FMCSA Safety Program Effectiveness Measurement:

Compliance Review Effectiveness Model

Results for Carriers with Compliance Reviews in Fiscal Year 2005

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Prepared for:
Federal Motor Carrier Safety Administration
Office of Research and Analysis
Analysis Division, MC-RRA
1200 New Jersey Avenue, S.E.
Washington, DC 20590

Prepared by:
John A. Volpe National Transportation Systems Center
Office of Surface Transportation Programs
Motor Carrier Safety Division, RTV-3E
Kendall Square
Cambridge, MA 02142

PREFACE

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. The model was developed for the FMCSA by the Research and Innovative Technology Administration's (RITA) 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 the 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 the 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.

In addition to the CR Effectiveness Model, the Intervention Model has been developed to measure the effectiveness of and estimate benefits resulting from roadside inspection and traffic enforcement activities. These two models have been developed to estimate the benefits of these FMCSA safety programs in terms of crashes avoided, lives saved, and injuries avoided.

This project is managed by the Analysis Division in the FMCSA's Office of Research and Analysis. The Volpe Center project manager is Kevin Gay of the Motor Carrier Safety Division. The analysis was performed by Jon Ohman with assistance from Kevin Gay and Julie Nixon, all of the Volpe Center. Technical support was provided by Richard Nguyen of the Volpe Center and Leon Parkin of Chenega Advanced Solutions & Engineering (CASE), LLC, under contract to the Volpe Center. Olu Ajayi of the FMCSA's Analysis Division deserves special thanks for his assistance in obtaining data that were used in the implementation of the model.

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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 (RITA) John A. Volpe National Transportation Systems Center (the Volpe Center) in Cambridge, MA under a project plan agreement with the 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) 2005. The benefits of the compliance review program are calculated in terms of crashes avoided, lives saved, and injuries avoided.

Methodology of Model

The on-site compliance review is perhaps the single greatest resource-consuming activity of the FMCSA. Thousands of CRs are conducted each year. In FY 2005, federal and state enforcement personnel conducted over 11,000 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 "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 on-site compliance review to its crash rate in the 12 months prior to that review. The model uses (1) crash data reported by the states and (2) 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 underlying trends occurring in the general carrier population, a control group of carriers is used. This Control Group consists of all carriers that did not receive CRs during the year in question. Any change in the average crash rate of the Control Group must be due to factors affecting the entire carrier population. 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. 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 was solely the result of the CRs.

All previous implementations of the model were on a calendar year (CY) basis. That is, the model has been used to estimate benefits only for carriers with CRs conducted in CY 2002, 2003, and 2004. Beginning with this report, the model will be implemented on a fiscal year (FY) basis to align the activities of the CR program with the program's funding cycle. It will now be 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 model succeeded the Compliance Review Impact Analysis Model, which was used to estimate the benefits for carriers with CRs in CY 1998, 1999, 2000, and 2001.[1] The estimates produced by the CR Effectiveness Model will establish new benchmarks and are not directly comparable to the estimates produced by the CR Impact Assessment Model.

Implementation of Model for Carriers with Compliance Reviews in FY 2005

The CR Effectiveness Model was implemented for carriers with CRs in FY 2005 to estimate the number of crashes (and associated fatalities and injuries) avoided in the first year following the reviews, i.e., FY 2005-2006. Table ES-1 shows these benefits, as well as the benefits that were estimated to have occurred (1) in CY 2002-2003 for carriers with CRs in CY 2002, (2) in CY 2003-2004 for carriers with CRs in CY 2003, and (3) in CY 2004-2005 for carriers with CRs in CY 2004.

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

Model Implementation for Motor Carriers with CRs in:	**CY 2002**	**CY 2003**	**CY 2004**	**FY 2005**
Compliance reviews conducted	12,139	11,086	10,671	11,431
Motor carriers that received compliance reviews and: • were interstate or intrastate HM, • 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
Estimated percentage reduction in average crash rate due to compliance reviews	12.6	17.6	21.1	16.3
Model Results (i.e., Benefits) Estimated for:	**CY 2002-2003**	**CY 2003-2004**	**CY 2004-2005**	**FY 2005-2006**
Crashes Avoided	1,426	2,276	2,720	2,306
Fatal crashes	53	77	92	79
Injury crashes	677	1,038	1,186	982
Towaway crashes	696	1,161	1,442	1,245
Lives saved	62	90	107	92
Injuries avoided	1,087	1,651	1,889	1,561

[1] Reports documenting these results are available at ai.fmcsa.dot.gov/CarrierResearchResults/Archives.asp?p=23.

Additional Analysis

To further assess the effectiveness of the compliance review program, the results of the implementation of the model were broken out by carrier size (i.e., number of power units), by the state of domicile of the carrier, by carrier safety status (i.e., the carrier's SafeStat[2] category before receiving its CR in FY 2005), and by the planned course of action (i.e., enforcement or no enforcement) for the carrier.

1) The breakout of the results of the model implementation by carrier size showed that the carriers with 1 to 5 power units had the largest reduction in the average crash rate in the 12 months following their CRs.

