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Strategies to Reduce CMV-Involved Crashes, Fatalities, and Injuries in Michigan: 2013 Update

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16. Abstract

The objectives of this research are to update data analyses of the 2007 study of crashes, fatalities, and injuries in Michigan; to assess if the strategies and countermeasures recommended by the 2007 study are still relevant to the commercial motor vehicle (CMV) safety challenges of today, the extent to which the countermeasures were implemented, and recommend any new areas for strategic improvement; and to evaluate the possible safety effect of Public Act 231 which exempts intrastate medium duty trucks (gross vehicle weight 10,000 to 26,000 lb.) from compliance with certain regulations that govern medium duty interstate CMVs and all heavy duty CMVs (GVW over 26,000 lb).

Data files used include the Michigan crash data file, Michigan driver history records, the Motor Carrier Management Information System (MCMIS) Carrier and Inspection files.

Analysis of crash data showed that crash involvements declined over the period 2006-2011, particularly in 2009. Despite this, the same issues identified in the 2007 report also were prevalent in the present analysis. The distribution of serious CMV crashes across the state was similar. Head-on, angle, and rear-end crashes accounted for most harm in CMV crashes. Driver fatigued/asleep was seldom identified as a hazardous action. Younger CMV drivers were significantly more likely to contribute to crashes than older drivers. Fleet size was strongly correlated with vehicle and driver violations in inspections.

Accordingly, it was assessed that the strategies recommended in the prior report are still relevant. Favorable trends include the increasing prevalence of crash avoidance technologies; and a strong program to address aggressive driving around trucks.

Evaluating the effect of exempting medium/intrastate trucks from compliance hours of service and vehicle inspection standards was accomplished by comparing medium- and heavy-duty CMV crash statistics and interstate and intrastate driver behavior. It was found that medium/intrastate carriers had low rates of crashes due to fatigued or sleepy drivers. Inspections showed comparable rates of vehicle violations and out-of-service (OOS) conditions, though medium trucks had significantly lower rates of brake violations, likely because many are equipped with hydraulic brakes. Exemption from hours-of-service (HOS) regulations likely will have little effect because of the operations of medium/intrastate carriers. Exemption from vehicle inspection requirements will likely have a negative safety effect if truck mechanical condition is allowed to deteriorate.

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Strategies to Reduce CMV-Involved Crashes, Fatalities, and Injuries in Michigan: 2013 Update

Executive summary

Objectives

- Update data analyses in the 2007 study of crashes, fatalities, and injuries in Michigan. The results reported in that report were based on analysis of 2001-2005 data. The present report is updated based on data from 2006-2011. The purpose is to compare the resulting commercial motor vehicle (CMV) safety and behavior measures from the two time periods (2001-2005 and 2006-2011) and identify any significant differences between them.
- Assess if the strategies and countermeasures recommended by the 2007 study are still relevant to the CMV-related safety challenges of today, the extent to which the strategies were implemented, and recommend any new areas for strategic improvement.
- Compare medium and heavy-duty CMV crash statistics and interstate and intrastate driver behavior. Public Act 231 of 2012 exempted intrastate medium duty trucks (gross vehicle weight (GVW) 10,000 to 26,000 lb.) from compliance with certain regulations that govern medium duty interstate CMVs and all heavy duty CMVs (GVW over 26,000 lb). The objective of this task is to estimate the probable effects of this exemption on CMV safety through the comparative analysis of crash data, driver history records, and inspection information of medium and heavy duty intrastate and interstate CMVs and drivers.

Data

- The Michigan crash data file, covering all motor vehicle crashes from 2006-2011, was used. These data were extracted from the Michigan Traffic Crash Reporting Form (UD-10), which is completed by police officers on traffic crashes that result in a fatality, injury, or property damage over $1000 (previously $400 until changed effective January 1, 2004).
- Motor Carrier Management Information System (MCMIS) files:
    - The Inspection file contains the results of all CMV inspections conducted under the Motor Carrier Safety Assistance Program (MCSAP). These include Level 1 inspections, walk-around, driver-only, terminal, and special inspections.
    - The Carrier file registers all operators of commercial vehicles in interstate commerce, or carriers of hazardous materials. Many states, including Michigan, require intrastate carriers to register. The file provides information about the type of operations of the carrier, the number of vehicles operated in different categories, the number of drivers, and the types of cargo transported. This information was used to characterize the size of the fleet operating vehicles and the type of operations.
- The Crash file contains records of all CMV crashes meeting a crash-severity threshold. The data include US Department of Transportation (DOT) numbers, which were used to link crashes in the Michigan Crash file with carriers in the MCMIS Carrier file.

- The Michigan Driver Database was used to analyze the driver records of crash-involved medium and heavy-truck drivers. The files contain records of all licensed drivers in the state of Michigan. The database itself is a moving database, with new records added continuously, and old records deleted periodically. Records for most drivers contain information going back seven years. However, convictions for serious offenses are kept in the file indefinitely.
- Estimates of costs resulting from CMV crashes. Estimates were based on two national studies (Zaloshnja and Miller 2007, Zaloshnja and Miller 2002). These studies present crash costs per victim injured by injury severity. The crash costs estimates include medical costs, emergency services, property damage, lost productivity (to the injured person), lost productivity due to delays and from other sources, and monetized QALY (quality-adjusted life years) lost. The costs were adjusted to 2012 dollars so that crash costs may be compared by year.

Methods

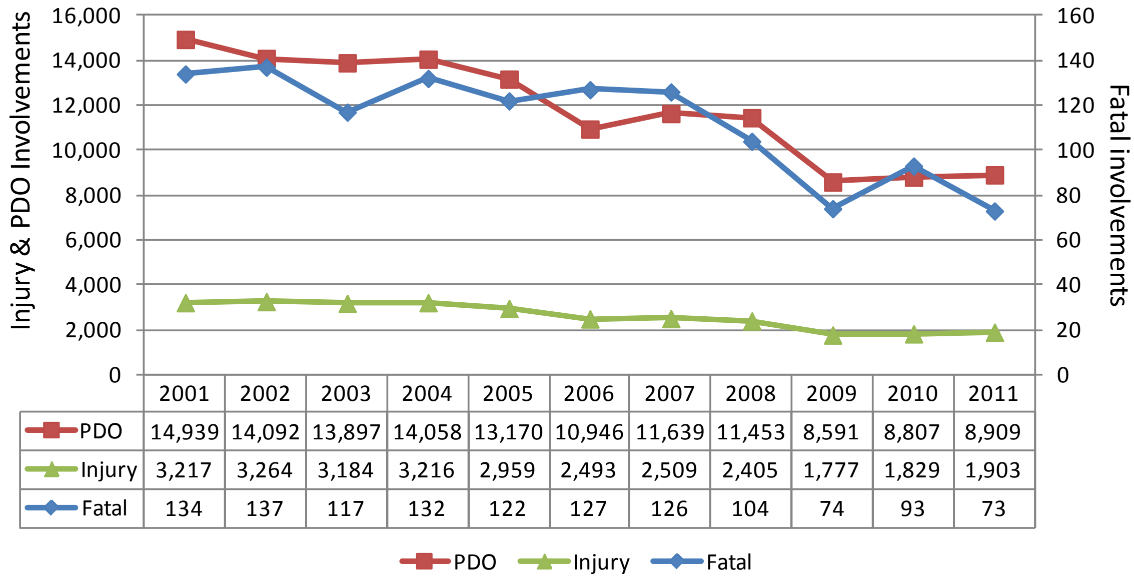
Prior study results were updated by repeating the analyses for crash years 2006-2011. The study identified crash trends over the entire period (2001-2011), encompassing the period of the 2007 study and of the current study. Results from the 2007 study were compared with current results to identify any changes. The analysis covered crash types, environmental factors, driver actions and behavior, the geographic distribution of crashes, and vehicle and driver inspection results. Crash costs were used as a metric of harm to identify the primary crash types, hazardous actions, environmental conditions, and driver factors.

Results from the updated analysis were used to assess the continuing relevance of the strategies recommended in the 2007 study, and to identify any new strategies. Industry trends were surveyed to determine the extent to which certain recommendations were being realized. State and industry stakeholders were surveyed through questionnaires and personal communications to identify any activities consistent with the recommended strategies.

Medium and heavy trucks were identified in the Michigan crash data by decoding vehicle identification numbers (VINs) and linking crashes to the MCMIS Carrier file to determine whether carriers were inter- or intrastate carriers. The carriers' inspection records were extracted from the MCMIS Inspection files. Prior crash and violation charge records were obtained by linking crash-involved drivers to driver history records in the Michigan Driver database. A series of analyses compared crash, driver record, and inspection results from medium-duty intrastate carriers with medium- and heavy-truck interstate carriers and heavy-truck intrastate carriers.

Trends & results

The number of CMV involvements declined over the entire period from 2001 to 2011. Figure E-1 shows the pattern for fatal, injury, and property damage only (PDO) crash involvements. Fatal involvements declined from 134 in 2001 to 73 in 2011. Injury crash involvements over the period encompassing the earlier project (2001-2005) and the current review (2006-2011) declined from about 3,200 in 2001 to less than 2,000 in 2011.



	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
PDO	14,939	14,092	13,897	14,058	13,170	10,946	11,639	11,453	8,591	8,807	8,909
Injury	3,217	3,264	3,184	3,216	2,959	2,493	2,509	2,405	1,777	1,829	1,903
Fatal	134	137	117	132	122	127	126	104	74	93	73

Figure E-1 CMV Involvements by Crash Severity, 2001-2011

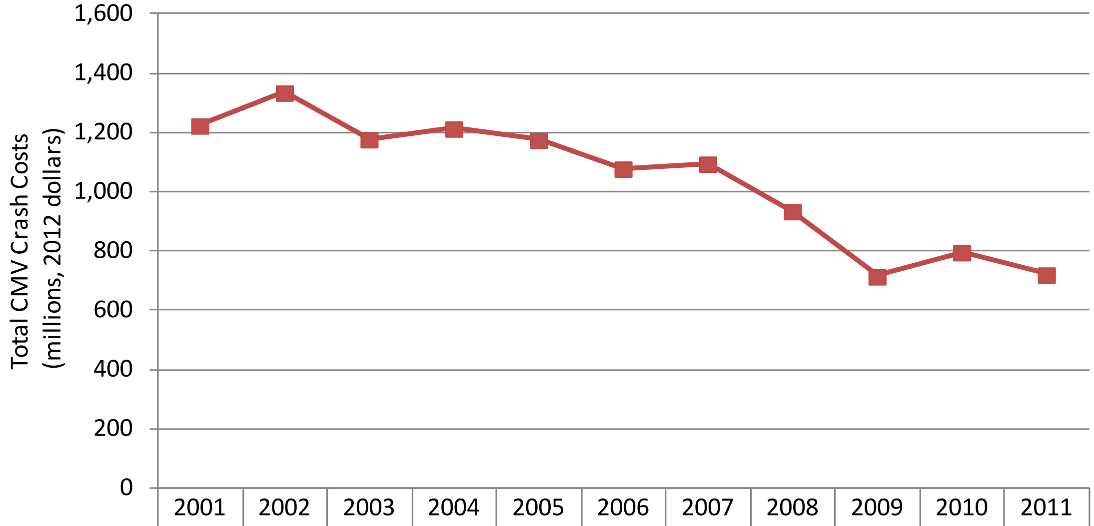
Table E-1 shows the average number of CMV involvements of different severities for the earlier period (2001-2005) and the period of the current analysis (2006-2011). For each level of crash severity the number of involvements was significantly lower. In the case of fatal involvements, the average for the current period was almost 30% lower. The combination of fatal with A-injury or fatal with A- and B-injury involvements declined even more.[1] Annual averages declined by almost half for each.

Table E-1 Annual Average of CMV Involvements by Crash Severity

Crash severity	2001-2005	2006-2011	% change
Fatal	128	100	-29.0
Fatal & A-injury	554	378	-46.6
Fatal, A-, & B-injury	1,359	908	-49.7

Crash costs also declined significantly over the period. See Figure E-2. Total costs were fairly stable from 2001 to 2007 and then declined sharply from 2008 to 2011. The declines in 2008 and 2009 were likely related in part to the economic recession. There was an increase in 2010 but then costs declined again in 2011 to almost 2009 levels. These results track closely the number of fatal and A-injury crashes shown in Figure E-1.

[1] Injury severity is classified using the KABC0 scale. An A-injury is defined as an incapacitating injury; a B-injury is evident at the scene of the crash, but not incapacitating; a C-injury is any injury that is reported or claimed, but not classified as fatal, incapacitating, or non-capacitating but evident.



	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Total	1,225	1,336	1,178	1,214	1,175	1,079	1,096	936.0	716.0	797.4	722.1

Figure E-2 CMV Crash Costs in 2012 Dollars, 2001-2011

Some fraction of the decline in CMV crashes and crash costs was related to reduced travel by CMVs, and therefore exposure to the risks of traffic crashes. In 2008, CMV vehicle miles traveled (VMT) declined by 3.2% followed by another year-over-year drop of 15.4% in 2009. These changes probably reflect the economic recession that began in the middle of 2008 and accelerated into 2009. There was a 2.5% recovery of VMT in 2010, and in 2011 CMV travel was essentially unchanged.

However, the decline in crashes and crash costs cannot be attributed entirely to lower CMV travel. Computing crash rates for CMVs showed that there was a significant decline in CMV crash rates over the period. Fatal rates declined from 2.08 per 100 million miles in 2001 to 1.27 per 100 million miles in 2011, a reduction of 38.8%. Injury crash involvement rates dropped from 49.9 per 100 million miles in 2001 to 33.2 in 2011, a reduction of 33.5%. There was a clear increase in safety over the period, primarily related to a drop in crash involvements in 2005-2006 and another drop in 2008-2009.

Fatal and A-injury level crashes accounted for 61.1% of estimated costs related to CMV crashes. (Table E-2) Although 12,310 CMVs were involved in traffic crashes annually over the period, 378 accounted for most of the associated crash costs.

Table E-2 Annual CMV Involvements by Crash Severity and Crash Costs 2006-2011

Crash severity	Involve-ments	%	Costs (millions)	%
Fatal	100	0.8	$387.6	43.5
A-injury	278	2.3	155.8	17.5
B-injury	530	4.3	102.4	11.5
C-injury	1,345	10.9	126.9	14.2
PDO	10,056	81.7	118.6	13.3
Total	12,310	100.0	$891.3	100.0

Costs in 2012 dollars. Totals include unknown severity.

In terms of crash types, rear-end, angle, head-on, and same-direction sideswipes accounted for the most costs, but in terms of costs per crash, head-on crashes were by far the most severe. Head-on crashes accounted for only about 1.4% of CMV crash involvements annually, but resulted in 12.4% of associated harm, as measured by crash costs. These crashes were the most deadly because closing speeds are typically high. Angle collisions, which include both a CMV into the side of another vehicle or another vehicle into the side of a CMV, were also disproportionately severe. Same-direction sideswipes were the most common crash type, accounting for over a quarter of crash involvements, but the speed differential between sideswiping vehicles is typically not large, so they were not as severe.

