits that were estimated to have occurred in:

- CY 2002–03 for carriers with CRs in CY 2002.
- CY 2003–04 for carriers with CRs in CY 2003.
- CY 2004–05 for carriers with CRs in CY 2004.
- FY 2005–06 for carriers with CRs in FY 2005.
- FY 2006–07 for carriers with CRs in FY 2006.
- FY 2007–08 for carriers with CRs in FY 2007.

The estimates from the model implementations for carriers with CRs in FY 2007 and 2008 were made using a control group based on carrier size. The estimates from the five previous model implementations (i.e., CY 2002 to FY 2006) were made using a control group consisting of all non-CR carriers. To determine if the results of the implementations for FY 2007 and 2008 are comparable with the results for the previous years, the model was rerun for carriers with CRs in CY 2002–03 and FY 2004–06 using the new control group. The analysis showed that, in each of the 5 years, the estimate of crashes avoided produced by the new (i.e., carrier size) control group differed from the estimate produced by the old (i.e., all non-CR carriers) control group by no more than 4 percent. Since the two sets of estimates are of the same magnitude and follow the same trends, they are comparable. Therefore, the estimates produced using the new (i.e., carrier size) control group do not constitute a new data series.

[1] Reports documenting these results are available at http://ai.fmcsa.dot.gov/CarrierResearchResults/Archives.asp?p=24

As shown in Table 1, the number of CRs conducted decreased from 15,530 in FY 2007 to 14,906 in FY 2008. This decrease may be due, in part, to the Compliance, Safety, Accountability (CSA)[2] Operational Model Test that began in February 2008 in four States (Colorado, Georgia, Missouri, and New Jersey). FMCSA randomly divided the motor carriers domiciled in the four test States into two equal sized groups: a test group and a control group. Carriers in the control group were subject to CRs as before, while the carriers in the test group were subject to new CSA interventions, many of which were not CRs. As a result, fewer CRs were conducted in these States in FY 2008 than in FY 2007.

Table 1. Implementation of CR Effectiveness Model for Carriers With CRs in CY 2002–04 and FY 2005–08

Model Implementation for Motor Carriers with CRs in:	CY 2002	CY 2003	CY 2004	FY 2005	FY 2006	FY 2007	FY 2008
CRs conducted	12,139	11,086	10,671	11,431	14,426	15,530	14,906
Motor carriers that received CRs 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. • 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	11,032
Estimated percentage reduction in average crash rate due to CRs	12.6	17.6	21.1	16.3	18.6	14.7	19.9

Table 2. Estimated Results of Implementation of CR Effectiveness Model for Carriers With CRs in CY 2002–04 and FY 2005–08

Model Results (i.e., Benefits) Estimated for:	CY 2002–03	CY 2003–04	CY 2004–05	FY 2005–06	FY 2006–07	FY 2007–08	FY 2008–09
Crashes Avoided	1,426	2,276	2,720	2,306	2,860	2,175	2,886
Fatal Crashes	53	77	92	79	93	68	87
Injury Crashes	677	1,038	1,186	982	1,185	879	1,157
Towaway Crashes	696	1,161	1,442	1,245	1,582	1,228	1,642
Lives Saved	62	90	107	92	109	79	101
Injuries Avoided	1,087	1,651	1,889	1,561	1,866	1,399	1,853

[2] Compliance, Safety, Accountability (CSA) is an FMCSA initiative to improve large truck and bus safety and ultimately reduce crashes, injuries, and fatalities that are related to commercial motor vehicles. It introduces a new enforcement and compliance model that allows FMCSA and its State partners to contact a larger number of carriers earlier in order to address safety problems before crashes occur. Rolled out in December 2010, the program establishes a new nationwide system for making the roads safer for motor carriers and the public alike.

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 1–5 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 larger reduction in their average crash rate than did the carriers for which no enforcement actions were planned.

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 [CRs]).