2) The results of the implementation of the model by the state of domicile of the carrier showed that two states (Arizona and Texas) had over 200 crashes avoided in FY 2005-2006 as a result of CRs conducted in FY 2005. Five other states (Illinois, Georgia, Tennessee, Missouri, and Indiana) each had more than 100 crashes avoided.

3) The results of the implementation of the model by carrier safety status (i.e., the carrier's SafeStat category before receiving its CR in FY 2005) showed that the reduction in the average crash rate was related to carrier safety status. Carriers in Categories A and B (the carriers with the highest crash risk according to SafeStat), which are identified and prioritized first for CRs, had the largest reduction in their average crash rate.

4) 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.

[2] SafeStat (Safety Status Measurement System) is an automated, data-driven analysis system that is designed to incorporate on-road safety performance information and enforcement history with on-site compliance review information in order to measure the relative safety fitness of interstate motor carriers. A thorough description of SafeStat methodology can be found in: John A. Volpe National Transportation Systems Center, Motor Carrier Safety Assessment Division, DTS-47, *SafeStat, Motor Carrier Safety Status Measurement System, Methodology: Version 8.6*, January 2004. This document is available at ai.fmcsa.dot.gov/CarrierResearchResults/PDFs/SafeStat_method.pdf.

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 both at the federal and state levels. The Surface Transportation Assistance Act of 1982 established the Motor Carrier Safety Assistance Program, a grants-in-aid program to states to conduct roadside inspection and traffic enforcement programs aimed at commercial motor vehicles. The 1984 Motor Carrier Safety Act directed the U.S. Department of Transportation (U.S. DOT) to establish safety fitness standards for carriers. The U.S. DOT, in conjunction with the states, implemented the Motor Carrier Safety Assistance Program (MCSAP) to fund the roadside inspection and traffic enforcement programs and the safety fitness determination process and rating system (based on on-site 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 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 satisfy the desire of the FMCSA to verify the effectiveness of one of its motor carrier safety programs, the compliance review 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 compliance reviews (CRs) in FY 2005, including estimates of crashes avoided by carrier size, state of domicile, carrier safety status, and planned course of action.

All previous implementations of the model were on a calendar year (CY) basis. That is, the model has been used to estimate benefits only for carriers with CRs conducted in CY 2002, 2003, and 2004. Beginning with this report, the model will be implemented on a fiscal year (FY) basis to align the activities of the CR program with the program's funding cycle. It will now be 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 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.[1] The results from the two models are not directly comparable, because the estimates produced by the CR Effectiveness Model will establish new benchmarks, which may differ from the level of the estimates produced by the CR Impact Assessment Model.

[1] Reports documenting these results are available at ai.fmcsa.dot.gov/CarrierResearchResults/Archives.asp?p=23.

2. COMPLIANCE REVIEW EFFECTIVENESS MODEL

2.1. COMPLIANCE REVIEWS

The on-site compliance review (CR) is perhaps the single greatest resource-consuming activity of the FMCSA. Thousands of CRs are conducted each year. In FY 2005, federal and state enforcement personnel conducted over 11,000 CRs on individual motor carriers. In addition to actually conducting CRs, the FMCSA invests in: extensive analysis of the requirements of the Federal Motor Carrier Safety Regulations (FMCSR), enhancements to the design of the CR to better assess safety performance and compliance with the FMCSR, continued safety investigator training, enhancements to prioritization methodologies such as SafeStat[1] to determine what carriers should receive CRs, and enhancements to information systems to report and store the results of the CRs that are conducted.

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 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 "deterrent" effects (i.e., the "threat" of having a CR) on carriers that did not actually receive CRs. In addition, the model was developed 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 on-site compliance review to its crash

[1] SafeStat (Safety Status Measurement System) is an automated, data-driven analysis system that is designed to incorporate on-road safety performance information and enforcement history with on-site compliance review information in order to measure the relative safety fitness of interstate motor carriers. A thorough description of SafeStat methodology can be found in: John A. Volpe National Transportation Systems Center, Motor Carrier Safety Assessment Division, DTS-47, *SafeStat, Motor Carrier Safety Status Measurement System, Methodology: Version 8.6,* January 2004. This document is available at ai.fmcsa.dot.gov/CarrierResearchResults/PDFs/SafeStat_method.pdf.

rate in the 12 months prior to that review. The model uses (1) crash data reported by the states and (2) 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 2005

A diagram of the CR Effectiveness Model, as implemented for carriers with CRs in fiscal year (FY) 2005, is shown in Figure 2-1. 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 2005 occurred in both FY 2005 and FY 2006.