Almost half of crash-involved CMV drivers committed no hazardous action in the crashes, according to police reports. The most common hazardous actions for CMV drivers were unable to stop, (which usually means following too closely in a rear-end crash), failure to yield the right-of-way, and improper lane use, which was typically the hazardous action in same-direction sideswipe crashes. Almost two-thirds of crash costs occurred in crashes where no hazardous actions were attributed to CMV drivers. Most of these were crashes where car or pickup truck drivers were assigned a hazardous action.

Most CMV crashes occurred on highways—Interstates, US routes, or Michigan (M-) routes—although an average of 43.7% occurred on county roads and city streets. However, crashes on highways were disproportionately severe because of higher travel speeds. Crashes on US routes and M-routes accounted for a higher percentage of crash costs than of crashes. Unlike Interstate highways, some US routes and M-routes have two-way travel, not separated by medians or barriers. Head-on collisions were rare on Interstate highways because of the controlled access and one-way travel. Head-on crashes were more common on two-way roads and, with the higher speeds of US and M-routes, can be much more severe.

- Driver fatigue/asleep was rarely identified in the crash data. Only 0.28% of CMV drivers were coded as fatigued or asleep. This was about the same percentage as in the 2007 report (0.33%).
- As in the previous report, a higher proportion of younger drivers were coded with a hazardous action compared with older drivers. Two-thirds of CMV drivers 16-20 were coded with a hazardous action, compared with 51.7% of drivers 21 to 30 and 45.5% of drivers 31 to 40. The most common young driver errors were following too close, improper backing, and failure to yield.
- Fleet size was strongly associated with inspection violations and out-of-service (OOS) conditions. Carriers with one to eight trucks averaged 2.65 violations and 0.37 OOS per inspection, compared with 1.45 violations and 0.13 OOS per inspection for carriers with more than 1,000 trucks.
- Vehicle violations and OOS were more common than driver-related violations and OOS, overall and for all carrier sizes. Violations were most common for light systems (head-lights, tail-lights, marker, and identification lights) and brakes. About 40% of vehicles inspected had one or more light system violations, and about 37% had at least one brake violation.
- Hours of service (HOS) and driver logbook violations were less frequent. In Level 1 inspections, 2.3% of drivers had at least one HOS violation and 7.4% had a log violation.

Nine of the top 10 counties in terms of crash costs were also in the top 10 in the previous report. Eight counties (Wayne, Oakland, Macomb, Kent, Washtenaw, Genesee, Monroe, and Kalamazoo) accounted for over one-half of Michigan's annual CMV crash costs. Wayne County alone accounted for 20.5% of the costs. Four of the above eight counties (Macomb, Kent, Washtenaw, and Kalamazoo) were not among the top eight counties when CMV inspections were considered.

Evaluation of strategies & recommendations

Updating the crash analysis from the 2007 Report showed that there has been no fundamental change in the nature of the CMV safety problem in Michigan. There has been a trend toward a decline in the number of CMV crashes, fatalities, injuries, and associated crash costs, and a general improvement in the truck safety climate over the last decade. In Michigan, there has been a general decline over the entire period covered by the two reports. Beginning in 2002, there was a gradual decline in crashes, fatal and non-injuries. The decline accelerated in 2008 and 2009 with the recession, and then returned to the general downward trend as the economy recovered slightly.

Despite this welcome improvement in the CMV safety climate, many of the primary safety issues identified in the previous study remain.

- Vehicle maintenance continued to be an issue, with relatively high rates of driver and vehicle violations and OOS conditions. Brake and light systems continued to be the primary vehicle condition issues. HOS and logbook violations were identified at roughly the same levels as previously. Fleet size was strongly associated rates of violations. Small carriers had higher rates of driver and especially vehicle violations than large fleets.
- Younger CMV drivers were coded with hazardous actions that contribute to crashes at a significantly higher rate than older drivers. Younger drivers were over-represented in crashes related to vehicle control, such as rear-end and backing crashes.
- Certain crash types tended to account for most fatalities and injuries, such as head-on, angle, and rear-end crashes. Crash type distributions in the 2006-2011 period were very similar to those identified in the 2001-2005 period.
- The primary hazardous actions by CMV drivers that contributed to crashes were following too close, failure to yield, improper turns, and improper lane use. These same actions were also identified for CMV drivers in the 2007 report.

The 2007 report recommended several strategies, which remain valid. (Blower and Kostyniuk 2007)

Improve maintenance of CMVs.

Targeted enforcement, mandating maintenance programs, and improving fleet safety management were all recommended in the 2007 report.

In 2010, the Federal Motor Carrier Safety Administration (FMCSA) implemented the Compliance, Safety, and Accountability (CSA) program. The CSA process was designed to identify more carriers earlier, and to intervene at a less severe level of violations before a compliance review was necessary. For example, CSA includes a “warning” letter for carriers found with relatively minor violations. Evaluation of the Pilot rollout of CSA showed that it was more effective at identifying unsafe carriers and bringing them back into compliance through a series of graded interventions. (Green and Blower 2011)

The 2007 report also identified educational training and consultation as paths to improve fleet safety management. While there have been no new such programs introduced in Michigan, either from FMCSA or otherwise, the Michigan Center for Truck Safety (MCTS) makes available a safety management specialist to consult on-site with carriers who may be experiencing problems. The Director of the MCTS indicated that most of the requests for safety management specialists come from small fleets, which is appropriate since the analysis of inspection data showed that small fleets tended to have higher rates of violations.

Deployment of truck safety technologies: The previous report described several safety-related technologies that could improve truck safety, including improved brakes, electronic braking systems, and collision avoidance technologies, such as forward crash warning, electronic stability control, and lane departure warning. Promoting these technologies through tax incentives was recommended.

There have been no changes in the tax law to encourage the adoption of these technologies. Nevertheless, many of them are beginning to show up on trucks. The National Highway Traffic Safety Administration (NHTSA) is considering a rulemaking to require electronic stability control (ESC) on new truck-tractors and certain buses. Several large carriers are already buying ESC as optional equipment on new tractors and studies have shown its effectiveness. Similarly, carriers are buying collision mitigation braking systems and adaptive cruise control, which studies have shown can significantly reduce truck-striking rear-end crashes. While surveys show that the overall penetration of safety technologies has been slow (other than speed limiters, which are probably on half over-the-road tractors), the pace is accelerating and many carriers have plans to add these technologies in the future. (Woodrooffe, Blower et al. 2009; Woodrooffe, Blower et al. 2012; Belzowski, Blower et al. 2009)

Increase Knowledge of Sharing the Road: The MCTS manages the *Share the Road* public information and education program in Michigan, and continues to do so. The MCTS also provides online videos and supplies DVDs to promote the "share the road" message. In addition, OHSP is conducting a TACT (Ticketing Aggressive Cars and Trucks) program in Michigan. This program includes targeted media campaigns to encourage safe driving around trucks, along with stepped-up enforcement to reduce unsafe driving around trucks. The program has been used successfully in several other states, and has evolved into a continuing program in the State of Washington.

Strengthen Commercial Driver License (CDL) program: Fraudulent issuance of CDLs was identified as a concern throughout the United States. The Michigan Secretary of State has recently increased staff focus on detecting fraud by more aggressively monitoring testing in the field. There has been better communication with third-party testers to alert them about suspicious activities by CDL applicants and facilitators. In addition, the examiners are subject to criminal history searches, with regular follow-ups every five years, and their own driving history is monitored.

Improve Crash Data: Several issues were identified with respect to the identification of trucks and buses in the Michigan crash data. In the intervening period, the information captured by crash data has not been changed. However, a working group has been established to make the Michigan Traffic Crash Report more compliant with the Model Minimum Uniform Crash Criteria (MMUCC). The MMUCC is a voluntary national standard, developed and promoted by NHTSA and the Governors Highway Safety Association.

In light of the updated findings and the assessment of the implementation of the strategies recommended last time, it is clear that the same areas need to be addressed. The following strategies are recommended as the most practical means to accelerate positive trends.

Improve the compliance of drivers and vehicles with Federal Motor Carrier Safety Regulations: Analysis of the inspection data showed that violations and OOS conditions for both drivers and vehicles continued at relatively high rates. These violations clearly reduced the safety of truck and bus operations. Implementation and refinement of the CSA program should contribute to improving safe operations.

Encourage the use of advanced safety technologies: The NHTSA is actively investigating a variety of technologies and considering rulemakings. Technology manufacturers continue to improve and aggressively market them, and an increasing number of truck buyers are ordering them because of their favorable cost/benefit profiles. Tax incentives would help increase the rate at which advanced safety technologies are spreading across the industry.

Share the Road: There is a need to continue to spread the message to the public about safe driving practices around trucks. The interaction of cars and trucks on the road may improve with the new TACT program. In addition, the feasibility of a sustained long- term TACT program modeled after the Washington state program could be considered.

Strengthen the CDL program, education, and outreach to truck drivers: While light vehicle drivers tended to contribute disproportionately to truck-light vehicle crashes, CMV drivers continued to commit the same hazardous actions in crashes. The driver continues to be the most important safety system in the vehicle. The MCTS programs of outreach, education, and training for drivers should be continued and supported.

Improve crash data: There is a continuing need to improve the identification of trucks and buses in crashes in the Michigan crash data system. Adopting the MMUCC guidelines would strengthen the usefulness of Michigan crash data to identify and understand CMV crash safety issues.

Evaluation of medium-and heavy-duty trucks

Public Act 231 of 2012, which went into effect on June 29, 2012, exempted intrastate medium duty trucks (GWV 10,000 to 26,000 lb.) from compliance with certain regulations that govern medium duty interstate CMVs and all heavy duty CMVs (GVW over 26,000 lb.). The objective of this task is to estimate the probable effects of this exemption on CMV safety through a comparative analysis of crash data, driver history records, inspection data of medium and heavy duty intrastate and interstate CMVs and drivers.

Trucks in the Michigan crash data were classified as medium- or heavy-duty and as intrastate or interstate. Michigan crash data classify carriers as intrastate or interstate. Trucks were classified by size by decoding vehicle identification numbers (VIN) to obtain the gross vehicle weight rating (GVWR). About 38,000 trucks over the six years of data could be cross-classified by size and inter/intrastate. Almost 12% of the trucks were medium/intrastate, 8.1% were medium/interstate, 29.7% heavy/intrastate, and 51.5% heavy/interstate.

The Act affects the regulation of medium/intrastate trucks in four ways: 1) they are not required to obtain or display a US DOT number; 2) they are exempt from HOS regulations; 3) they are exempt from regulations related to knowledge of and compliance with the inspection or maintenance of commercial motor vehicles; and 4) they are exempt from the requirement to provide certain safety-related documents to enforcement personnel.

Exemption from HOS and the vehicle inspection and maintenance requirements regulations have the most direct relationship to traffic safety. The HOS regulations are intended to reduce fatigue in truck drivers and fatigue-related truck crashes. More broadly, the HOS regulations are intended to help drivers remain alert and attentive to the driving task, and thus reduce crashes overall. The vehicle inspection and maintenance regulations are intended to ensure that trucks on the roads are mechanically sound, and reduce crashes related to defective equipment.

The analysis compared the crashes of medium/intrastate trucks to the other three truck classifications by weather, light, road condition, time of day, crash type, driver condition, and hazardous actions.

- With respect to environmental conditions, heavy/interstate truck crashes differed from the other three classifications, which were similar to each other. Heavy/interstate truck crashes occurred more often in snowy weather; on icy or slushy roads; and in dark, unlighted conditions. Only 15% of the crashes of medium/intrastate trucks occurred from 6 pm to 6 am, compared with almost 25% for heavy/interstate trucks.
- Compared with other truck types, medium/intrastate trucks were involved in fewer single-vehicle crashes and more rear-end crashes, probably because they tended to operate more during the daytime and on local roads.
- In crashes, about 50% of medium/intrastate drivers were coded with hazardous actions, compared with 44.2% of heavy/interstate drivers. Following too close, failure to yield, and improper backing were the most common actions identified. Though fatigue/asleep was rarely coded for truck drivers, it was coded substantially less for medium/intrastate drivers in crashes than interstate truck drivers. Only 0.06% of medium/intrastate truck drivers were coded fatigued/asleep, compared with 0.5% for heavy/interstate drivers.
- The incidence of illegal drug use was low for medium/intrastate drivers (0.07%); alcohol use was low (0.3%) but higher than for heavy/interstate truck drivers (0.2%).
- In terms of driver history, medium/intrastate drivers tended to have higher rates of prior alcohol-related charges (6.2%) compared with heavy/interstate (3.7%), but somewhat lower on prior speeding and prior other moving violations. If the prior record was limited to charges in a CMV, medium/intrastate drivers had zero alcohol charges (0.1% for heavy/interstate drivers); lower rates of prior speeding (7.7% to 14.1%); and lower rates of prior other moving violations (7.2% to 9.3%).
- When driving light vehicles, medium/intrastate drivers had higher rates of alcohol, speeding, and moving violations (4.8%, 31.7%, and 24.2% respectively) than heavy/interstate drivers (2.9%, 26.8%, and 17.8%, respectively).
- In Level 1 inspections, 2.3% of medium/intrastate drivers had HOS or log violations, compared with 9.5% of heavy/interstate drivers.
- Medium/intrastate trucks had significantly lower rates of brake violations (14.8%) than heavy/interstate, though this may reflect a higher incidence of hydraulic brakes on medium-duty

trucks. Overall, medium/intrastate trucks had about the same rate of any vehicle violation (84.4%) as heavy/interstate trucks (82.9%). They had higher driver violation rates (42.7%) than heavy/interstate (35.2%). The vehicle violation rate was only slightly higher.

Overall, it appears that medium/intrastate trucks were at less risk of being in violation of HOS regulations because they tended to be operated during the daytime in the work week and used in businesses where the primary activity was not driving. In terms of vehicle condition, truck inspections showed comparable overall rates of vehicle condition violations and OOS conditions, with the exception of brakes, where the rates were significantly lower. This may be because many are equipped with hydraulic brakes, which are less susceptible to adjustment problems.

Accordingly, it appears that, possibly because of operational factors, compliance with the HOS regulations was not a significant safety issue for medium/intrastate carriers in general. However, with respect to the vehicle condition requirements of the Federal Motor Carrier Safety Administration Regulations (FMCSRs), medium/intrastate trucks had about the same or higher rates of vehicle violations as other carrier classes, with exception of brake system violations.