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 were 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 mission of the Federal Motor Carrier Safety Administration (FMCSA) 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 satisfy the desire of the FMCSA to verify the effectiveness of one of its motor carrier safety programs, the 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 CR, 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 CR 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 CR Effectiveness Model and presents the results of the implementation of the model for carriers receiving CRs in fiscal year (FY) 2008, 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 CR Effectiveness Model succeeded the CR Impact Assessment Model, which was used to estimate the benefits for carriers with CRs in CY 1998, 1999, 2000, and 2001.[1] The results from the two models are not directly comparable because the models use different methodologies and different data sources.

[1] Reports documenting these results are available at ai.fmcsa.dot.gov/CarrierResearchResults/Archives.asp?p=24.

2. CR EFFECTIVENESS MODEL

2.1 THE CR PROCESS

The onsite CR is perhaps the single greatest resource-consuming activity of the FMCSA. Thousands of CRs are conducted each year. In FY 2008, Federal and State enforcement personnel conducted nearly 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 Measurement System (SMS) 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 CRs 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 CR 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 CRs IN FY 2008

A diagram of the CR Effectiveness Model, as implemented for carriers with CRs in FY 2008, 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 2008 occurred in both FY 2008 and FY 2009.

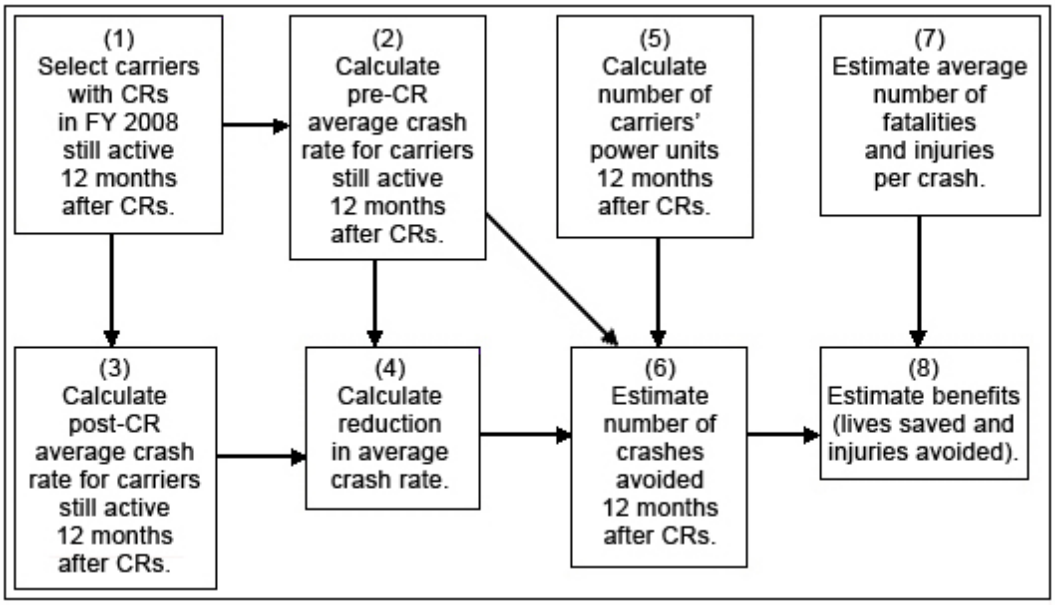

Figure 1. Flowchart. CR Effectiveness Model

A step-by-step description of the implementation procedure follows. The step numbers (shown in parentheses) correspond to the numbers in parentheses in the diagram.

(1) Select carriers with one or more CRs in FY 2008 that were still active 12 months after their CRs.

There were 11,032 carriers that received CRs in FY 2008, were still active 12 months after their CRs (i.e., throughout their post-CR periods), and met the following conditions:

- The carrier had to be either an interstate carrier or intrastate hazardous materials (HM) carrier.
- The carrier must have been active throughout the pre-CR period (i.e., the 12 months before the CR).
- The carrier must have 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 2008, the latest one was used.
- The carrier's crash and power unit data had to pass edit checks designed to screen out erroneous data.[1]

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

[1] 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.