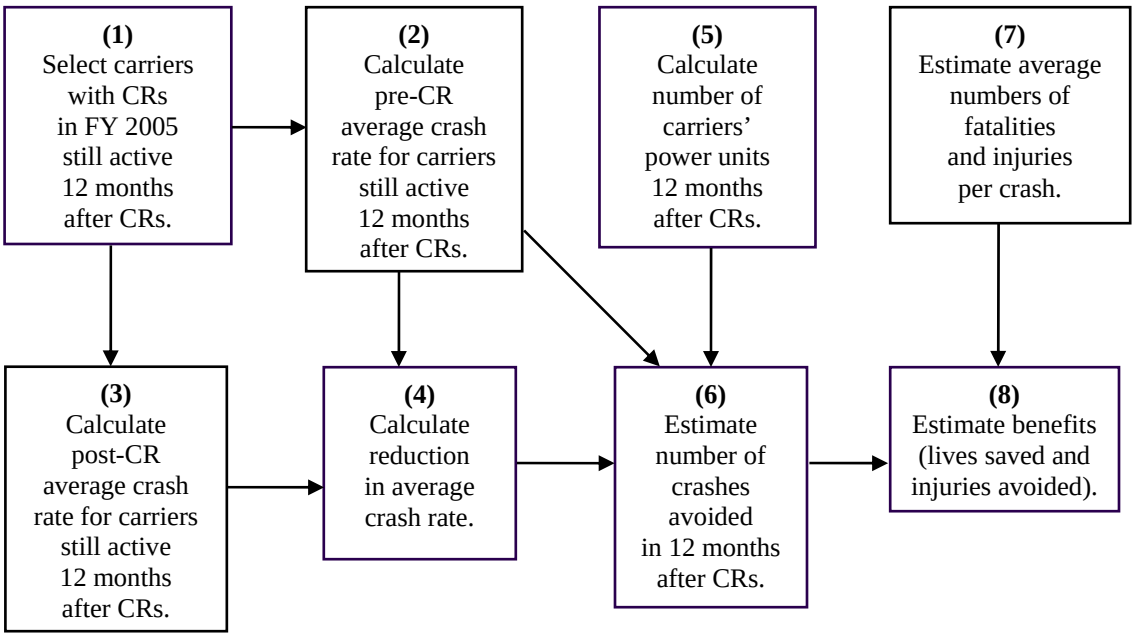

Figure 2-1. Compliance Review Effectiveness Model

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 compliance reviews (CRs) in FY 2005 that were still active 12 months after their CRs.

There were 8,941 carriers that received CRs in FY 2005, 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 interstate or intrastate HM (hazardous materials).
- The carrier must have been active throughout the pre-CR period (i.e., the 12 months before the CR).
- The carrier must have had 1 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 2005, the latest one was used.
- The carrier's crash and power unit data had to pass edit checks designed to screen out erroneous data.

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

The 8,941 carriers that received CRs in FY 2005 and were still active 12 months after their CRs had a pre-CR average crash rate of 5.785 crashes per 100 power units. This average was obtained by dividing the total number of carriers' crashes in the 12 months before their FY 2005 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 8,941 carriers that received CRs in FY 2005 and were still active 12 months after their CRs had a post-CR average crash rate of 4.756 crashes per 100 power units. This average was obtained by dividing the total number of carriers' crashes in the 12 months after their FY 2005 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 one year after the snapshot used to calculate the carrier's pre-CR average crash rate.

For example, if a carrier had a CR on August 15, 2005, then power unit data from the September 2005 MCMIS data snapshot would have been used to calculate its pre-CR average crash rate, and power unit data from the September 2006 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, 2004 to August 14, 2005, while its post-CR period (i.e., the 12 months after the CR) would have been August 16, 2005 to August 15, 2006. This information is shown in the timeline in Figure 2-2.

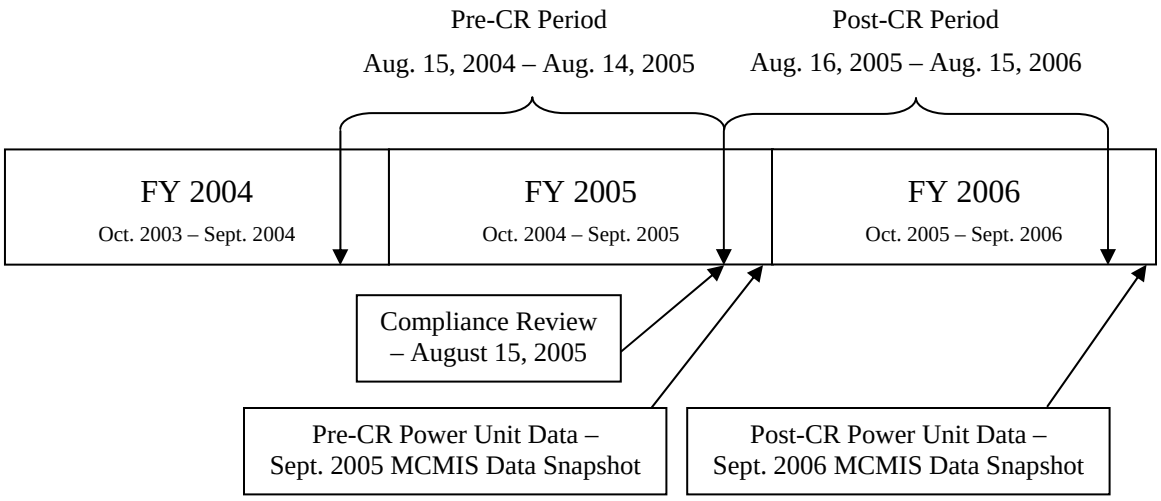

Figure 2-2. Timeline for a Carrier with a Compliance Review on August 15, 2005

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

(4a) Calculate the reduction using the data for the carriers with CRs in FY 2005.