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Strategies to Reduce CMV-Involved Crashes, Fatalities, and Injuries in Michigan: 2013 Update

1. Introduction

Truck-involved crashes and the deaths, injuries, and damages they produce, take a tremendous toll on society. Those affected include not only road users, but also the freight industry and its industrial partners, as well as parties involved in transportation infrastructure and management. In 2011, 210,000 large trucks (gross vehicle weight rating [GVWR] greater than 10,000 pounds) were involved in traffic crashes in the United States (US) in which 3,757 people were killed. In addition, over 88,000 persons suffered nonfatal injuries. Nationally, crashes involving trucks accounted for 12% of all traffic fatalities, and 5% of all injuries. (FMCSA, 2013)

Patterns were similar in Michigan. In 2011, commercial motor vehicles (CMV) were involved in over 10,000 crashes in Michigan, representing about 4% of all crashes that year. However, there were 73 fatalities in CMV-involved crashes, representing about 8% of the total of 889 motor vehicle fatalities in 2010. In addition, CMV crashes accounted for 2,591 injuries, about 4% of the 71,796 nonfatal injuries in motor vehicle crashes in 2011. (OHSP, 2013)

Although CMVs make up only about 2.5% of vehicles involved in motor vehicle accidents, the crashes they are involved in tend to be more severe than other crashes, because CMVs are heavier, higher, and structurally-stiffer than the other vehicles involved in the crashes. Crashes involving CMVs typically result in higher economic costs than other crashes and are more disruptive to other road users than other crashes because of congestion and traffic delays. They disrupt freight services and tend to be expensive with respect to infrastructure cleanup and repair costs.

In 2006, the Michigan Truck Safety Commission (MTSC) sponsored a study to identify key issues contributing to CMV crashes, fatalities, and injuries in Michigan and recommend strategies to enhance CMV safety. The study was conducted by the University of Michigan Research Institute (UMTRI) and was documented in two reports (Blower and Kostyniuk, 2007; Kostyniuk and Blower, 2008). The strategies and countermeasures proposed were based on a review of the literature and practice in other states, and judged as applicable to Michigan problems identified in an analysis of Michigan data from CMV crashes, Commercial Driver License (CDL) driver history records, and CMV inspection records from 2001-2005.

In 2012, the MTSC sponsored a follow-on study to update the results of the previous study to better understand the current status of truck safety in Michigan, evaluate the effectiveness of the strategies that have been implemented, and identify any new or emerging issues and the countermeasures that might be implemented to address them. The MTSC also requested a study of the safety differences between interstate and intrastate carriers and medium duty CMVs (10,000 to 26,000 lbs. GVWR and heavy-duty CMVs (GVWR over 26,000 lbs.) Michigan Public Act 231 of 2012 exempts intrastate medium duty large trucks from compliance with certain regulations that govern medium duty interstate CMVs and all heavy-duty trucks. UMTRI undertook this task and the research results are presented in this report.

The objectives of this report are:

- Update data analyses in the 2007 study of crashes, fatalities, and injuries in Michigan. The results reported therein are based on analysis of 2001-2005 data. The present report updates the analyses to the 2006-2011 period. The purpose was to compare the resulting commercial motor vehicle (CMV) safety and behavior measures from the two time periods (2001-2005 and 2007-2011) and identify any significant differences between them.
- Assess whether the strategies and countermeasures recommended by the 2007 study are still relevant to the CMV-related safety challenges of today, the extent to which they were implemented, and recommend any new areas for strategic improvement.
- Compare medium- and heavy-duty CMV crash statistics and interstate and intrastate driver behavior. Public Act 231 of 2012 exempts intrastate medium duty trucks (GWV 10,000 to 26,000 lb.) from compliance with certain regulations that govern medium duty interstate CMVs and all heavy duty CMVs (GVW over 26,000 lb). The objective of this task was to estimate the probable effects of this deregulation on CMV safety through the comparative analysis of crash data, driver history records, and inspection information of medium and heavy duty intrastate and interstate CMVs and drivers.

The next section describes the methods and data sources used. Sections 3, 4, and 5 present data analysis results, and the final section summarizes the analysis of the effect of exemption medium duty intrastate trucks from certain regulations.

1.1. Data

This section describes the crash and driver history data files used in the study. In each case, raw data covering multiple years were obtained from the source and built into data files suitable for analysis.

State of Michigan crash data

The Michigan crash data file, covering all motor vehicle crashes from 2006-2011, was the primary crash data file used. These data were extracted from the Michigan Traffic Crash Reporting Form (UD-10), which is completed by police officers on traffic crashes that result in a fatality, injury, or property damage over $1,000 (previously $400 until changed effective January 1, 2004). Among other things, the data identify vehicle type (including CMV), crash circumstances, driver hazardous actions, condition, fatalities and injuries in the crashes, and the longitude/latitude of each crash.

Six years of data were used, covering the period from 2006 through 2011. In combination with the results from the previous study, the data for the present report form a continuous 11-year period. Approximately 74,000 CMVs were involved in crashes over the period. The files also include records for 2.2 million automobiles and 480,000 pickups involved in traffic crashes over the period.

Motor Carrier Management Information System (MCMIS) files

Three national administrative files that are part of FMCSA's Motor Carrier Management Information System (MCMIS) were used. The files are the Inspection file, which contains records on CMV inspections, the Carrier file, which contains information on all registered motor carriers operating in interstate commerce, and the Crash file, which contains state-reported records of qualifying trucks and buses involved in crashes that meet a given severity threshold.

The Inspection file contains the results of all CMV inspections conducted under the Motor Carrier Safety Assistance Program (MCSAP). These include Level 1 inspections, walk-around, driver-only, terminal, and special inspections. Inspection file records were obtained for 2006-2011, which include approximately 370,000 inspections in Michigan, of which 69,000 were Level 1 inspections. These data provide the most detailed and comprehensive information available about the compliance of drivers and vehicles with regulations governing driver hours of service and licensing, and the mechanical condition of the vehicles.

The Carrier file is a registration file of all operators of commercial vehicles in interstate commerce, or carriers of hazardous materials. Many states, including Michigan, require intrastate carriers to register. The file provides information about the type of operations of the carrier, the number of vehicles operated in different categories, the number of drivers, and the types of cargo transported. This information was used to characterize the size of the fleet operating vehicles and the type of operations.

The Crash file contains records of all CMV crashes in which there was a fatality, an injured person transported for medical attention, or at least one vehicle towed due to disabling damage. The data include carrier US DOT numbers, which were used to link crashes in the Michigan Crash file with carriers in the MCMIS Carrier file.

Michigan Driver History Database

The Michigan Driver Database was used to analyze the driver records of crash-involved medium and heavy-truck drivers. The files contain records of all licensed drivers in the state of Michigan. The database itself is an active administrative database, with new records added continuously, and old records deleted periodically. Records for most drivers contain information going back seven years. However, convictions for serious offenses are kept in the file indefinitely. The violations analyzed were limited to those charged in the five years prior to a driver’s earliest crash in the crash data.

1.2. Crash costs

Estimates of costs resulting from crashes involving CMVs used in this report were developed from a recent assessment of costs of large-truck crashes. (Zaloshnja and Miller 2007) The authors estimated crash costs per victim injured in truck crashes for 2005. The crash costs estimated include medical costs, emergency services, property damage, lost productivity (to the injured person), lost productivity due to delays and from other sources, and monetized QALY (quality-adjusted life years) lost.

The costs were computed on a per-victim basis. Total costs increase with the severity of the injury.[2] These costs are useful as an estimate of the harm resulting from different truck crashes, and are commonly used in cost/benefit calculations. The absolute value for any given injury severity can vary significantly. For example, a 2011 internal memorandum from the Assistant Secretary for Transportation Policy in the US Department of Transportation (DOT) directed that a value of $6.2 million be used as the Value of a Statistical Life, up from $6.0 million set in 2009. (US DOT, 2011) The values from the Zaloshnja reports were used, because they pertain to truck crashes. However, in the context of the current report, the absolute value of the numbers is not as critical as the relative weighting of different

[2] Injury severity is classified using the KABC0 scale. An A-injury is defined as an incapacitating injury; a B-injury is evident at the scene of the crash, but not incapacitating; a C-injury is any injury that is reported or claimed, but not classified as fatal, incapacitating, or non-capacitating but evident.

injury severities, property damage, and other costs. The costs should be regarded as a system of weights, serving to identify the most pressing targets for reduction.

Cost estimates in the Zaloshnja and Miller (2007) study are only for truck crash involvements. It was not possible to isolate trucks using the vehicle type field in the Michigan crash data. An estimate of the proportion of trucks in the Michigan crash file was developed from information in the MCMIS truck supplemental data. Crash costs for the mix of vehicles in the Michigan crash data were estimated using an earlier study by Zaloshnja. (Zaloshnja and Miller 2002). The estimates from 2005 dollars were adjusted to 2012 dollars, using the consumer product inflation calculator from the Bureau of Labor Statistics. (Bureau of Labor Statistics) Table 1 shows the resulting estimated costs in 2012 dollars. These costs were used to calculate the total costs for CMV-involved crashes in Michigan.

Table 1 Crash Costs for CMVs, 2012 Dollars

Injury severity	Estimated costs
Fatal	$3,613,000
A-injury	$453,800
B-injury	$152,000
C-injury	$70,000
PDO*	$7,000

* Property damage only

Because the costs given were on a per-victim basis, costs for any particular crash were determined using the following equation:

Crash cost = (Number of fatalities*3,613,000) +
(Number of A-injured*453,800) +
(Number of B-injured*152,000) +
(Number of C-injured*70,000) +
(Number uninjured*7,000)

To compute crash costs, the number of persons were counted for each level of injury, multiplied by the cost associated with that level of injury, and summed for each crash. The crash file used for this analysis was at the vehicle level, with one record for each CMV in the crash. There can be more than one CMV in any given crash. To estimate the total costs for different types of crashes, it was necessary to reduce the data to one record per crash to avoid double-counting crashes with more than one CMV involved.

1.3. Methods

Prior study results were updated by repeating the analyses for crash years 2006-2011. The study identified crash trends over the entire period (2001-2011), encompassing the period of the 2007 study and of the current study. Results from the 2007 study were compared with current results to identify any changes. The analysis covered crash types, environmental factors, driver actions and behavior, the geographic distribution of crashes, and vehicle and driver inspection results. Crash costs were used as a metric of harm to identify the primary crash types, hazardous actions, environmental conditions, and driver factors.

The results from the update were used to assess the continuing relevance of the strategies recommended in the 2007 study, and identify any new strategies. Industry trends were surveyed to determine the extent to which certain recommendations are being realized. State and industry stakeholders were surveyed through questionnaires and personal communications to identify any activities consistent with the recommended strategies.

Identifying commercial vehicle types

The structure of the data collected on the UD-10 does not make it possible to identify trucks, as trucks are usually defined in traffic safety research. The common definition of a truck is a vehicle designed to transport property or pull trailers with a gross vehicle weight rating over 10,000 pounds. The vehicle type variable on the UD-10 combines trucks with buses, into a “truck/bus” category.

There was no other information in the crash data that can be used to definitively distinguish trucks from buses in this category. The vehicle identification number (VIN) was available for some vehicles, but the VIN is not adequate by itself. The VIN describes the vehicle as it was manufactured, not as it was operated. Many truck producers also make chassis for buses. Many small vans are operated either as buses or as cargo vans. The VIN cannot indicate how the vehicle was modified after manufacture.

The vehicle type in the truck/bus supplementary data is very detailed, but not adequate for a number of reasons. The configuration variable is focused on vehicles that require a CDL, not all trucks as defined above. CDLs are required primarily for trucks with a GVWR over 26,000 pounds, smaller vehicles transporting quantities of hazardous materials requiring a placard, or commercial buses. A simpler variable would be more useful and therefore more reliable.

Because of the limitations in vehicle type identification, it was not possible to separate trucks with a GVWR over 10,000 pounds from buses for analysis in the Michigan crash data. The “truck/bus” category in the UD-10 vehicle type variable was the most feasible method of identifying CMVs, but the category includes an unknown quantity of buses. Based on the experience of other states, the percentage of buses in the category was estimated at about 10 to 12%. Clearly, trucks dominate in the category, so the distributions primarily reflect the crash experience of trucks.

Medium and heavy trucks were identified in the Michigan crash data by decoding their VINs. Because the VIN was not available for about half of the CMVs in the data, the analysis of the relative safety of medium/intrastate trucks and other trucks was limited to just the vehicles for which GVWR could be determined. It is not believed that the missing data were biased in any significant way with respect to GVWR, so it is not likely that the pattern of missing data would affect the results significantly. The trucks were assigned as interstate or intrastate by linking the vehicles in the Michigan crash data to records in the MCMIS Carrier file.

2. Updated Results

Several sets of results are presented. Section 2.1 provides an overview of crash trends over the entire period, 2001-2011, including the annual number of CMVs involved in crashes, trends in crash severity, and annual crash costs. In this section, some trends for CMVs are compared with automobiles and pickup trucks. The next section (2.2) identifies the primary crash types that accounted for the most harm, in terms of fatalities, injuries, and crash costs. Following this is a section that describes the environmental conditions for CMV crashes and identifies conditions that were overrepresented in serious crashes.

Next, results relating to CMV drivers are presented, including the primary actions that contributed to CMV involvements in section 2.4; the contribution, insofar as it can be identified, of driver condition, including fatigue (section 2.5); and the effect of driver age (section 2.6). The contribution of vehicle condition and the factors associated with vehicle condition, as determined by CMV inspections, are presented in section 2.7. Finally, the geographic distribution of CMV crashes is illustrated in section 2.8, to identify locations with high concentrations of crash involvements and associated harm.

Most of the results in this study are reported in terms of "involvements." An involvement is a vehicle, a CMV in this case, involved in a crash. A count of involvements is a count of vehicles in traffic crashes. A few tables, particularly those relating to crash costs, are presented in terms of crashes. Crash costs are computed at the crash level, to avoid double-counting costs if more than one CMV was involved in a crash. Because there can be more than one CMV involved in a crash, counts of involvements are typically greater than counts of crashes.

2.1. Trends

Figure 1 shows the trend in the annual number of CMV and automobile/pickup truck involvements from 2006 to 2011. Automobiles were combined with pickup trucks to represent light passenger vehicles. The trend was down over the period for light vehicles, but not as dramatically as for CMVs. Light vehicle involvements declined by 7.8% over the period. However, the number of CMV involvements in 2011 was 19.8% lower than in 2006. Both declined rapidly from 2008 to 2009, but the drop for light vehicles was only 7.1%, while it was 25.2% for CMVs. That single year-over-year drop accounted for much of the reduction over the six-year period.