The 11,032 carriers that received CRs in FY 2008 and were still active 12 months after their CRs had a pre-CR average crash rate of 5.205 crashes per 100 power units. This average was obtained by dividing the total number of carriers' crashes in the 12 months before their FY 2008 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 11,032 carriers that received CRs in FY 2008 and were still active 12 months after their CRs had a post-CR average crash rate of 3.762 crashes per 100 power units. This average was obtained by dividing the total number of carriers' crashes in the 12 months after their FY 2008 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, 2008, then power unit data from the September 2008 MCMIS data snapshot would have been used to calculate its pre-CR average crash rate, and power unit data from the September 2009 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, 2007–August 14, 2008, while its post-CR period (i.e., the 12 months after the CR) would have been August 16, 2008–August 15, 2009. This information is shown in the timeline in Figure 2.

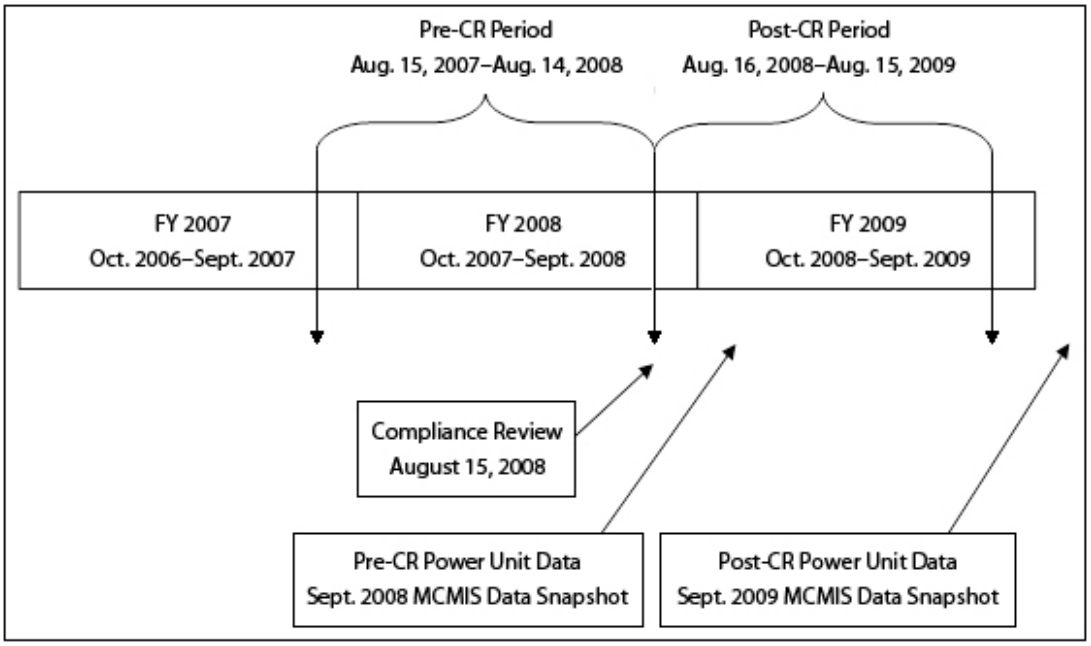

Figure 2. Flowchart. Timeline for a Carrier With a CR on August 15, 2008

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

(4a) Calculate the reduction using the data for the carriers with CRs in FY 2008.

The percent change in the average crash rate of carriers with CRs in FY 2008 was calculated as shown in Figure 3:

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

$$\frac{3.762 - 5.205}{5.205} \times 100 = -27.72 \text{ (i.e., a decrease of 27.72 percent)}$$

Figure 3. Formula. Calculate Average Crash Rate Reduction

(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 2008 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 2008. The difference resulting from this calculation represents the change in the average crash rate of the carriers that received CRs in FY 2008 that could be attributed to the CRs.

To create this control group, the population of carriers that did not receive CRs or non-ratable reviews in FY 2008 (i.e., non-CR carriers) was used. The control group was generated from non-CR carriers that also did not have any CRs or non-ratable reviews in the 4 years prior to FY 2008, i.e., FY 2004–07. These carriers were used to generate a control group based on carrier size and consisting of 11,032 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 11,032 carriers in the control group had a pre-CR average crash rate of 1.794 crashes per 100 power units and a post-CR average crash rate of 1.654 crashes per 100 power units.