The percentage change in the average crash rate of carriers with CRs in FY 2005 was calculated as follows:

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

$$= \frac{4.756 - 5.785}{5.785} \text{ X } 100$$

$$= -17.79\% \text{ (i.e., a decrease of 17.79 percent)}$$

(4b) Adjust the reduction for underlying factors in 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 yet adjusted for underlying factors occurring in 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 underlying factor that must be considered in the analysis of carriers that received CRs in FY 2005 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 underlying factors, a control group of carriers was selected. This Control Group consisted of all carriers that did not receive CRs in FY 2005. Any change in the average crash rate of the Control Group must have been due to factors affecting the entire carrier population. 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 2005. The difference resulting from this calculation represents the change in the average crash rate of the carriers that received CRs in FY 2005 that was solely the result of the CRs.

To be eligible for the Control Group, a carrier had to meet the following conditions:

- The carrier had to be either interstate or intrastate HM.
- The carrier must have been active throughout the pre-CR period (i.e., October 2003 to September 2005) and the post-CR period (i.e., October 2004 to September 2006).
- The carrier must have had 1 or more power units throughout the pre-CR and post-CR periods (i.e., October 2003 to September 2006).
- The carrier's crash and power unit data had to pass various edit checks designed to screen out erroneous data.

There were 489,084 carriers that met these criteria.

The change in the average crash rate of the Control (i.e., non-CR) Group was calculated as follows:

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

The pre-CR crash rate is the average crash rate for the entire pre-CR period, i.e., FY 2004-2005, while the post-CR crash rate is the average crash rate for the entire post-CR period, i.e., FY 2005-2006. The pre-CR and post-CR average crash rates were calculated as follows:[2]

$$\text{Pre-CR Average Crash Rate} = \frac{\text{Crashes in FY 2004} + \text{Crashes in FY 2005}}{\text{Power Units in FY 2004} + \text{Power Units in FY 2005}}$$

[2] The pre-CR average crash rate is actually the weighted average of the average crash rates for FY 2004 and FY 2005. The post-CR average crash rate is actually the weighted average of the average crash rates for FY 2005 and FY 2006. A detailed derivation of these formulas can be found in Appendix A.

$$\text{Post-CR Average Crash Rate} = \frac{\text{Crashes in FY 2005 + Crashes in FY 2006}}{\text{Power Units in FY 2005 + Power Units in FY 2006}}$$

The 489,084 carriers in the Control Group had a pre-CR average crash rate of 2.088 crashes per 100 power units and a post-CR average crash rate of 2.056 crashes per 100 power units.

The percentage change in the average crash rate of the Control Group was calculated as follows:

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

$$= \frac{2.056 - 2.088}{2.088} \text{ X } 100$$

$$= -1.53\% \text{ (i.e., a decrease of 1.53 percent)}$$

This decrease in the average crash rate of the Control Group (and therefore, the general carrier population) is the sum of the effects of (1) any change in the average crash rate of the general carrier population and (2) other underlying factors in the general carrier population (e.g., changes in crash reporting). To determine how much of the decrease was due to each element, a separate set of calculations was performed. The calculations showed that there was a 7.37 percent decrease in the average crash rate of the general carrier population. Therefore, the 1.53 percent decrease in the average crash rate of the Control Group (and therefore, the general carrier population) was the sum of a 7.37 percent decrease in the crash rate of the general carrier population and a 5.84 percent increase due to other underlying factors in the general carrier population (e.g., changes in crash reporting). These calculations are shown in Appendix B.

Therefore, the adjusted change in the average crash rate due to the CRs conducted in FY 2005 was:

Percentage Change in Average Crash Rate of Carriers with CRs in FY 2005

– Percentage Change in Average Crash Rate of Control Group

$= (-17.79) - (-1.53)$

$= -16.3\%$ (i.e., a decrease of 16.3 percent)

(5) Calculate the number of post-CR power units, i.e., the number of power units 12 months after the CRs in FY 2005.

The 8,941 carriers that received CRs in FY 2005 and were still active 12 months after their CRs had a total of 244,549 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 2005-2006 as a result of the CRs conducted in FY 2005.

The estimated number of crashes avoided in FY 2005-2006 by the 8,941 carriers that received CRs in FY 2005 and were still active 12 months after their CRs was calculated as follows:

Pre-CR Average Crash Rate X Crash Rate Reduction (%) X Post-CR Power Units

= 5.785 crashes per 100 power units X 16.3% X 244,549 power units

= 2,306 crashes

Next, estimates were made of the number of crashes avoided in FY 2005-2006 by the carriers receiving CRs in FY 2005 by severity, i.e., fatal, injury, and towaway.[3] 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 2005-2006, the period in which the benefits of the CRs conducted in FY 2005 would occur, 3.4 percent were fatal crashes, 42.6 percent were injury crashes, and 54.0 percent were towaway crashes.

Applying these proportions to the estimate of 2,306 crashes avoided produced the following results:

Fatal crashes	=	2,306	X	3.4%	=	79
Injury crashes	=	2,306	X	42.6%	=	982
Towaway crashes	=	2,306	X	54.0%	=	1,245

(7) Estimate the average numbers of fatalities and injuries per crash in FY 2005-2006.