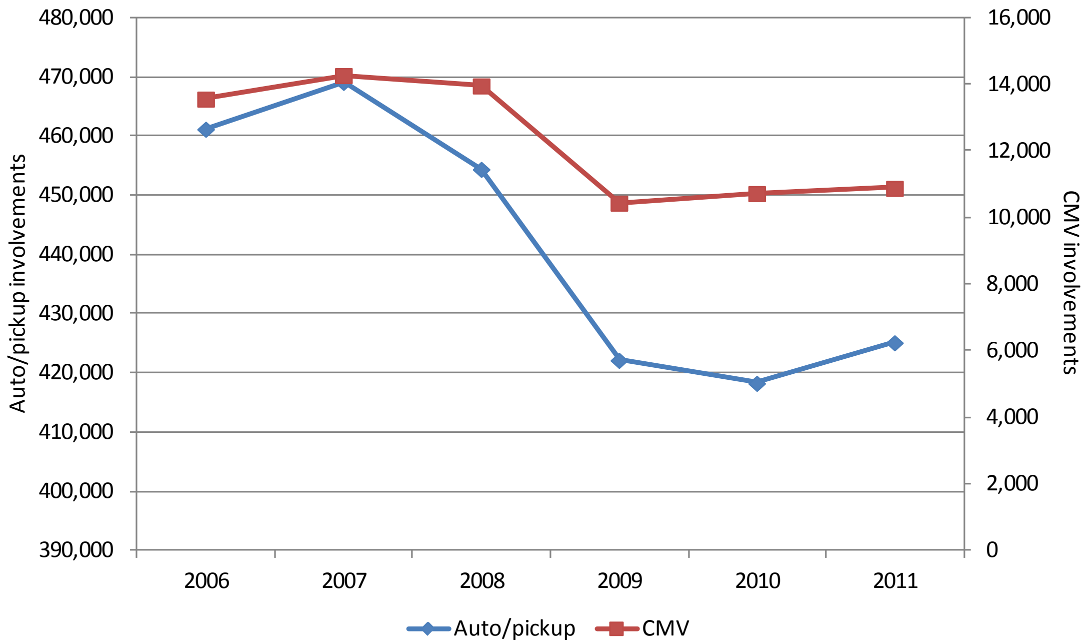
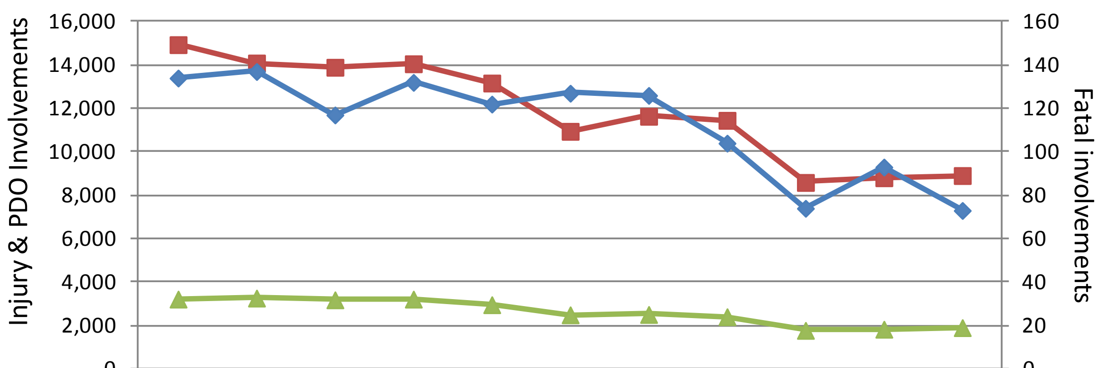


Figure 1 Annual CMV and Automobile/Pickup Involvements, 2006-2001

Figure 2 shows the pattern for fatal, injury, and property damage only (PDO) crash involvements. The left scale is for injury and property damage only (PDO) involvements and fatal involvements are shown on the right scale. Fatal involvements declined from 134 in 2001 to 73 in 2011. The number of fatal involvements was fairly stable from 2004 to 2007, but then declined sharply from 2007 to 2009, recovered in 2010 and then declined again in 2011. Injury crash involvements also declined over the period, dropping from about 3,200 in 2001 to about 1,900 in 2011. Injury involvements were stable from 2001 to 2004, but then declined steadily to 2009, before rising slightly in the following two years.

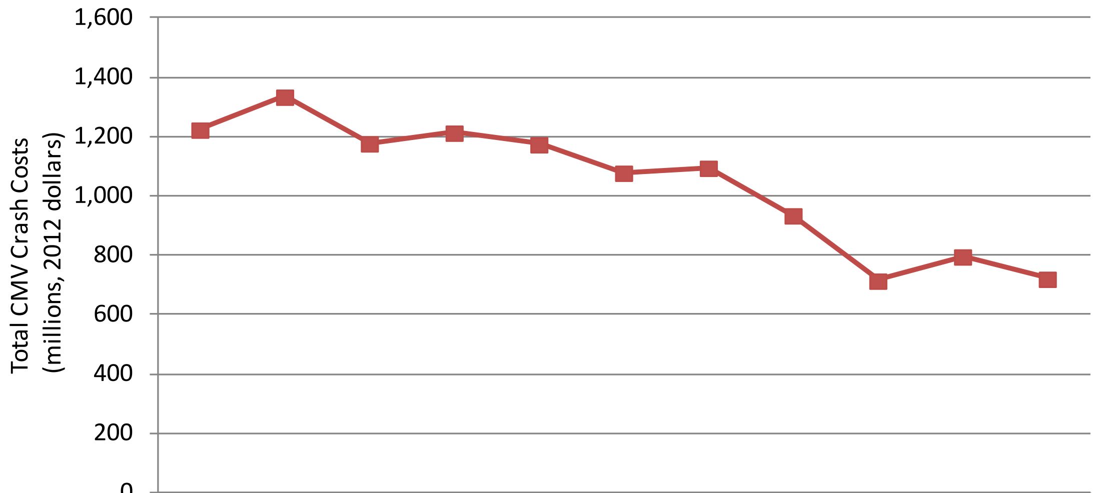


	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
PDO	14,939	14,092	13,897	14,058	13,170	10,946	11,639	11,453	8,591	8,807	8,909
Injury	3,217	3,264	3,184	3,216	2,959	2,493	2,509	2,405	1,777	1,829	1,903
Fatal	134	137	117	132	122	127	126	104	74	93	73

PDO Injury Fatal

Figure 2 CMV Involvements by Crash Severity, 2001-2011

As would be expected, crash costs also declined significantly over the period. (See Figure 3.) CMV crash costs were reasonably stable from 2001 to 2005 and then gradually declined from 2006 to 2008, followed by a sharp drop to 2009.[3] Crash costs rose about 10% in 2010, but then declined almost to the 2009 level in 2011. The steepness of the drop in 2008 and 2009 was likely explained in part by the economic recession of those years. These results track closely the number of fatal and A-injury crashes shown in Figure 2.



	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Total	1,225	1,336	1,178	1,214	1,175	1,079	1,096	936.0	716.0	797.4	722.1

Costs in 2012 dollars.
Figure 3 CMV Crash Costs, 2001-2011

Some fraction of the decline in CMV crashes and crash costs was related to reduced travel by CMVs, and therefore reduced exposure to the risks of traffic crashes. Figure 4 shows estimates of CMV travel in Michigan over the period. From 2001 to 2002 there was a nearly 11% increase in estimated CMV vehicle miles traveled (VMT), but then CMV travel was stable from 2003 to 2007. In 2008, VMT declined by 3.2% followed by another year-over-year drop of 15.4% in 2009. The recession began in the middle of 2008 and accelerated into 2009. There was a 2.5% recovery in CMV mileage in 2010, and then CMV travel was essentially unchanged in 2011. (OHSP, 2006; OHSP, 2012.) The sharp decline in VMT in 2009 coincided with the dips in crashes and crash costs noted in Figure 2 and Figure 3.

[3] Crash costs for 2001-2005 were re-computed to reflect the updated valuations.

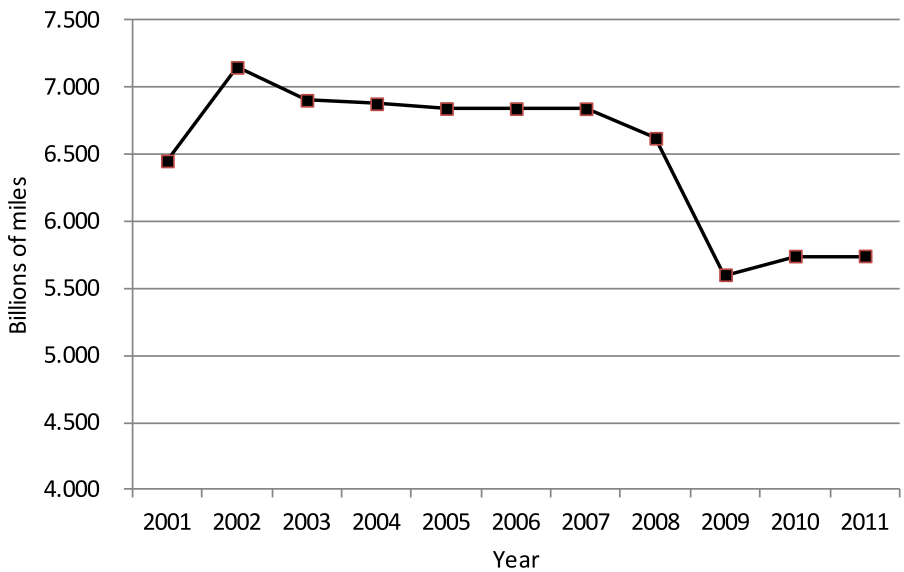


Figure 4 Estimated CMV Travel, 2001-2011

However, all of the decline in crashes and crash costs cannot be attributed to lower CMV travel. Figure 4 showed that estimated CMV travel was stable from 2004 to 2007, yet there was a significant decline in fatal and injury involvements. Computing crash rates for CMVs show that there was a significant decline in CMV crash rates over the period. CMVs were involved in fewer fatal, injury, and PDO crashes per mile of travel. Figure 5 shows crash rates calculated as involvements per 100 million miles. The left scale in the figure is for injury and PDO crash rates, and the right scale is for fatal crash involvement rates. Overall, fatal rates declined from 2.08 per 100 million miles in 2001 to 1.27 per 100 million miles in 2011, a decline of 38.8%. Injury crash involvement rates dropped from 49.9 per 100 million miles in 2001 to 33.2 in 2011, a reduction of 33.5%. Most of the declines in crash rates came in two periods. Injury and PDO rates declined sharply in 2006 from 2005 and in 2009 from 2008, and the lower rates were sustained in the years following. There was more variability in the pattern for fatal involvement rates, in part because there were fewer fatal involvements. Yet there was a clear reduction in crash rates over the period, primarily related to drops crash involvements in 2005-2006 and then again in 2008-2009.

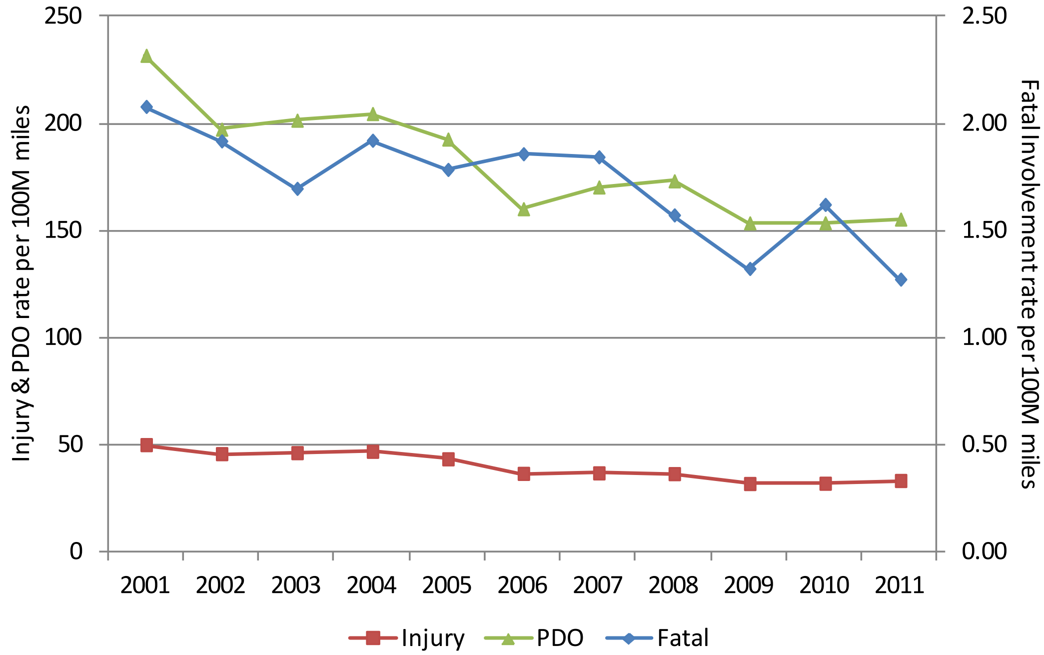


Figure 5 CMV Fatal, Injury, and PDO Crash Involvement Rates, 2001-2011

Table 2 compares the average number of CMV involvements of different severities for the earlier period (2001-2005) and the period of the current analysis (2006-2011). For each level of crash severity, the number of involvements was significantly lower. In the case of fatal involvements, the average for the later period was almost 30% lower than the earlier. The relative reduction of the combination of fatal with A-injury or fatal with A- and B-injury involvements was even larger. The annual average for the 2006-2011 period was almost half of the 2001-2005 period.

Table 2 Annual Average of CMV Involvements by Crash Severity

Crash severity	2001-2005	2006-2011	% change
Fatal	128	100	-29.0
Fatal & A-injury	554	378	-46.6
Fatal, A-, & B-injury	1,359	908	-49.7

Fatal and A-injury level crashes accounted for 58.8% of estimated costs related to CMV crashes. Table 3 shows the distribution of CMV involvements by the greatest injury severity in the crashes. It also shows the estimated total associated annual costs for each crash severity. On average, 0.8% of CMV involvements resulted in a fatality; but these crashes accounted for almost 44% of total CMV crash costs. For about 2.3% of CMV involvements, the most serious injury was an A-injury; but this average of 278 annual involvements accounted for 17.5% of total CMV crash costs. In contrast, there was an average of about 10,000 CMV involvements each year with only property damage, no injuries. These involvements were almost 82% of all, but accounted for only 13.3% of total crash costs. Although 12,310 CMVs were involved in traffic crashes annually over the period, 378 (3.1%) accounted for 61.0% of the associated crash costs.

Table 3 Annual CMV Involvements by Crash Severity and Crash Costs 2006-2011

Crash severity	Involve-ments	%	Costs (millions)	%
Fatal	100	0.8	$387.6	43.5
A-injury	278	2.3	155.8	17.5
B-injury	530	4.3	102.4	11.5
C-injury	1,345	10.9	126.9	14.2
PDO	10,056	81.7	118.6	13.3
Total	12,310	100.0	$891.3	100.0

Costs in 2012 dollars. Totals include unknown severity.
Cell frequencies are averages rounded to the nearest integer.

2.2. Crash types

A crash type classification was developed using several variables. The primary variable used was the crash type variable as it was recorded on the UD-10 (Michigan Department of State, 2004). This variable has ten levels that capture the vectors of movement of the vehicles at the first impact. Crash as coded captures the intended direction of travel, not the points of impact on the vehicles. In other words, it captures the relative movement of the vehicles without regard to their orientation. This is a reasonable approach but can involve some difficulties. For example, head-on crashes are defined as crashes in which the intended direction of travel of both vehicles was toward each other. This crash type includes not just crashes in which vehicles were traveling in opposite directions and collide front-to-front but also some backing crashes, when a vehicle backs into another vehicle intending to go straight ahead.