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

$$\frac{1.654 - 1.794}{1.794} \times 100 = -7.80\% \text{ (i.e., a decrease of 7.80 percent)}$$

Figure 4. Formula. Average Crash Rate of Control Group

This decrease in the average crash rate of the control group is the sum of the effects of the following:

- 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 of the lack of change was due to each element, a separate set of calculations was performed. The calculations showed that there was an estimated 15 percent decrease in the average crash rate of the general carrier population. Therefore, the estimated 7.80 percent decrease in the average crash rate of the control group was the sum of an estimated 15 percent decrease in the crash rate of the general carrier population and an estimated 7.20 percent increase due to changes in crash reporting and possibly other unknown factors. These calculations are shown in Appendix B.

The adjusted change in the average crash rate due to the CRs conducted in FY 2008 is shown in Figure 5:

Percent Change in Average Crash Rate of Carriers With CRs in FY 2008
- Percent Change in Average Crash Rate of Control Group

(-27.72) - (-7.80) = -19.9% (i.e., a decrease of 19.9 percent)

Figure 5. Formula. Adjusted Change in Average Crash Rate Due To CRs Conducted in FY 2008

(5) Calculate the number of post-CR power units, i.e., the number of power units 12 months after the CRs in FY 2008.

The 11,032 carriers that received CRs in FY 2008 and were still active 12 months after their CRs had a total of 278,628 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 2008–09 as a result of the CRs conducted in FY 2008.

The estimated number of crashes avoided in FY 2008–09 by the 11,032 carriers that received CRs in FY 2008 and were still active 12 months after their CRs was calculated as shown in Figure 6:

5.205 Crashes Per 100 Power Units x 19.9% x 278,628 Power Units = 2,886 Crashes Avoided

Figure 6. Formula. Estimated Number of Crashes Avoided for Carriers Receiving CRs in FY 2008

Next, estimates were made of the number of crashes avoided in FY 2008–09 by the carriers receiving CRs in FY 2008 by severity, i.e., fatal, injury, and towaway.[2] 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 2008–09, the period in which the benefits of the CRs conducted in FY 2008 would occur, 3.0 percent were fatal crashes, 40.1 percent were injury crashes, and 56.9 percent were towaway crashes.

Applying these proportions to the estimate of 2,886 crashes avoided produced the following results:

- Fatal crashes = 2,886 × 3.0% = 87.
- Injury crashes = 2,886 × 40.1% = 1,157.
- Towaway crashes = 2,886 × 56.9% = 1,642.

(7) Estimate the average numbers of fatalities and injuries per crash in FY 2008–09.

The average number of fatalities per fatal crash was estimated from State-reported crash data from the MCMIS Crash File. For crashes in FY 2008–09 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 2008–09 large truck and bus crashes, the averages were as follows:

- Fatal crashes: 1.09 injuries per crash.
- Injury crashes: 1.52 injuries per crash.

[2] A *fatal* crash results in at least one fatality. An *injury* crash results in no fatalities, but 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.

(8) Estimate the benefits (i.e., lives saved and injuries avoided) that occurred in FY 2008–09.

The estimated number of lives saved in the crashes avoided in FY 2008–09 by the carriers with CRs in FY 2008 was calculated as shown in Figure 7.

Number of Fatal Crashes x Average Number of Fatalities Per Fatal Crash

87 x 1.16 = 101 Lives Saved

Figure 7. Estimated Number of Lives Saved by Crashes Avoided in FY 2008-09 by Carriers With CRs in FY 2008

The estimated number of injuries avoided in the crashes avoided in FY 2008–09 by the carriers with CRs in FY 2008 was calculated as shown in Figure 8.