The average number of fatalities per fatal crash was estimated from state-reported crash data from the MCMIS Crash File. The benefits of the CRs conducted in FY 2005 occurred in the period FY 2005-2006. For crashes in FY 2005-2006 involving large trucks or buses, the ratio was 1.17 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 2005-2006 large truck and bus crashes, the averages were as follows:

- Fatal crashes: 0.99 injuries per crash
- Injury crashes: 1.51 injuries per crash

[3] 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 2005-2006.

The estimated number of lives saved in the crashes avoided in FY 2005-2006 by the carriers with CRs in FY 2005 was calculated as follows:

Number of fatal crashes avoided X Average number of fatalities per fatal crash

= 79 X 1.17

= 92 lives saved

The estimated number of injuries avoided in the crashes avoided in FY 2005-2006 by the carriers with CRs in FY 2005 was calculated as follows:

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

= (79 X 0.99) + (1,245 X 1.51)

= 1,561 injuries avoided

Table 2-1 summarizes the estimated benefits that occurred in FY 2005-2006 as a result of the CRs conducted in FY 2005 on the 8,941 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, 2003, and 2004 that occurred in CY 2002-2003, 2003-2004, and 2004-2005, respectively.

Table 2-1. Results of Implementation of Compliance Review Effectiveness Model for Carriers with Compliance Reviews in CY 2002-2004 and FY 2005

Model Implementation for Motor Carriers with CRs in:	**CY 2002**	**CY 2003**	**CY 2004**	**FY 2005**
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Motor carriers that received compliance reviews and: • were interstate or intrastate HM, • 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
Estimated percentage reduction in average crash rate due to compliance reviews	12.6	17.6	21.1	16.3
Model Results (i.e., Benefits) Estimated for:	**CY 2002-2003**	**CY 2003-2004**	**CY 2004-2005**	**FY 2005-2006**
Crashes Avoided	1,426	2,276	2,720	2,306
Fatal crashes	53	77	92	79
Injury crashes	677	1,038	1,186	982
Towaway crashes	696	1,161	1,442	1,245
Lives saved	62	90	107	92
Injuries avoided	1,087	1,651	1,889	1,561

3. ADDITIONAL ANALYSIS

3.1. OVERVIEW

The results of the implementation of the model were broken out by carrier size (i.e., number of power units), by the state of domicile of the carrier, by carrier safety status (i.e., the carrier's SafeStat category before receiving its CR in FY 2005), and by the planned course of action (i.e., enforcement or no enforcement).

The results of these analyses revealed 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.

The sums of the estimates of crashes avoided by power unit group, state of domicile, SafeStat category group, and planned course of action group did not equal the estimate of 2,306 crashes avoided that was obtained in Section 2.3. Therefore, the estimates were prorated to sum to this number. The estimated numbers of crashes avoided, the post-CR average crash rates, and the percent changes in the average crash rates shown in Tables 3-1, 3-2, 3-3, and 3-4 were all derived using this prorating procedure.

3.2. CARRIER SIZE

The results of the implementation of the model were broken out 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 3-1 shows the results of the implementation of the model for the four power unit groups:

- 1 to 5 power units,
- 6 to 20 power units,
- 21 to 100 power units, and
- 101 or more power units.

Table 3-1 shows, for each power unit group, the number of carriers in the group that received CRs in FY 2005, 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 3-1 also shows, for each power unit group, the estimated number of crashes avoided as a result of the CRs.

Table 3-1. Results of Implementation of Model by Carrier Size

Number of Pre-CR Power Units	Number of Carriers with CRs in FY 2005	Pre-CR Average Crash Rate*	Post-CR Average Crash Rate*	Percent Change in Average Crash Rate	Estimated Number of Crashes Avoided in FY 2005–2006
1 – 5	4,064	10.832	5.880	–45.7	583
6 – 20	3,097	7.434	5.202	–30.0	778
21–100	1,430	5.906	4.912	–16.8	607
≥101	350	4.908	4.661	–5.0	338
All Carriers	8,941	5.785	4.842	–16.3	2,306

* – Crashes per 100 power units

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 reduction in the average crash rate ranged from 45.7 percent for carriers with 1-5 power units to 5.0 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 (778), followed by carriers with 21-100 power units (607). The carriers with 1-5 power units had only the third highest number of crashes avoided (583), despite having the largest crash rate reduction. This result was a consequence of the distribution of power units. The carriers with 1-5 power units accounted for 45.5 percent of the carriers in the analysis, but only 4.8 percent of the post-CR power units.

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, CY 2003, and CY 2004[1] and (2) the results of analyses of data from the implementations of the previous model, the Compliance Review Impact Assessment Model.[2]

3.3. STATE OF DOMICILE OF CARRIER

Table 3-2 shows the results of the implementation of the model broken out by the carrier's state of domicile. For a state's results to be published in the table, it had to have at least 50 carriers with CRs in FY 2005. Five states,[3] the District of Columbia, and Puerto Rico did not meet this requirement. Their data were combined and are shown in the row labeled "Other S. and P." (Other States and Possessions). Since there were not enough Canadian or Mexican carriers receiving CRs in FY 2005 to summarize at the province/state level, these results were summarized at the national level.