It is reasonable to include backing as a separate crash type for CMVs. Backing trucks is a greater challenge than backing passenger cars because of the larger size of trucks and because of reduced visibility to the rear. In addition, backing crashes are typically very low speed, and occur in circumstances that are quite different from other crashes they are combined with in the UD-10 crash type field. Accordingly, a method was developed to identify back crashes. The crash type variable developed largely follows the crash types from the UD-10, except backing crashes were identified separately. Pre-crash maneuver and hazardous action were used to identify backing crashes.

Table 4 shows the crash types and distributions by crash severity. Crash severity was based on the most serious injury in the crash, not in the CMV. Most of the crash types are self-explanatory. Note that rear-end crashes here combine both cases where a CMV struck the rear of another vehicle and where another vehicle hit the rear of a CMV. In head-on, left turn crashes, one of the vehicles turned left in front of the other. Sideswipes are crashes where the main impact was between the sides of the vehicles and occur either when they were traveling in the same direction or in opposite direction.

Overall, the most common collision types were same-direction sideswipes and rear-end crashes. Together, they were almost 50% of all crash involvements. Angle collisions were the next most common, with about one out of seven crashes. Single-vehicle crashes were the other primary crash type, with 14.3%. Single vehicle crashes may just be run-off the road types, but also include crashes where a non-motorist, such as a pedestrian or bicyclist, was involved. Head-on crashes accounted for only 1.4% of CMV crash involvements, while backing crashes accounted for 6.9%. Head-on and head-on left turn crashes were highly over-involved in fatal and injury crashes, as were angle collisions. Rear-end crashes were over-involved in injury crashes. Same direction sideswipes were under-involved in fatal and injury crashes. Backing was under-involved in fatal and injury crashes. Interestingly, single vehicle crashes were somewhat over-involved in property damage only crashes.

Table 4 Average Annual CMV Involvements by Crash Type and Crash Severity, 2006-2011

Crash type	Fatal		Injury		Property damage		Total	
	N	%	N	%	N	%	N	%
Single vehicle	13	13.4	209	9.7	1,544	15.4	1,766	14.3
Head-on	22	21.6	71	3.3	83	0.8	175	1.4
Head-on, left turn	3	2.7	50	2.3	72	0.7	125	1.0
Angle	23	23.5	507	23.6	1,278	12.7	1,809	14.7
Rear-end	21	21.4	736	34.2	1,978	19.7	2,735	22.2
Sideswipe, same direction	5	5.4	321	14.9	3,005	29.9	3,332	27.1
Sideswipe, opposite direction	5	4.9	77	3.6	525	5.2	607	4.9
Backing	2	1.5	37	1.7	811	8.1	849	6.9
Other/Unknown	6	5.7	145	6.7	762	7.6	912	7.4
Total	100	100.0	2,153	100.0	10,057	100.0	12,310	100.0

Cell frequencies are averages rounded to the nearest integer.

Note that the distributions of crash type differed depending on the severity of the crashes. Head-on crashes were 1.4% of all crash involvements, but they were 21.6% of fatal involvements. Angle collisions were over-represented in fatal involvements (23.5%) compared with involvements of all severities (14.7%). These crash types produce very serious injuries and fatalities because they typically involve relatively high closing speeds. In contrast, same-direction sideswipes were 27.1% of all crashes, but only 5.4% of fatal involvements. The dramatic differences in crash severity between crash types is illustrated in Figure 6.

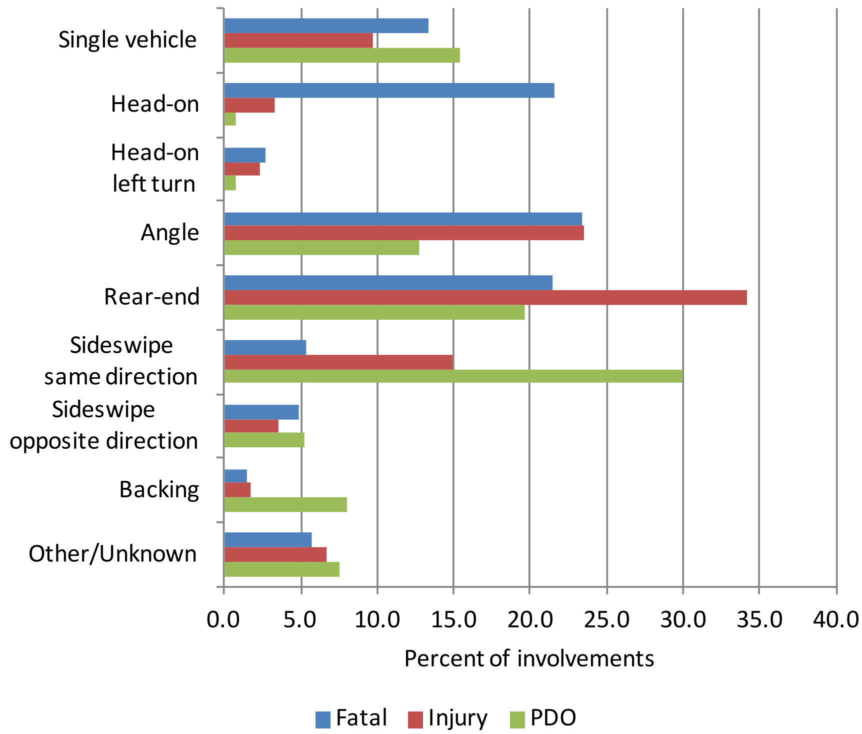


Figure 6 CMV Involvements by Crash Type by Crash Severity, 2006-2011

Table 5 shows crash costs and involvements by crash type. The table is a good example of using crash costs as a measure of harm to identify the primary sources of societal harm from CMV crashes. In total dollar terms, the most important crash types were rear-end and angle collisions, which together accounted for about 50% of all CMV crash costs. These two crash types were relatively common (36.9% of all) and also typically more severe than most other types of crashes. In contrast, head-on crashes were relatively uncommon (1.4%) but were disproportionately the most harmful. These crashes were the most deadly because closing speeds are typically high. Same-direction sideswipes were the most common crash type, accounting for over a quarter of crash involvements, but the speed differential between sideswiping vehicles is typically not large, so they were not as severe.

Table 5 Average Annual Involvements and Crash Costs (Millions) by Crash Type 2006-2011

	Involvements		Crash costs	
Crash type	N	%	(millions)	%
Single vehicle	1,766	14.3	$94.9	10.7
Head-on	175	1.4	110.3	12.4
Head-on, left turn	125	1.0	23.1	2.6
Angle	1,809	14.7	217.4	24.4
Rear-end	2,735	22.2	228.3	25.6
Sideswipe, same direction	3,332	27.1	99.9	11.2
Sideswipe, opposite direction	607	4.9	38.7	4.3
Backing	849	6.9	21.6	2.4
Other/Unknown	912	7.4	57.0	6.4
Total	12,310	100.0	$891.3	100.0

Costs in 2012 dollars.
Cell frequencies are averages rounded to the nearest integer.

Table 6 shows the average cost per crash for different types of crashes. Fatal crashes were by far the most costly, averaging $4.1 million per crash, compared with $190,000 for an injury level crash and $10,000 on average for property damage only crashes. The right-most column shows “normalized” costs for each crash type, which was computed by dividing the average cost for each crash type (all severities combined) by the overall average cost of a CMV-involved crash. For example, on average a single-vehicle CMV crash resulted in harm amounting to $53,793, while the average across all crash types was $75,066. 53,793÷75,066=0.72, so single-vehicle CMV crashes were, on average, about 0.72 of the cost of the average truck crash. The “normalized” cost column provides a quick method to identify the most costly crash types. In this case, head-on crashes were about 8.63 times more costly than the average CMV crash, which was the greatest differential. Head-on, left turn crashes were the next most costly, at about 2.51 times more costly than average, followed by angle and rear-end crashes. Head-on, angle, and rear-end crashes were the crash types that produced the greatest impact on society and where the greatest gains can be realized through crash reduction.

Table 6 Average Cost per Crash, by Crash Type and Severity

Crash type	Crash severity				Normalized
	Fatal (millions)	Injury	PDO	All severities	
Single vehicle	$3.75	$164,902	$6,822	$53,793	0.72
Head-on	4.30	282,950	14,021	647,919	8.63
Head-on, left turn	4.20	222,244	14,265	188,369	2.51
Angle	4.25	211,695	13,953	123,123	1.64
Rear-end	4.11	178,694	14,217	88,149	1.17
Sideswipe, same direction	4.04	144,432	12,711	31,327	0.42
Sideswipe, opposite direction	3.77	203,779	12,816	67,700	0.90
Backing	3.79	169,833	12,369	26,149	0.35
Other/Unknown	3.94	200,093	12,387	65,392	0.87
Total	4.10	186,796	12,203	75,066	1.00

Costs in 2012 dollars.

2.3. Road type, weather, road, & light condition

Trucks are working vehicles, used for work purposes. For commercial for-hire truck operators, the truck is the driver's office, his work place. This influences many aspects of the truck's operations, from when and where it is operated, to the conduct of the driver while at his place of business. CMV involvements occurred primarily during the day. CMV involvements peaked at around 8 am, followed by a slight reduction but still relatively high through the morning, and then increased to a second peak around 3 pm, at which point they decreased to a low around midnight. The hourly percentage of crashes stabilized at about 1% of crash involvements for each hour from midnight to about 5 am, when the percentage started to rise again. Figure 6 clearly shows that CMV operations reflect to the rhythms of work and most work is in the day.

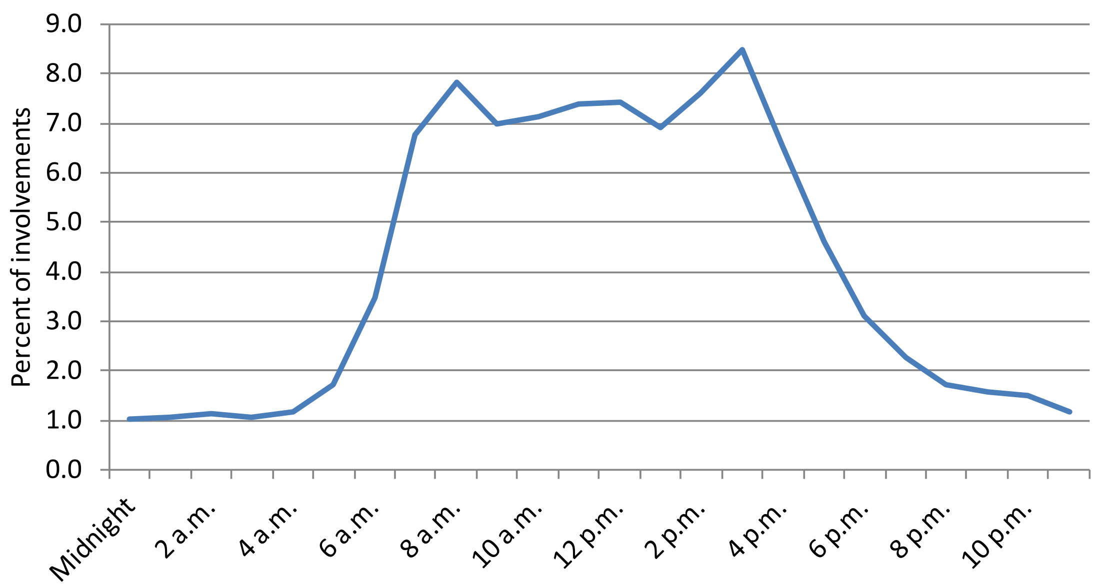


Figure 7 CMV Crashes by Hour of Day, 2006-2011

While most CMV involvements occurred during daylight (Table 7), crash involvements at night tended to be relatively more severe. About 76.6% of CMV involvements occurred in daylight conditions, but the percentage of associated crash costs was somewhat lower, at 71.6%. However, CMV crash involvements in dark/lighted and dark/unlighted conditions tended to account for a higher share of crash costs than of crash involvements. Crashes at night tended to be on higher speed roads, and therefore had a higher probability of fatal or serious injuries.

Table 7 Annual Average Involvements and Crash Costs (Millions) by Light Condition, 2006-2011

	Involvements		Costs	
Light condition	N	%	(millions)	%
Daylight	9,440	76.6	$638.0	71.6
Dark lighted	932	7.6	87.8	9.8
Dark unlighted	1,273	10.4	123.4	13.8
Dawn/dusk	571	4.6	39.1	4.4
Other/unknown	94	0.8	3.1	0.4
Total	12,310	100.0	$891.3	100.0

Costs in 2012 dollars.
Cell frequencies are averages rounded to the nearest integer.

Interestingly, road surface condition did not have a dramatic effect on crash severity, at least overall. In the first place, most CMV crash involvements occurred on dry roads. Almost 65% of CMV crash involvements were on dry roads, compared with only 16.4% on wet roads and 17.3% on the combination of snowy and icy roads. (Figure 8.) Note, however, the percent of crash costs on wet roads was effectively identical to the percent of crash involvements. The proportion of crash costs on icy or snowy/slushy roads was actually less than their share of CMV involvements, although the differences were not significant.

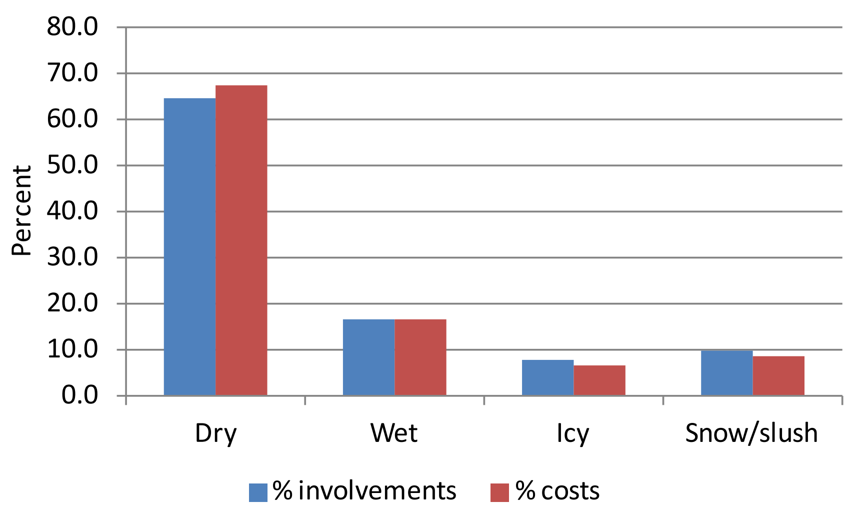


Figure 8 Distribution of CMV Involvements and Crash Costs by Road Condition, 2006-2011

Figure 9 shows the distribution of crash involvements by weather condition. Again, it is notable that most crash involvements occurred when conditions were reasonably favorable. Almost 80% occurred when the weather was either clear or cloudy. Only 8.6% occurred during rain and 11.3% when it was snowing or hailing. Inclement weather was not present in most crashes and does not appear to be a significant problem. Crash costs were slightly higher in cloudy and rainy weather, but lower in clear or snowy conditions. The differences were not significant.