(Number of Fatal Crashes Avoided x Average Number of Injuries Per Fatal Crash)
+ (Number of Injury Crashes Avoided x Average Number of Injuries Per Injury Crash)

(87 x 1.09) + (1,157 x 1.53) = 1,853 Injuries Avoided

Figure 8. Estimated Number of Injuries Avoided by Crashes Avoided in FY 2008-09 by Carriers With CRs in FY 2008

Table 3 and Table 4 summarize the estimated benefits that occurred in FY 2008–09 as a result of the CRs conducted in FY 2008 on the 11,032 carriers that were still active 12 months after their CRs and met the additional criteria listed in Table 3. The tables also show the estimated benefits from the CRs conducted in CY 2002, 2003, 2004, and FY 2005, 2006, 2007 that occurred in CY 2002–03, 2003–04, 2004–05, and FY 2005–06, 2006–07, 2007–08, respectively.

Table 3. Implementation of CR Effectiveness Model for Motor Carriers With CRs CY 2002–04 and FY 2005–08

Model Implementation for Motor Carriers With CRs in:	CY 2002	CY 2003	CY 2004	FY 2005	FY 2006	FY 2007	FY 2008
CRs Conducted	12,139	11,086	10,671	11,431	14,426	15,530	14,906
Motor carriers that received CRs and: • Were interstate carriers or intrastate HM 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. • 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	11,032
Estimated percentage reduction in average crash rate due to CRs	12.6	17.6	21.1	16.3	18.6	14.7	19.9

Table 4. Estimated Results of CR Effectiveness Model for Motor Carriers With CRs CY 2002–04 and FY 2005–08

Model Results (i.e., Benefits) Estimated for:	CY 2002–03	CY 2003–04	CY 2004–05	FY 2005–06	FY 2006–07	FY 2007–08	FY 2008–09
Crashes Avoided	1,426	2,276	2,720	2,306	2,860	2,175	2,886
Fatal Crashes Avoided	53	77	92	79	93	68	87
Injury Crashes Avoided	677	1,038	1,186	982	1,185	879	1,157
Towaway Crashes Avoided	696	1,161	1,442	1,245	1,582	1,228	1,642
Lives Saved	62	90	107	92	109	79	101
Injuries Avoided	1,087	1,651	1,889	1,561	1,866	1,399	1,853

The estimates from the model implementations for carriers with CRs in FY 2007 and FY 2008 were made using a control group based on carrier size. The estimates from the five previous model implementations (i.e., CY 2002–FY 2006) were made using a control group consisting of all non-CR carriers. To determine if the results of the implementations for FY 2007 and FY 2008 are comparable with the results for the previous years, the model was rerun for carriers with CRs in CY 2002–04 and FY 2005–06 using the new control group. The analysis showed that, in each of the 5 years, the estimate of crashes avoided produced by the new (i.e., carrier size) control group differed from the estimate produced by the old (i.e., all non-CR carriers) control group by no more than 4 percent. Since the two sets of estimates are of the same magnitude and follow the same trends, they are comparable. Therefore, the estimates produced using the new (i.e., carrier size) control group do not constitute a new data series.

As shown in Table 3, the number of CRs conducted decreased from 15,530 in FY 2007 to 14,906 in FY 2008. This decrease may be due, in part, to the Compliance, Safety, Accountability (CSA)[3] Operational Model Test that began in February 2008 in four States (Colorado, Georgia, Missouri, and New Jersey). FMCSA randomly divided the motor carriers domiciled in the four test States into two equal sized groups: a test group and a control group. Carriers in the control group were subject to CRs as before, while the carriers in the test group were subject to a broad range of new CSA interventions, many of which were not CRs. As a result, fewer CRs were conducted in these States in FY 2008 than in FY 2007.

[3] Compliance, Safety, Accountability (CSA) is an FMCSA initiative to improve large truck and bus safety and ultimately reduce crashes, injuries, and fatalities that are related to commercial motor vehicles. It introduces a new enforcement and compliance model that allows FMCSA and its State partners to contact a larger number of carriers earlier in order to address safety problems before crashes occur. Rolled out in December 2010, the program establishes a new nationwide system for making the roads safer for motor carriers and the public alike.