[1] Reports documenting these results are available at ai.fmcsa.dot.gov/CarrierResearchResults/Archives.asp?p=23.

[2] A report documenting these results is available at ai.fmcsa.dot.gov/CarrierResearchResults/Archives.asp?p=23.

[3] Alaska, Delaware, Hawaii, Rhode Island, and Vermont

Table 3-2. Results of Implementation of Model by State of Domicile of Carrier

State/Country of Domicile	Number of Carriers with CRs in FY 2005	Pre-CR Average Crash Rate*	Post-CR Average Crash Rate*	Percent Change in Average Crash Rate	Estimated Number of Crashes Avoided in FY 2005–2006
Alabama	263	7.480	5.860	–21.6	91
Arizona	149	6.252	5.127	–18.0	276
Arkansas	148	9.248	6.736	–27.2	56
California	333	4.850	4.134	–14.8	56
Colorado	186	3.448	2.977	–13.6	28
Connecticut	55	5.418	2.969	–45.2	27
Florida	232	5.937	4.760	–19.8	67
Georgia	441	7.718	5.514	–28.6	160
Idaho	99	6.975	5.268	–24.5	25
Illinois	310	7.713	5.635	–26.9	174
Indiana	286	5.188	4.408	–15.1	107
Iowa	92	6.597	7.250	+9.9	(49)
Kansas	401	4.511	3.961	–12.2	26
Kentucky	204	5.877	4.313	–26.6	56
Louisiana	123	7.221	5.627	–22.1	31
Maine	54	5.924	5.202	–12.2	3
Maryland	76	3.156	2.770	–12.2	6
Massachusetts	70	3.941	3.894	–1.2	1
Michigan	154	7.607	6.917	–9.1	40
Minnesota	323	5.172	4.487	–13.3	58
Mississippi	148	6.715	6.070	–9.6	32
Missouri	275	5.821	4.786	–17.8	111
Montana	59	5.773	3.701	–35.9	25
Nebraska	113	6.237	5.074	–18.6	41
Nevada	124	3.935	3.200	–18.7	9
New Hampshire	60	4.280	3.200	–25.2	6
New Jersey	247	5.921	5.726	–3.3	15
New Mexico	73	3.565	3.832	+7.5	(5)
New York	143	5.863	4.749	–19.0	31
North Carolina	310	8.710	6.537	–25.0	61
North Dakota	118	4.696	3.336	–29.0	24
Ohio	540	5.195	4.693	–9.7	72
Oklahoma	124	5.333	5.023	–5.8	10
Oregon	53	3.491	2.519	–27.8	10
Pennsylvania	76	3.842	3.974	+3.4	(3)
South Carolina	176	5.973	6.251	+4.6	(7)
South Dakota	65	3.181	2.617	–17.7	6
Tennessee	266	7.519	5.902	–21.5	143
Texas	647	5.248	4.344	–17.2	228
Utah	196	5.058	4.381	–13.4	42
Virginia	68	4.238	2.587	–38.9	23
Washington	296	3.765	3.248	–13.7	28
West Virginia	96	8.704	4.387	–49.6	49
Wisconsin	230	5.970	5.519	–7.5	32
Wyoming	90	4.255	2.317	–45.6	17
Other S. and P.†	99	3.479	1.681	–51.7	33
Canada	133	5.323	3.983	–25.2	34
Mexico	117	0.393	0.355	–9.7	0
Total	8,941	5.785	4.842	–16.3	2,306

* – Crashes per 100 power units

† – Other States & Possessions: Alaska, Delaware, District of Columbia, Hawaii, Puerto Rico, Rhode Island, and Vermont

Table 3-2 shows, for each state (or country), the number of carriers that received CRs in FY 2005, 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 3-2 also shows, for each state (or country), the estimated number of crashes avoided as a result of the CRs. (Note: A number in parentheses indicates an increase in the number of crashes.)

Table 3-2 shows that two states, Arizona (276) and Texas (228), had more than 200 crashes avoided in FY 2005-2006 due to CRs performed in FY 2005. Five other states (Illinois, Georgia, Tennessee, Missouri, and Indiana) each had more than 100 crashes avoided. Four states showed increases in the number of crashes in FY 2005-2006 by carriers that received CRs in FY 2005.

There are several factors that affect the state estimates of crashes avoided. The equation that is used to calculate the number of crashes avoided consists of three factors: the pre-CR average crash rate, the percentage reduction in the average crash rate due to the CRs, and the number of post-CR power units. The states with the largest numbers of crashes avoided are usually among the states with the highest numbers of post-CR power units, which is a function of the number of carriers receiving CRs. The more carriers in a state that receive reviews, the greater the number of post-CR power units that results, which increases the potential for a large number of crashes to be avoided. For example, Indiana had a reduction in its average crash rate of only 15.1 percent, but had 107 crashes avoided because it had 286 carriers with CRs in FY 2005. On the other hand, Connecticut had a reduction in its average crash rate of 45.2 percent, but had only 27 crashes avoided because it had only 55 carriers with CRs in FY 2005.