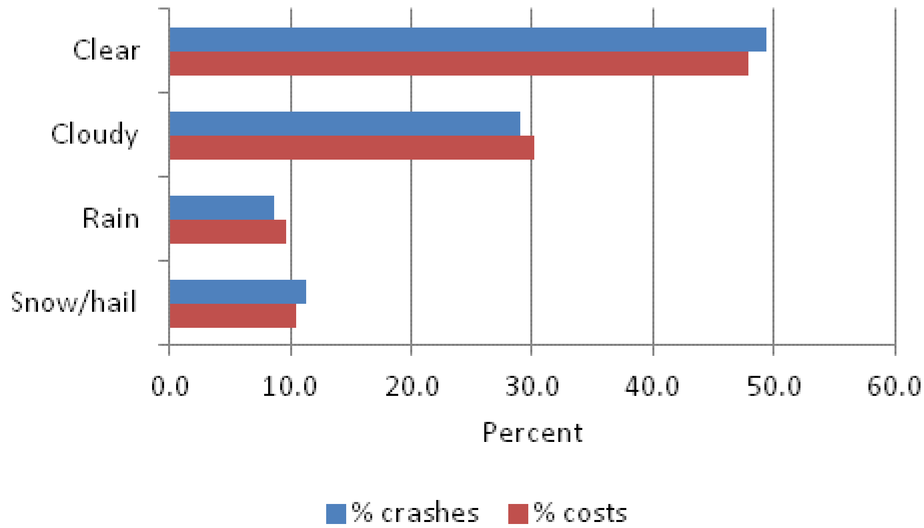


Figure 9 Distribution of CMV Involvements and Crash Costs by Weather Condition, 2006-2011

Most CMV crashes occurred on highways: Interstates, US routes, or Michigan (M-) routes. Together, these three road types accounted for 53.1% of CMV involvements. This reflects the fact that CMVs are heavily used for long-haul freight transport, which uses the main highways. Only about 43.7% of involvements were on city streets or country roads. (In contrast, the previous report found that about 60% of light vehicle crashes were on city streets or county roads.) Crashes on highways were disproportionately severe because of the higher travel speeds. Crashes on M-routes accounted for 18.8% of involvements but 24.7% of crash costs. US routes were 10.4% of involvements, but 13.1% of costs. Interstates had about the same percentage of involvements and costs (23.8% and 23.2% respectively). Unlike Interstate highways, some US routes and M-routes have two-way travel, often not separated by medians or barriers. Head-on collisions were rare on Interstate highways because of the controlled access and one-way travel. However, head-on crashes were more common on two-way roads, and with the higher speeds of US and M-routes, were much more severe.

Table 8 Annual Average Involvements and Crash Costs (Millions) by Highway Class, 2006-2011

Highway class	Involvements		Costs	
	N	%	(millions)	%
Interstate route	2,936	23.8	$207.1	23.2
U.S. route	1,282	10.4	117.1	13.1
Michigan route	2,319	18.8	219.7	24.7
Business route, connector	360	2.9	20.0	2.2
Other road, city street	5,382	43.7	326.3	36.6
Unknown/missing	31	0.3	1.1	0.1
Total	12,310	100.0	$891.3	100.0

Costs in 2012 dollars. Cell frequencies are averages rounded to the nearest integer.

In the last report, it was found that crashes involving CMVs were much more likely to occur during the normal working hours and during the workweek. During the day, CMV crash involvements were more uniformly from 8 am to 6 pm because they were working. There were no significant differences in terms of weather at the time of the crash, but large differences in the types of roads on which the crashes occurred. CMV crash involvements occurred more frequently on major road types such as freeways, as they operate to transport people and property over long distances. (Blower and Kostyniuk, 2007) The results from this update are similar for each of these dimensions.

2.4. Hazardous actions

Hazardous actions record the police officer's judgment of driver actions that contributed to crashes. Officers investigating crashes record any actions or errors that may have contributed, for each driver in the crash. Officers can indicate a hazardous action, regardless of whether a violation was charged. Officers typically exercise judgment as to whether charging a violation is appropriate, which can depend on other circumstances. For this reason, the hazardous action code is a good indicator of what police officers thought contributed to crashes.

Table 9 shows whether a hazardous action was recorded for CMV drivers by crash severity. All crash types were included here, including single-vehicle crashes. Overall, in crashes of any severity, 42.2% of CMV drivers were recorded with a hazardous action, 49.4% were not and hazardous action was left unrecorded or unknown in 8.4%. The proportions varied by crash severity. In fatal crashes, a hazardous action was recorded for only 19.3% of CMV drivers, compared with 39.3% in injury crashes and 43.1% in PDO crashes. The more severe the crash, the less likely that CMV drivers were identified on the crash reports as contributing to the crashes.

Table 9 CMV Driver Hazardous Action by Crash Severity, Annual Average, 2006-2011

CMV hazardous action?	Crash severity			Total
	Fatal	Injury	PDO	
Yes	19	846	4,335	5,199
No	74	1,169	4,837	6,080
Unknown	7	138	886	1,031
Total	100	2,153	10,057	12,310
Column percentages				
Yes	19.3	39.3	43.1	42.2
No	74.2	54.3	48.1	49.4
Unknown	6.5	6.4	8.8	8.4
Total	100.0	100.0	100.0	100.0

Note: Cell frequencies are averages rounded to the nearest integer.

Table 10 details the specific actions coded for CMV drivers, along with aggregate crash costs for each hazardous action type. Almost half of crash-involved CMV drivers committed no hazardous action in the crashes, according to police reports. The most common hazardous action over all crash severities for CMV drivers was unable to stop, (which usually means following too closely in a rear-end crash), failure to yield the right-of-way, and improper lane use, which was a typical hazardous action in same-direction sideswipe crashes. In terms of crash costs, almost two-thirds were incurred in crashes where no hazardous action was attributed to the CMV driver. In most of these crashes, a light vehicle driver was assigned a hazardous action. For CMV drivers, the hazardous actions that resulted in the highest aggregate costs were unable to stop, failure to yield, careless/negligent, and speeding. Following too closely and failure to yield were the most costly errors for CMV drivers, overall.

Table 10 Annual Average Involvements and Crash Costs (Millions) by CMV Driver Hazardous Action, 2006-2011

	Involvements		Costs	
Hazardous action	N	%	(millions)	%
None	6,080	49.4	$590.3	66.2
Speed too fast	408	3.3	25.7	2.9
Speed too slow	9	0.1	1.0	0.1
Failed to yield	623	5.1	41.9	4.7
Disregard traffic control	123	1.0	20.7	2.3
Drove wrong way	9	0.1	0.4	0.0
Drove left of center	64	0.5	5.7	0.6
Improper passing	74	0.6	1.7	0.2
Improper lane use	588	4.8	14.5	1.6
Improper turn	442	3.6	11.1	1.2
Improper/no signal	24	0.2	0.7	0.1
Improper backing	501	4.1	8.9	1.0
Unable to stop	1,007	8.2	68.8	7.7
Reckless driving	11	0.1	1.7	0.2
Careless/negligent	286	2.3	27.7	3.1
Other	1,032	8.4	44.3	5.0
Unknown	1,031	8.4	59.3	6.7
Total	12,310	100.0	$891.3	100.0

Costs in 2012 dollars. Costs do not sum to total because some crashes involved more than one truck. Cell frequencies are averages rounded to the nearest integer.

Table 11 shows the distribution of CMV driver coded hazardous actions by crash severity. Cases in which no hazardous action or the action was unknown were excluded from the table. Thus, the table shows the distribution of known hazardous actions. It shows the predominant hazardous actions when committed by a CMV driver. The most common hazardous action for fatal and PDO crashes, unfortunately, was “other,” which sheds no light on the nature of the action. Beyond the “other” category, for fatal involvements, the most common hazardous actions were unable to stop, which primarily occurs in rear-end crashes, careless/negligent, failure to yield, and disregard traffic control. In injury crashes, the most common type was unable to stop, accounting for almost a third of actions, followed by failure to yield, and speeding.

Note the high proportion of careless/negligent in comparison with reckless driving in fatal crashes. Reckless driving is clearly aggressive driving, e.g., driving without regard for the safety of others. The percentage of reckless CMV drivers was quite small at each crash severity, though clearly associated with more severe crashes. The careless/negligent category encompasses distracted driving or inadequate attention, i.e., failing to take sufficient care. Careless driving was more strongly associated with serious crashes than less serious crashes.

Table 11 CMV Driver Hazardous Action by Crash Severity, 2006-2011

	Fatal		Injury		PDO	
Hazardous action	N	%	N	%	N	%
Speed too fast	2	8.7	99	11.7	307	7.1
Speed too slow	0	0.9	1	0.2	7	0.2
Failed to yield	2	12.2	145	17.1	477	11.0
Disregard traffic control	2	9.6	48	5.7	73	1.7
Drove wrong way	0	0.0	2	0.3	7	0.2
Drove left of center	1	4.3	10	1.2	53	1.2
Improper passing	0	0.0	7	0.8	68	1.6
Improper lane use	0	1.7	52	6.1	536	12.4
Improper turn	1	2.6	33	3.9	408	9.4
Improper/no signal	0	0.0	3	0.4	21	0.5
Improper backing	0	0.9	16	1.8	485	11.2
Unable to stop	3	17.4	274	32.4	730	16.8
Other	5	25.2	88	10.4	939	21.7
Reckless driving	0	1.7	3	0.3	8	0.2
Careless/negligent	3	14.8	67	7.9	217	5.0
Total	19	100.0	846	100.0	4,335	100.0

Note: Cell frequencies are averages rounded to the nearest integer.

Table 12 tabulates computed average costs per crash by CMV driver hazardous action and by crash severity. Obviously, crash costs were higher for more severe crashes. The interest here was in the normalized costs, which are expressed as the ratio of cost per crash for a hazardous action to the average cost for all crashes. For example, the average cost of a crash in which the CMV driver was coded with “speed too slow” was 1.62 times higher than the average cost of all CMV crashes. The hazardous actions that resulted in the highest costs were failure to yield, disregard traffic control, reckless driving, careless/negligent driving, and drove wrong way. On average, a crash in which the hazardous action for a CMV driver was disregarding a traffic control was over $168,000, or 2.24 times the mean CMV crash cost. Reckless driving crashes were rare, but 2.14 times more harmful than average. Crashes caused by CMV driving too slowly were also rare, ranking last out of 15 possible hazardous actions, but costly when they did happen. These were mainly rear-end crashes, which can have severe consequences if there was underride.

Table 12 Average Cost (Millions) per Crash by CMV Driver Hazardous Action and Crash Severity

Hazardous action	Crash severity			Total	Normalized
	Fatal (millions)	Injury	PDO		
Speed too fast	$3.93	$168,705	$9,017	$63,523	0.85
Speed too slow	4.07	205,355	12,096	121,902	1.62
Failed to yield	4.29	174,566	13,942	67,199	0.90
Disregard traffic control	4.35	244,552	12,850	168,392	2.24
Drove wrong way	No crashes	130,804	12,701	43,320	0.58
Drove left of center	3.99	174,658	14,088	90,506	1.21
Improper passing	No crashes	129,355	12,221	22,726	0.30
Improper lane use	3.70	127,878	12,464	24,747	0.33
Improper turn	3.62	135,528	11,866	25,106	0.33
Improper/no signal	No crashes	130,906	13,969	28,386	0.38
Improper backing	3.62	147,987	12,371	17,770	0.24
Unable to stop	4.48	160,092	14,079	68,550	0.91
Other	4.12	163,539	10,691	43,099	0.57
Reckless driving	3.62	177,801	8,142	160,666	2.14
Careless/negligent	4.30	201,923	9,554	96,855	1.29
All crashes	$4.10	$186,796	$12,203	$75,066	1.00

Costs in 2012 dollars.

Hazardous actions also vary by the type of crash they cause. Table 13 through Table 20 show distributions of the top CMV hazardous actions for each crash type. The percentages were low for some crashes because some crash types were much more frequently caused by other drivers. For example, in head-on crashes, over 80% of CMV drivers were not given a hazardous action. This was because a large proportion of head-on collisions occurred when a light vehicle crossed over into the CMVs lane. The primary actions coded were quite consistent with the crash type.

In single-vehicle crashes (Table 13), the primary hazardous action noted for CMV drivers was speeding. Single-vehicle crashes included cases in which a driver drove off the road or went into a curve too fast and lost control, although some may involve a pedestrian, bicyclist, or animal. Careless/negligent or reckless was identified in 8.0% of the crashes. These could be cases where the truck drifted off the road due to inattention or distraction. In addition, “other” was coded for 17.8% of involvements, meaning that the officer did not find an appropriate code on the list. In the large majority of head-on crashes (Table 14), the officer did not code any hazardous action for the CMV driver. In crashes where the CMV driver was considered to have contributed to the crash, the primary actions were speeding, drove left of center, and failure to yield. Failure to yield was the primary hazardous action in head-on, left turn, crashes (Table 15), followed by improper turn and disregard of traffic control. Those were also the primary hazardous actions by the CMV driver in angle crashes (Table 16).

Table 13 Single-vehicle

Hazardous action	%
None	50.1
Speed too fast	16.3
Careless/negligent/reckless	8.0
Improper turn	4.5
Improper lane use	1.1
Unable to stop	2.2
Other	17.8
Total	100.0

Table 14 Head-on

Hazardous action	%
None	80.6
Speed too fast	3.0
Drove left of center	2.6
Failure to yield	2.1
Unable to stop	1.9
Improper lane use	1.7
Other	8.1
Total	100.0

Table 15 Head-on, Left Turn

Hazardous action	%
None	58.8
Failed to yield	26.5
Improper turn	6.8
Disregard traffic control	3.0
Other	4.9
Total	100.0

Table 16 Angle

Hazardous action	%
None	64.8
Failed to yield	16.9
Disregard traffic control	4.7
Improper turn	4.2
Improper lane use	1.9
Speed too fast	1.2
Unable to stop	1.5
Other	5.0
Total	100.0

Table 17 Sideswipe Same Direction

Hazardous action	%
None	54.4
Improper lane use	15.2
Failed to yield	6.6
Improper turn	6.3
Careless/negligent	2.3
Improper passing	1.7
Unable to stop	1.5
Speed too fast	1.1
Other	10.9
Total	100.0

Table 18 Sideswipe, Opposite Direction

Hazardous action	%
None	53.6
Improper turn	10.1
Improper lane use	7.4
Drove left of center	5.5
Failed to yield	4.3
Careless/reckless	2.3
Improper passing	1.6
Speed too fast	1.5
Unable to stop	1.5
Other	12.3
Total	100.0

Table 19 Rear-end

Hazardous action	%
None	56.9
Unable to stop	33.4
Speed too fast	2.1
Careless/reckless	1.5
Failed to yield	1.0
Other	5.1
Total	100.0

Table 20 Backing

Hazardous action	%
None	22.2
Improper backing	62.3
Failed to yield	2.7
Unable to stop	1.7
Careless/reckless	1.6
Other	9.4
Total	100.0

Hazardous actions in other crash types also were consistent with the type. In the case of sideswipes, only slightly less than half of the CMV drivers were given a hazardous action. Improper lane was most frequently noted for same direction sideswipe, followed by failure to yield and improper turn.(Table 17) For opposite direction sideswipes, the most frequent CMV driver action was improper turn, followed by improper lane use and drove left of center. (Table 18.) Following too close was the primary action in rear-end involvements, naturally, with failure to maintain an assured clear distance to stop coded in 33.4% of cases. The next highest action was “other,” at only 5.1%. (Table 19.) Finally, improper backing by the CMV driver was coded in 62.3% of backing crash involvements. (Table 20.) Backing was the only crash type in which the CMV driver was overwhelmingly identified as contributing to the crash. No hazardous action by the CMV driver was coded for only 22.2%. This disproportion doubtless reflects the relative difficulty of backing a CMV compared with a light vehicle. CMVs are much larger than light vehicles, and the driver’s field of view to the rear is obstructed by the cargo body.