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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 CR program may be improved. Alternative treatment approaches may be suggested for carriers that are at risk but most likely will not respond positively to CRs.

3.2 METHODOLOGY

The control group was broken down by size subgroup and planned course of action. 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 2,886 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 2,886 by multiplying each subgroup estimate by the factor $(2{,}886 \div X)$. These prorated estimates were then used to derive the percentage 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 5 and Table 6 were both derived using this prorating procedure.

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 5 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 5. Results of Implementation of Model by Carrier Size

Number of Pre-CR Power Units	Number of Carriers With CRs in FY 2008	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 2008–09
1–5	5,486	11.268	6.023	-46.5	792
6–20	3,595	6.900	4.410	-36.1	982
21–100	1,586	5.180	4.179	-19.3	661
≥101	365	4.200	3.915	-6.8	451
All Carriers	11,032	5.205	4.169	-19.9	2,886

*Crashes per 100 power units

Table 5 shows, for each size subgroup, the number of carriers in the group that received CRs in FY 2008, 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 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 46.5 percent for carriers with 1–5 power units to 6.8 percent for carriers with 101 or more power units.

Carriers with 6–20 power units had the largest number of crashes avoided due to the program (982), followed by carriers with 1–5 power units (792).

The results of this analysis are consistent with 1) the results of the analyses of data from the implementations of the model for carriers with CRs in CY 2002, 2003, 2004, and FY 2005, 2006, 2007,[1] and 2) the results of analyses of data from the implementations of the previous model, the CR Impact Assessment Model.[2]

[1] Reports documenting these results are available at ai.fmcsa.dot.gov/CarrierResearchResults/Archives.asp?p=24.

[2] 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 2008 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 either compliance monitoring or a Notice of Violation indicated as the planned course of action was classified as a "non-enforcement" carrier. The results for the five courses of action were calculated. The results for prosecution, State prosecution, and out-of-service order were then combined under "enforcement," while the results for compliance monitoring and Notice of Violation were combined under "non-enforcement."

It should be noted that these courses of action are the ones that were anticipated by FMCSA at the conclusions of the CRs that the carriers received in FY 2008, and may be different from the actions that were actually taken. The data in the MCMIS CR file do not indicate the actual actions taken after the CRs.

Table 6 shows, for each action type, the number of carriers that received CRs in FY 2008, 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 6 also shows, for each action type, the estimated number of crashes avoided as a result of the CRs.

Table 6. 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 2008	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 2008–09
Enforcement	3,551	5.819	4.363	-25.0	1,014
Non-Enforcement	7,481	4.990	4.094	-18.0	1,872
All Carriers	11,032	5.205	4.169	-19.9	2,886

*Crashes per 100 power units

Table 6 shows that it was anticipated that 3,551 (or 32.2 percent) of the 11,032 carriers that received CRs in FY 2008 would undergo enforcement actions. The "enforcement" carriers showed a crash rate reduction of 25 percent, compared to an 18 percent reduction for the "non-enforcement" carriers. The "enforcement" carriers accounted for 1,014, or 35.1 percent, of the 2,886 crashes avoided in FY 2008–09.

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APPENDIX A: CRASH AND POWER UNIT VALUES ASSIGNED TO CONTROL GROUP CARRIERS

OVERVIEW

This appendix describes the criteria used to create the control group. Since the control group carriers did not receive CRs, a procedure had to be developed for assigning crash and power unit values to these carriers for the pre-CR and post-CR time periods. This procedure is discussed below.

METHODOLOGY

To create the control group, the population of carriers that did not receive CRs or non-ratable reviews in FY 2008 (i.e., non-CR carriers) was used. The control group was generated from non-CR carriers that met the following additional conditions:

- The carrier had to be either interstate carrier or intrastate HM carrier.
- The carrier must have been active throughout the pre-CR period (FY 2007–08), i.e., October 2006–September 2008, and the post-CR period (FY 2008–09), i.e., October 2007–September 2009).
- The carrier must have had one or more power units throughout the pre-CR and post-CR periods (i.e., October 2006–September 2009).
- The carrier must not have had any CRs or non-ratable reviews in the 4 years prior to FY 2008, i.e., FY 2004–07.
- The carrier's crash and power unit data had to pass various edit checks designed to screen out erroneous data.