Another factor that influenced the state results was the proportion of the carriers with zero crashes in the pre-CR period in each state that received CRs in FY 2005. Of the total of 8,941 carriers that received reviews in FY 2005, 5,219, or 58.4 percent, had pre-CR crash rates of zero. Thus, the crash rates of these carriers could either stay the same or increase, but not decrease. If a state had an especially high percentage of these carriers, it would make it difficult for that state's average crash rate to decrease significantly.

In addition, the relatively low number of carriers in each state that received CRs in FY 2005 makes the state results subject to the influence of a few large carriers, i.e., carriers with large numbers of power units. As shown in Table 3-1, there were 350 carriers with 101 or more power units that received CRs in FY 2005. While these carriers made up only 3.9 percent of the 8,941 carriers that were analyzed, they accounted for 56.0 percent of the total number of post-CR power units. Thus, the data from one or two large carriers could greatly affect an individual state's results.

3.4. CARRIER SAFETY STATUS

One of the primary methods of prioritizing carriers for CRs is to use SafeStat results. Carriers are assessed in four Safety Evaluation Areas (SEAs): Accident, Driver, Vehicle, and Safety Management. Carriers are placed in SafeStat categories if they are found to be deficient in one or more SEAs. Carriers with the most extensive deficiencies are placed in Categories A and B

and are assigned the highest priority for CRs, followed by carriers in Category C, carriers in Categories D-G, and finally, carriers not in any category (i.e., carriers not deficient in any SEAs).

The purpose of the analysis in this section is to determine the impact of carrier safety status prior to CRs on crash rate reduction after the CRs. In other words, determine if carriers with the highest priority for CRs show the greatest improvement, i.e., the largest crash rate reduction, following their CRs.

The results of the CR Effectiveness Model were broken out by SafeStat category group based on each carrier's SafeStat category prior to receiving its FY 2005 CR. Table 3-3 shows, for each SafeStat category group, the number of carriers in the group that received CRs in FY 2005, 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 3-3 also shows, for each SafeStat category group, the estimated number of crashes avoided as a result of the CRs.

Table 3-3. Results of Implementation of Model by Carrier Safety Status

SafeStat Category Group	Number of Carriers with CRs in FY 2005	Pre-CR Average Crash Rate*	Post-CR Average Crash Rate*	Percent Change in Average Crash Rate	Estimated Number of Crashes Avoided in FY 2005–2006
A–B	3,120	8.767	6.412	–26.9	1,995
C	881	4.317	4.446	+3.0	(24)
D–G	1,948	4.921	4.338	–11.8	354
None	2,992	3.616	3.640	+0.7	(19)
All Carriers	8,941	5.785	4.842	–16.3	2,306

* – Crashes per 100 power units

Carriers in Categories A and B, the carriers with the highest priority for CRs, had the highest pre-CR average crash rate as well as the greatest percent reduction in their average crash rate. Their post-CR average crash rate showed a decrease of 26.9 percent. The carriers in this group accounted for 1,995 of the 2,306 crashes avoided in FY 2005-2006. Carriers in Categories D-G showed a decrease of 11.8 percent in their average crash rate and had 354 crashes avoided.

Carriers in Category C showed an increase of 3.0 percent in their average crash rate, while carriers not in any SafeStat category showed an increase of 0.7 percent in their average crash rate.

3.5. PLANNED COURSE OF ACTION

The results of the implementation of the model were also broken out by the course of action planned by the FMCSA for the carrier following its FY 2005 CR. A carrier with prosecution or an 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.

It should be noted that these courses of action are the ones that were anticipated by the FMCSA at the conclusions of the CRs that the carriers received in FY 2005, 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 3-4 shows, for each action type group, the number of carriers in the group that received CRs in FY 2005, 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 3-4 also shows, for each action type group, the estimated number of crashes avoided as a result of the CRs.

Table 3-4. 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 2005	Pre-CR Average Crash Rate*	Post-CR Average Crash Rate*	Percent Change in Average Crash Rate	Estimated Number of Crashes Avoided in FY 2005–2006
Enforcement	2,367	6.349	5.195	–18.2	843
Non-Enforcement	6,574	5.542	4.689	–15.4	1,463
Total	8,941	5.785	4.842	–16.3	2,306

* – Crashes per 100 power units

Table 3-4 shows that it was anticipated that 2,367 (or 26.5 percent) of the 8,941 carriers that received CRs in FY 2005 would undergo enforcement actions. The "enforcement" carriers showed a crash rate reduction of 18.2 percent, compared to a 15.4 percent reduction for the "non-enforcement" carriers. The "enforcement" carriers accounted for 843, or 36.6 percent, of the crashes avoided in FY 2005-2006.

It should be noted that unlike all the other estimates in this report, these estimates were calculated without the use of the Control Group, since this variable applies only to carriers that received CRs. As explained in Section 3.1, the estimated numbers of crashes avoided in Table 3-4 were calculated in the same manner as the estimated numbers of crashes avoided in Tables 3-1, 3-2, and 3-3. The numbers in each table were prorated to sum to the estimate of 2,306 crashes avoided. The only difference is that the estimates in Table 3-4 were not calculated using the Control Group.

APPENDIX A
CALCULATION OF PRE-CR AND POST-CR
AVERAGE CRASH RATES FOR CONTROL GROUP

The pre-CR and post-CR average crash rates for the Control (i.e., non-CR) Group are actually the weighted averages of the average crash rates of the individual years, as shown by the following derivation.