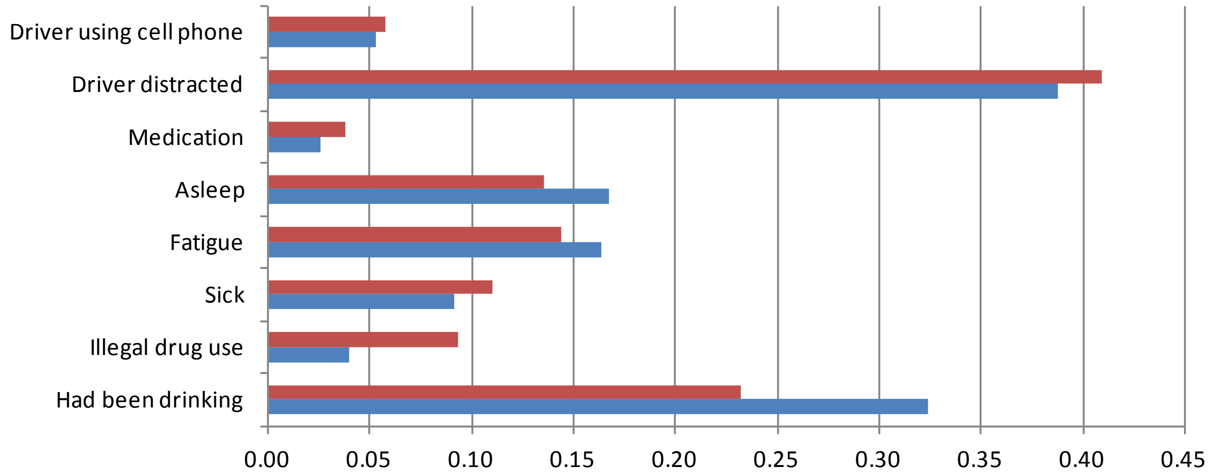
Driving errors made by CMV drivers were highly associated with both crash type and crash severity.

2.5. Driver condition

Driver condition was recorded on the UD-10 for all drivers. Reporting officers may record driver conditions such as drinking, illegal drug use, illness, fatigue, asleep, reactions to medication distracted driving, and the use of a cell phone. In light of the recent focus on federal Hours of Service (HOS) regulations and driver fatigue in general, it was useful to compare the distribution of driver condition in the current study to driver condition in the previous study.

Figure 10 displays the comparison. The overall shapes of the two distributions were similar, but there were some interesting patterns. The proportion of CMV drivers coded asleep or fatigued was very low in each period: only 0.33% in the earlier period and 0.28% in the later—virtually unchanged, although declining. Coded cell phone use, distraction, and medication were effectively identical. Driver drinking was down relatively substantially, and the proportion of driver drug use was up, relatively substantially. Statistical tests showed that the differences in drug use and had been drinking were both statistically significant, meaning that they were unlikely to be due to chance alone. The other differences were not statistically significant.

However, it must be said that the proportions were very small. Driver condition as coded was not meaningful in terms of capturing anything about why truck crashes occurred. Although it is good that the proportion of fatigue/asleep was down and not up, the proportion coded as fatigued was too small to be credible as an estimate of the incidence of fatigue in CMV crashes. Only 197 CMV drivers were coded on the UD-10 as fatigued or asleep over the six years and roughly 73,000 crash involvements. It is likely that a significant number of fatigue cases were not captured. Fatigue/asleep is objectively very difficult to determine after a crash occurs. In addition, it is also possible that reporting officers may leave this determination to other authorities in cases where legal charges were likely.



	Had been drinking	Illegal drug use	Sick	Fatigue	Asleep	Medication	Driver distracted	Driver using cell phone
2006-2011	0.23	0.09	0.11	0.14	0.14	0.04	0.41	0.06
2001-2005	0.32	0.04	0.09	0.16	0.17	0.03	0.39	0.05

Percent of CMV drivers

Figure 10 CMV Driver Condition, 2001-2005 and 2006-2011

Despite the likelihood that fatigue/asleep was largely underreported, it was of interest to see where and when it does occur. Almost two-thirds of reported fatigue/asleep cases happened in single-vehicle crashes. These were very likely crashes in which the CMVs ran or drifted off road and crashed. The second most common crash type was rear-end crashes, when a driver failed to stop or slow for traffic, followed by same-direction sideswipes, where the CMVs likely drifted out of lane and struck nearby traffic. This pattern was also observed in the prior study.

Table 21 Crash Type by CMV Driver Fatigue/Asleep, 2006-2011

	Other involvements		Fatigue/asleep	
Crash type	N	%	N	%
Single vehicle	10,466	14.2	129	65.5
Head-on	1,050	1.4	1	0.5
Head-on, left turn	748	1.0	0	0.0
Angle	10,842	14.7	11	5.6
Rear-end	16,386	22.2	26	13.2
Sideswipe, same direction	19,974	27.1	18	9.1
Sideswipe, opposite direction	3,637	4.9	4	2.0
Backing	5,091	6.9	4	2.0
Other/Unknown	5,467	7.4	4	2.0
Total	73,661	100.0	197	100.0

In terms of road type, fatigue/asleep crashes were much more likely to occur on Interstate and US routes. Almost half occurred on Interstates, and another 16.8% on US routes. Both percentages were higher than their percentage of all crashes. These roads are used more often on long-haul trips. Interstates are specifically designed for easy driving, so drivers can devote less vigilance to the driving task. Many US routes are designed to similar standards.

Table 22 CMV Driver Fatigued or Asleep and Other Involvements by Highway/Road Class, 2006-2011

Highway/road class	Other involvements		Fatigue/asleep	
	N	%	N	%
Interstate route	17,521	23.8	94	47.7
U.S. route	7,659	10.4	33	16.8
Michigan route	13,880	18.8	35	17.8
Other business/ connector	2,157	2.9	1	0.5
Other road, city street	32,257	43.8	34	17.3
Unknown/missing	187	0.3	0	0.0
Total	73,661	100.0	197	100.0

Fatigue/asleep-related crashes were much more likely to occur at night. (Figure 11.) Most fatigue/asleep-related crashes occurred between 10 pm and 8 am, with 35.5% between midnight and 6 am. There was a secondary peak between 2 pm and 4 pm, which is consistent with studies of human circadian rhythm that show an increase in fatigue in the early afternoon.

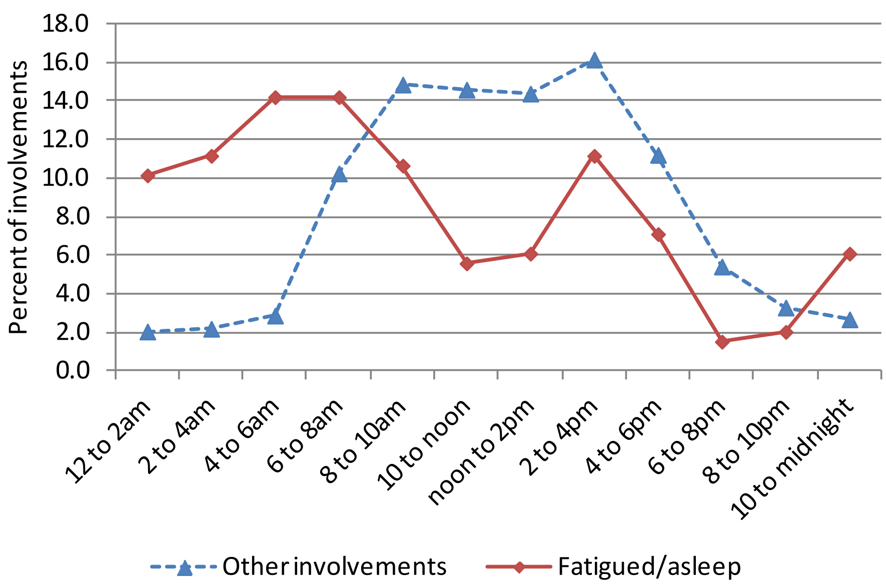
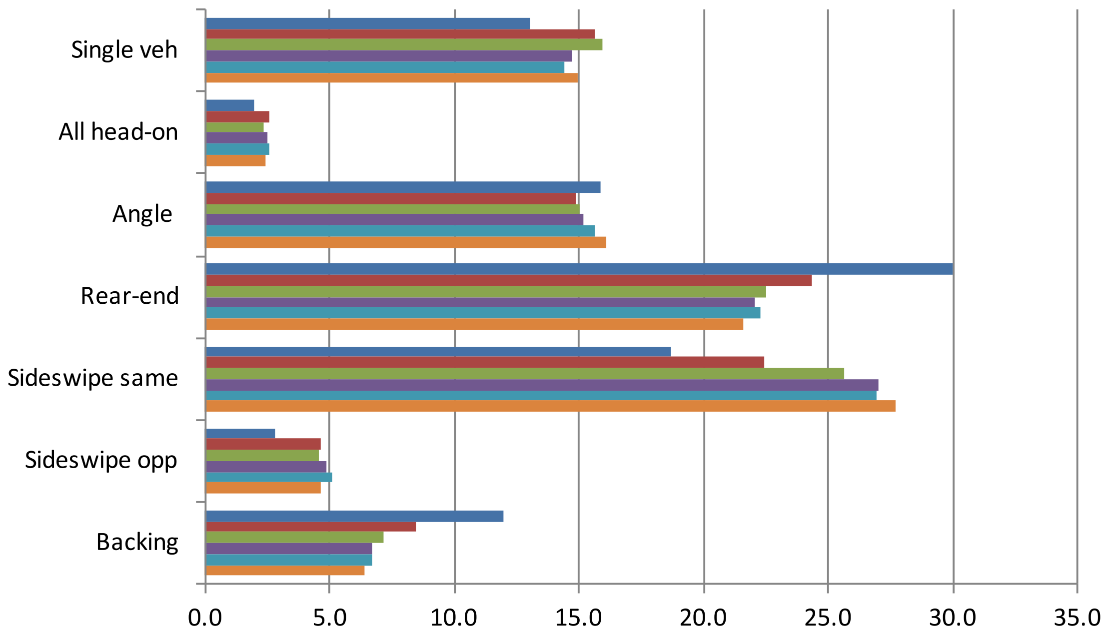


Figure 11 CMV Driver Fatigue by Time of Day

2.6. Driver age

The previous study showed that the overall the distributions of crash type were roughly similar across the age groups, but that younger drivers tended to show higher proportions of involvements in rear-end crashes, and slightly higher involvement in single-vehicle crashes. In addition, the younger drivers also had a significantly higher proportion of backing crashes. With respect to hazardous actions, younger drivers were more often identified as speeding, following too close to be able to stop, and improper backing. The findings in the present analysis were very similar.

Figure 12 shows the distribution of crash types for different driver age cohorts. Rear-end and backing crashes stand out for the youngest age group, 16 to 20. The distribution of rear-end and same-direction sideswipes seem complementary across the age groups. The proportion of crashes that were rear-end crashes went down as the age groups went up. For same direction sideswipes, the proportion went up as the age groups went up. However, the major result was the over-representation of young drivers in backing and rear-end crashes.



	Backing	Sideswipe opp	Sideswipe same	Rear-end	Angle	All head-on	Single veh
16 to 20	11.9	2.8	18.7	29.9	15.8	2.0	13.0
21 to 30	8.5	4.6	22.4	24.3	14.9	2.6	15.6
31 to 40	7.1	4.5	25.6	22.5	15.0	2.3	15.9
41 to 50	6.7	4.9	27.0	22.1	15.2	2.5	14.7
51 to 60	6.7	5.1	26.9	22.2	15.6	2.6	14.4
60 +	6.4	4.7	27.7	21.6	16.1	2.5	15.0

Percent of involvements

16 to 20 21 to 30 31 to 40 41 to 50 51 to 60 60 +

Figure 12 Crash Type by Driver Age, 2006-2011

Table 23 shows the distribution of hazardous actions by CMV driver age. The raw frequencies were not shown in the table to save space. Rare hazardous actions like speed too slow, drove wrong way, and improper/no signal were combined with the “other” category. In addition, unknown hazardous actions were excluded.

As in the previous report, a higher proportion of younger drivers were coded with a hazardous action compared with older drivers. Two-thirds of CMV drivers 16-20 were coded with a hazardous action, compared with 51.7% of drivers 21 to 30 and 45.5% of drivers 31 to 40. The most common young driver errors were following too close, improper backing, and failure to yield. Drivers tend to speed less as they get older. About 4.7% of drivers 21 to 30 were coded as speeding, compared to only 3.1% of drivers over 50. On the other hand, the 60+ age group had the highest rate of failure to yield at 6.8%, improper lane use at 6.0%, and improper turn at 5.3%.

Table 23 Percent Distribution of Hazardous Action by CMV Driver Age Group, 2006-2011

	Driver age group						
Hazardous action	16 to 20	21 to 30	31 to 40	41 to 50	51 to 60	60 +	Total
None	33.8	48.3	54.5	57.1	56.0	50.5	54.5
Speed too fast	3.4	4.7	4.4	3.5	3.1	3.1	3.7
Failed to yield	5.9	5.9	5.2	5.2	5.9	6.8	5.6
Disregard traffic control	2.1	1.4	1.2	1.0	1.0	1.1	1.1
Improper passing	1.6	0.5	0.5	0.6	0.6	0.9	0.6
Improper lane use	3.7	4.9	4.4	4.3	5.2	6.0	4.8
Improper turn	2.7	3.6	3.5	3.8	3.9	5.3	3.9
Improper backing	8.7	5.9	4.4	4.2	4.3	3.9	4.5
Unable to stop	22.4	11.5	9.5	8.5	8.3	8.8	9.2
Careless/reckless	3.2	2.9	2.5	2.4	2.3	2.7	2.5
Other	12.6	10.2	9.9	9.4	9.5	10.9	9.8
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0

In terms of the distribution of crash costs, the differences were not great. Younger drivers may be overrepresented in rear-end and backing crashes, but backing crashes were among the least severe. The youngest group was only slightly overrepresented in terms of costs, compared with their share of involvements. (Table 24.) The distribution of costs for other age groups was very similar to the distribution of involvements.