The 493,901 carriers that met these criteria are herein referred to as the eligible non-CR carrier population. These carriers were broken down into the four size subgroups[1] used in the additional analysis in Section 3.3. For each of the size subgroups, the average numbers of crashes and power units were estimated for these non-CR carriers for the pre-CR and post-CR time periods. Next, a "pseudo" control group match record was created for each carrier in the CR group, containing the average pre-CR and post-CR crash and power unit values for the non-CR carriers in that particular size subgroup. Each "pseudo" control group carrier match record was also assigned the same planned course of action value (compliance monitoring, Notice of Violation, prosecution, State prosecution, or out-of-service order) as the CR group carrier to which it was matched.

[1] Subgroup 1: 1–5 power units, Subgroup 2: 6–20 power units, Subgroup 3: 21–100 power units, Subgroup 4: ≥101 power units.

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, i.e., all carriers with no CRs or non-ratable reviews in FY 2004–08. The formulas used are shown in this section.

Let x be an eligible non-CR carrier population size subgroup.

Let C_{xy} = the number of crashes in subgroup x in FY y, and

- P_{xy} = the number of power units in subgroup x in FY y, and
- N_x = the number of carriers in subgroup x.

The pre-CR period covers FY 2007 and FY 2008. Therefore, the average number of pre-CR crashes per carrier per year in subgroup x is defined in Figure 9:

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

Figure 9. Formula. Average Number of Pre-CR Crashes Per Year in Subgroup *x*

The post-CR period covers FY 2008 and FY 2009. Therefore, the average number of post-CR crashes per carrier per year in subgroup x is defined in Figure 10:

$$\frac{\frac{1}{2}\sum_{y=2008}^{2009}\sum_{n=1}^{N_x} C_{xy}}{N_x}$$

Figure 10. Formula. Average Number of Post-CR Crashes Per Carrier Per Year in Subgroup *x*

Similarly, the average number of pre-CR power units per carrier per year in subgroup x is defined in Figure 11:

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

Figure 11. Formula. Average Number of Pre-CR Power Units Per Carrier Per Year in Subgroup *x*

The average number of post-CR power units per carrier per year in subgroup *x* is defined in Figure 12:

$$\frac{\frac{1}{2}\sum_{y=2008}^{2009}\sum_{n=1}^{N_x} P_{xy}}{N_x}$$

Figure 12. Formula. Average Number of Post-CR Power Units Per Carrier Per Year in Subgroup *x*

Table 7 shows the crash and power unit values that were assigned to the "pseudo" 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 non-CR carrier population. Table 7 also shows the resulting pre-CR and post-CR average crash rates for each size subgroup.

Table 7. Crash and Power Unit Values Assigned to Control Group Carriers

Size Subgroup†	Pre-CR Period Average Number of Crashes	Pre-CR Period Average Number of Power Units	Pre-CR Period Average Crash Rate*	Post-CR Period Average Number of Crashes	Post-CR Period Average Number of Power Units	Post-CR Period Average Crash Rate*
1	0.02374	1.7456	1.360	0.02171	1.7713	1.226
2	0.15381	9.7393	1.579	0.14767	9.8714	1.496
3	0.72748	39.7812	1.829	0.66946	40.1135	1.669
4	7.20949	387.4213	1.861	6.66568	388.5614	1.715

* Crashes per 100 power units

† Size Subgroup 1: 1.0–5.0 power units, Size Subgroup 2: 5.5–20.0 power units, Size Subgroup 3: 20.5–100 power units, Size Subgroup 4: ≥100.5 power units

The size subgroup definitions shown for the non-CR carriers are the same as for the carriers with CRs in FY 2008 (i.e., the CR group). The lower limits for the non-CR carrier subgroups 2, 3, and 4 are different than those for the carriers in the CR group, because the numbers of pre-CR and post-CR crashes and power units for a non-CR carrier are averages of two FYs. For example, size subgroup 2 consists of carriers with more than 5 but no more than 20 pre-CR power units. For a non-CR carrier, the number of pre-CR power units is the average of the numbers of power units in FY 2007 and FY 2008. That number could be 5.5, which would put the carrier in subgroup 2.