The weighted average of the crash rates of two individual years is calculated by the equation:

Weighted Average Crash Rate

$$= \frac{\sum_{n=1}^{2} W_n R_n}{\sum_{n=1}^{2} W_n}$$

where R_n = the average crash rate for year n, and
W_n = the weight for year n.

R_n, the average crash rate for year n, is defined as:

$$= \frac{C_n}{P_n}$$

where C_n = the number of crashes in year n, and
P_n = the number of power units in year n.

In this case, W_n, the weight for year n, is defined as Pn, the number of power units in year n.

Therefore, the weighted average of the crash rates for years 1 and 2

$$= \frac{\sum_{n=1}^{2} P_n \left(\frac{C_n}{P_n}\right)}{\sum_{n=1}^{2} P_n}$$

$$= \frac{\sum_{n=1}^{2} C_n}{\sum_{n=1}^{2} P_n}$$

Therefore, the weighted average of the average crash rates for the Control Group for FY 2004 and FY 2005

$$= \frac{\text{Crashes in FY 2004 + Crashes in FY 2005}}{\text{Power Units in FY 2004 + Power Units in FY 2005}}$$

= Pre-CR Average Crash Rate for the Control Group

Also, the weighted average of the average crash rates for the Control Group for FY 2005 and FY 2006

$$= \frac{\text{Crashes in FY 2005 + Crashes in FY 2006}}{\text{Power Units in FY 2005 + Power Units in FY 2006}}$$

= Post-CR Average Crash Rate for the Control Group

APPENDIX B
ALLOCATION OF CHANGE IN AVERAGE CRASH RATE OF CONTROL GROUP TO CHANGE IN CRASH RATE AND OTHER UNDERLYING FACTORS

The 489,084 carriers in the Control Group had a pre-CR average crash rate of 2.088 crashes per 100 power units and a post-CR average crash rate of 2.056 crashes per 100 power units.

The percentage change in the average crash rate of the Control Group was calculated as follows:

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

$$= \frac{2.056 - 2.088}{2.088} \text{ X } 100$$

$$= -1.53\% \text{ (i.e., a decrease of 1.53 percent)}$$

This decrease in the average crash rate of the Control Group, and therefore, the general carrier population, is the sum of the effects of (1) any change in the average crash rate of the general carrier population and (2) other underlying factors in the general carrier population (e.g., changes in crash reporting). To determine how much of the decrease was due to each element, the change in the average crash rate of the general carrier population was calculated.

To verify if the crash rate actually decreased during the period in which the benefits from the CRs conducted in FY 2005 would have occurred (i.e., FY 2005-2006), 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 periods FY 2004-2005 and FY 2005-2006. The percentage change in the two crash rates was then calculated.

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: (1) an incapacitating injury, (2) a visible but not incapacitating injury, (3) a possible, but not visible injury, or (4) 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 2004, 2005, and 2006 were obtained, GES data were not available by fiscal year at the time that this analysis was performed. Thus, calendar year GES crash data were used in the model.

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 2003, 2004, and 2005. These CY numbers were used because (1) they are the only national registration figure available and (2) some states report their data on a fiscal year basis. Therefore, the FHWA numbers are not pure calendar year numbers, but a mixture of calendar and fiscal year numbers.

The change in the average crash rate of the general carrier population, as measured by the FARS and GES data, is calculated as follows:

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

The pre-CR crash rate is the average crash rate for the entire pre-CR period, i.e., FY 2004-2005, while the post-CR crash rate is the average crash rate for the entire post-CR period, i.e., FY 2005-2006. The pre-CR and post-CR average crash rates are calculated as follows:

$$\text{Pre-CR Average Crash Rate} = \frac{\text{Crashes in FY 2004 + Crashes in FY 2005}}{\text{Large Trucks Reg. in CY '04 + Large Trucks Reg. in CY '05}} \text{ X } 100$$

$$\text{Post-CR Average Crash Rate} = \frac{\text{Crashes in FY 2005 + Crashes in FY 2006}}{\text{Large Trucks Reg. in CY '05 + Large Trucks Reg. in CY '06}} \text{ X } 100$$

The general carrier population had a pre-CR average crash rate of 4.942 crashes per 100 power units and a post-CR average crash rate of 4.578 crashes per 100 power units.

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

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

$$= \frac{4.578 - 4.942}{4.942} \text{ X } 100$$

$$= -7.37\% \text{ (i.e., a decrease of 7.37 percent)}$$

Thus, the combined data from the NHTSA and FHWA suggest that the actual change in the crash rate for large trucks from FY 2004-2005 to FY 2005-2006 was a decrease of 6.22 percent.

Therefore, the increase in the crash rate of the Control Group caused by changes in other underlying factors (e.g., changes in crash reporting) in the general carrier population was:

= Percentage Change 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)

$= -1.53\% - (-7.37\%)$

$= 5.84\%$

Therefore, the 1.53 percent decrease in the average crash rate of the control group, and therefore, the general carrier population, was the sum of a 7.37 percent decrease in the crash rate of the general carrier population and a 5.84 percent increase due to other underlying factors in the general carrier population (e.g., changes in crash reporting).