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APPENDIX B: ALLOCATION OF CHANGE IN AVERAGE CRASH RATE OF CONTROL GROUP TO CRASH-RELATED AND NONCRASH-RELATED FACTORS

The 11,032 carriers in the control group had a pre-CR average crash rate of 1.794 crashes per 100 power units and a post-CR average crash rate of 1.654 crashes per 100 power units.

The percent change in the average crash rate of the control group was calculated using the formula in Figure 13:

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

$$\frac{1.654 - 1.794}{1.794} \times 100 = -7.80\% \text{ (i.e., a decrease of 7.80 percent)}$$

Figure 13. Formula. Percentage Change in the Average Crash Rate of the Control Group

This 7.80 percent decrease 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, and changes in crash reporting and possibly other unknown factors. To determine how much of the decrease was due to each element, 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 2007–08 and FY 2008–09, 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 the FARS, which contains data on a census of fatal crashes. Counts of injury crashes and property-damage-only crashes were obtained from the 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, although the NHTSA rule specifically requires that at least one death occur within 30 days of the crash. For non-fatal crashes, the differences are much greater.

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

- An *injury* crash is a crash that results in no fatalities, but 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 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 one of the following:
  - 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 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 should provide a reasonable indication of the change in the NGA crash rate calculated using the FMCSA's MCMIS data.

While FARS data for FY 2007, 2008, and 2009 were obtained, GES data are not available by FY. Thus, CY 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 2007, 2008, and 2009. These CY numbers were used because they are the only national registration figure available and some States report their data on a FY basis. Therefore, the FHWA numbers are not pure CY numbers, but a mixture of CY and FY numbers.

The change in the average crash rate of the general carrier population, as measured by the FARS and GES large truck crash data, was calculated as shown in Figure 12:

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

Figure 14. Formula. 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 2007–08, while the post-CR average crash rate is the average crash rate for the entire post-CR period, i.e., FY 2008–09. The pre-CR and post-CR average crash rates (as shown in Figure 13 and Figure 14, respectively) were calculated as follows:

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

$$\text{Post-CR Average Crash Rate} = \frac{\text{Large Truck Crashes in FY08 + Large Truck Crashes in FY09}}{\text{Large Trucks Registered in CY08 + Large Trucks Registered in CY09}} \times 100$$

Figure 15. Formula. Pre- and Post-CR Average Crash Rates

The general carrier population had a pre-CR average crash rate of 3.506 crashes per 100 power units and a post-CR average crash rate of 2.980 crashes per 100 power units.

The percent change in the average crash rate of the general carrier population was calculated as follows:

$$\frac{2.980 - 3.506}{3.506} \times 100 = -15\% \text{ (i.e., a decrease of 15 percent)}$$

Figure 16. Formula. Percent 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 average crash rate of the general carrier population from FY 2007–08 to FY 2008–09 was a decrease of 15 percent.

Therefore, the percent change in the crash rate of the control group caused by changes in crash reporting and possibly other unknown factors are shown in Figure 15:

$$\text{\% Change in Average Crash Rate of Control Group (State-Reported Data)} - \text{\% Change in Average Crash Rate of General Carrier Population (FARS and GES Data)}$$

$$= (-7.80) - (-15.00) = 7.20\% \text{ (i.e., an increase of 7.20 percent)}$$

Figure 17. Formula. Percent Change in the Control Group Crash Rate Caused by Changes in Crash Reporting or Other Unknown Factors

Therefore, the 7.80 percent decrease in the average crash rate of the control group was the sum of the estimated 15 percent decrease in the crash rate of the general carrier population and the estimated 7.20 percent increase due to changes in crash reporting and possibly other unknown factors.

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