Table 24 Distribution of Crashes and Crash Costs by CMV Driver Age 2006-2011

Age group	% of crashes	% of crash costs
16 to 20	0.7	1.2
21 to 30	12.4	12.4
31 to 40	23.0	22.2
41 to 50	31.7	31.8
51 to 60	24.2	23.5
60 +	8.0	8.9
Total	100.0	100.0

2.7. Driver and vehicle inspections

This section presents an analysis of CMV inspections to identify factors relating to the carrier that were associated with the mechanical condition and regulatory compliance. The MCMIS Inspection file has records of approximately 370,000 inspections of CMVs that took place in Michigan from 2006 to 2011. Table 25 shows the distribution of the inspections by the inspection level and the base of the carrier.

CMV inspections were carried out under a protocol developed by the Commercial Vehicle Safety Alliance (CVSA). There are different levels of inspection, differentiated by how the inspection was carried out and what was inspected. Level 1 inspections cover all items in the Federal Motor Carrier Safety Regulations (FMCSRs) that cover vehicles and drivers. A Level 1 inspection covers all the mechanical systems and all driver and carrier regulations, including medical certification, driver logs, and HOS. There were almost 69,000 Level 1 inspections in Michigan over the period. The analysis will focus on those inspections, because they are the most comprehensive.

Table 25 CMV Inspections in Michigan by Carrier Base, 2006-20011

	Michigan		Other		
Inspection level	N	%	N	%	Total
Full (1)	41,809	24.4	27,181	13.7	68,990
Walk around (2)	72,809	42.6	68,562	34.5	141,371
Driver only (3)	54,919	32.1	102,081	51.4	157,000
Special (4)	375	0.2	445	0.2	820
Terminal (5)	1,131	0.7	106	0.1	1,237
Other (6)	0	0.0	233	0.1	233
Total	171,043	100.0	198,608	100.0	369,651

Table 26 shows the distribution of inspections by level and by year, for 2006 to 2011. The top half of the table provides counts of inspections, and the bottom provides the percentage of each inspection level for each year. It should be noted that the data supplied for 2006 covered only August through the end of the year. The years 2007 and 2008 had the greatest number of inspections with about 83,000 and 88,000 respectively. Inspection totals dropped to about 52,000 in 2009, increased to almost 70,000 in 2010, but then declined again in 2011. About 17% to 21% of the inspections were Level 1 each year, and the average percentage of Level 1 inspections was 18.7%.

Table 26 Inspection Level by Year, 2006 to 2011

Inspection level	2006*	2007	2008	2009	2010	2011	Total
Full	5,483	15,903	14,629	9,459	12,565	10,951	68,990
Walk around	8,957	28,183	30,674	22,812	28,894	21,851	141,371
Driver only	9,639	38,642	41,634	19,784	28,272	19,029	157,000
Special	390	206	185	25	3	11	820
Terminal	121	203	321	181	200	211	1,237
Other	9	52	66	32	22	52	233
Total	24,599	83,189	87,509	52,293	69,956	52,105	369,651
Column percentages							
Full	22.3	19.1	16.7	18.1	18.0	21.0	18.7
Walk around	36.4	33.9	35.1	43.6	41.3	41.9	38.2
Driver only	39.2	46.5	47.6	37.8	40.4	36.5	42.5
Special	1.6	0.2	0.2	0.0	0.0	0.0	0.2
Terminal	0.5	0.2	0.4	0.3	0.3	0.4	0.3
Other	0.0	0.1	0.1	0.1	0.0	0.1	0.1
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0

* Note: 2006 data only includes 4 months of inspections.

This section primarily focuses on the effect of two carrier-related factors—fleet size and carrier type—on the incidence of violations in the population of trucks inspected. Fleet size was analyzed in terms of the number of trucks the carriers operated and was categorized into four groups. Carrier type was classified as either private or for-hire. A private carrier operates CMVs as part of a business that is not primarily freight hauling or passenger transport. For example, a big retailer may run a fleet of trucks to resupply its stores, but its business is retail sales and not freight-hauling. The primary business of a for-hire carrier is to transport persons or cargo. Examples include package delivery companies and truckload carriers. Carriers were also classified as interstate or intrastate firms. Interstate carriers operate in interstate commerce, that is, they participate in the transportation of goods or passengers across state lines. Intrastate carriers participate in commerce only within a state.

Fleet size and carrier type information were determined by linking the inspection records to carrier registration information in the MCMIS carrier file. This file contains records of all carriers that were registered with the US DOT and issued a DOT number. Registered carriers report the number of vehicles in their fleet as well as the type of operations in which they were operated, the number of drivers in different operations, types of cargo carried, and a few other descriptive details. Since this information was only available in the MCMIS Carrier file, not in the inspection file, fleet size and carrier type can only be determined for vehicles whose operator was registered with the US DOT. Of the approximately 370,000 CMV inspections, carriers were matched for 314,000. Table 27 shows the distribution of fleet size for inspected vehicles matched with the carrier file. About 31% of the vehicles inspected were operated by small carriers (one to eight CMVs), about 30% by small-to-moderate carriers (nine to 55 power units), about 30% by moderate to large carriers, and 9% by very large carriers. This distribution provides enough cases in each group to permit valid comparisons.

Table 27 Fleet Size of CMVs Inspected 2006-2011

Fleet size	N	%
1 to 8	98,117	31.2
9 to 55	93,479	29.7
56 to 999	93,577	29.8
1000+	28,723	9.1
Unknown	615	0.2
Total	314,511	100.0

The private/for-hire distinction was not cleanly determined in the MCMIS Carrier file. Carriers may select any or all of eleven different types of operations, including authorized carrier, exempt, private passenger, state government, and so on. A carrier can choose any combination of authorities, or all of them. Some identify themselves as both private and for-hire because they may act primarily as a private carrier but have for-hire authority (to transport other's goods) to allow them to transport for-hire loads on return trips, rather than running empty. To distinguish private from for-hire carriers, carriers that selected only one (or more) of the for-hire authority types were classified as for-hire, only private as private, and carriers that chose both were classified as "other." Some carriers selected no authority type and were left "unknown." Table 28 shows the resulting distribution. Note that the "other" category accounted for fewer than 9% of the CMVs inspected. In the discussion of the effect of carrier type, only private and for-hire carriers were included.

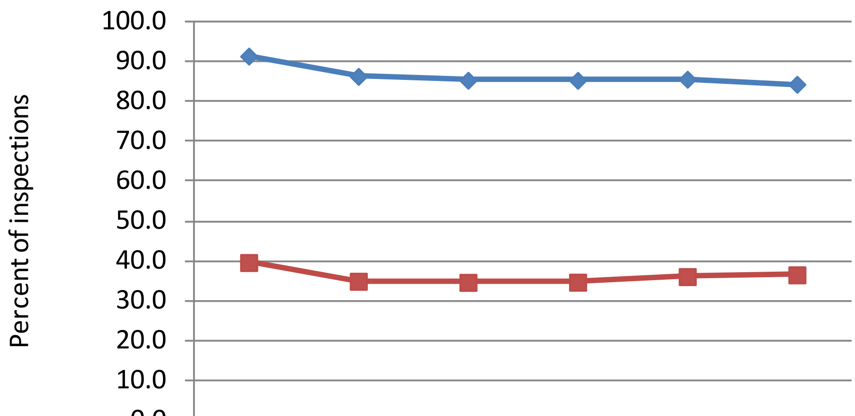
Table 28 Carrier Type of CMVs Inspected, Michigan 2006-2011

Carrier type	N	%
For-hire	217,536	69.2
Private	69,366	22.1
Other	27,530	8.8
Unknown	79	0.0
Total	314,511	100.0

Inspections may result in violations and out-of-service (OOS) conditions. A violation is a transgression of a driver or vehicle standard, but not qualifying as an OOS. A truck or driver with an OOS is not permitted to operate until the condition is corrected. For example, a truck with 20% or more of brakes out of adjustment would be placed OOS, and the truck must remain parked until the condition is corrected. Being over hours is an OOS, and normally the driver must stop driving until he has accumulated sufficient off-duty time to qualify to drive again.

Figure 13 shows the proportion of Level 1 inspections with violations and OOS by year over the period. Level 1 inspections were used because they are the most thorough. Table 26 showed that the percentage of Level 1 inspection varied by year, so using just Level 1 inspections removes the effect of variations in inspection level from year to year. The percentages of violations and OOS were fairly even over the period from 2006 to 2011, ranging from 91.4% in 2006 to 84.3% in 2011. The data for 2006 had higher percentages of inspections with violations and OOS than later years, but the data cover only part of the year. In other years, the percent of inspections with at least one violation was stable. In terms of OOS, there may be a slight tendency for the proportion to increase. The percentage was 39.7 in 2006, which also was the high-water mark for violations, but then around 35% in the next three years, increasing to 36.1% and 36.6% in the following two years.

The proportion of CMVs with violations and OOS conditions was high (though not out of line with other states.) Michigan has a probable-cause standard for inspection, so the inspections were not a random sample of CMVs on the road.[4] The absolute value of the proportions in part reflects how well the CMV officers identify trucks or drivers that probably have an issue, and in part that trucks pulled over for moving or other violations also had high rates of violations and OOS conditions. The true incidence of violations and OOS in the truck population was probably lower. Nevertheless, these inspection results indicate that a high proportion of CMVs on the road were not in compliance with applicable standards.

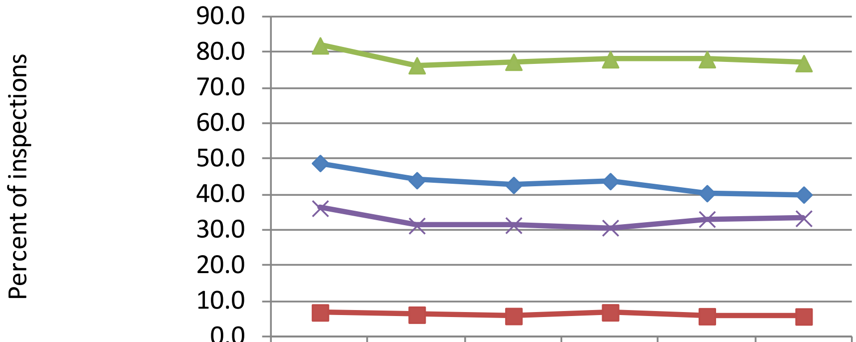


	2006	2007	2008	2009	2010	2011
Violations	91.4	86.3	85.4	85.3	85.6	84.3
OOS	39.7	35.0	34.7	34.7	36.1	36.6

Figure 13 Inspections with Violations and OOS by Year, 2006-2011

Figure 14 disaggregates the violations and OOSs into driver-related and vehicle-related sets. The incidence of vehicle violations was significantly higher than driver violations, and the same was true for OOSs. Violations were recorded for between 40% and 49% of drivers each year, and between 5.8% and 6.9% of drivers were placed OOS. Violation and OOS rates were much higher for vehicles than drivers. Between 76.4% and 82.0% of vehicles had at least one violation, and between 30.7% and 36.2% of vehicles had one or more OOS conditions. The rates of each were reasonably stable over the years.

[4] Probable cause means that there are reasonable grounds, based on facts that can be articulated, to believe that a violation has occurred.



	2006	2007	2008	2009	2010	2011
Driver violations	48.9	44.1	42.8	43.8	40.4	40.0
Driver OOS	6.9	6.3	5.9	6.9	5.8	5.8
Vehicle violations	82.0	76.4	77.4	78.1	78.1	77.0
Vehicle OOS	36.2	31.3	31.5	30.7	33.2	33.4

Figure 14 Level 1 Inspections, Driver & Vehicle Violations & OOS by Year, 2006-2011

Figure 15 shows the distribution of Level 1 inspections by carrier type and by fleet size. (Table 28 includes all inspections, not just Level 1.) Fleet size and carrier type were obtained by linking the inspections to the MCMIS carrier file. About 85% of the inspections could be linked to the carrier file. Most (59%) of the vehicles inspected were operated by for-hire carriers and 31% were operated by private carriers. Carrier type could not be assigned definitively for others because they claimed both private and for-hire operations. Some of these likely were private carriers with for-hire authority so they could haul loads when otherwise they would have an empty backhaul. Others were carriers that just checked all the boxes.

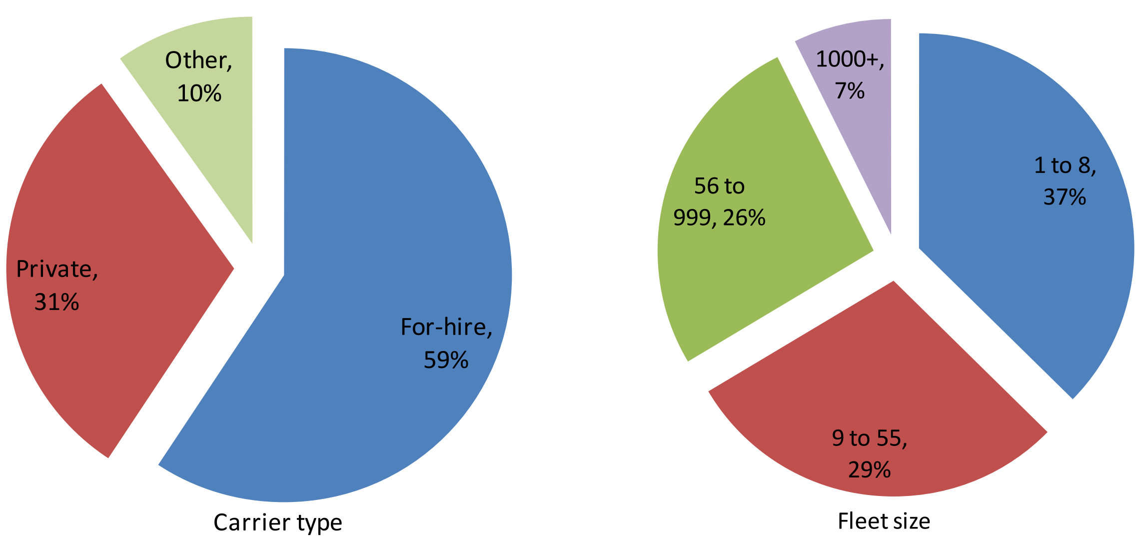


Figure 15 Level 1 Inspections by Carrier Type and Fleet Size, 2006-2011

The figure also illustrates the distribution of trucks by the size of the fleet. About 7% were part of very large firms, with 1,000 trucks or more. There was pretty good representation across the spectrum of carrier sizes. Note that these distributions reflect the carriers who operated vehicles that were actually inspected, not necessarily the trucks on the road. It is known, for example, that fleets with 1,000 or more trucks account for about half of trucks.

Figure 16 shows the results of Level 1 inspections. The figure shows the average number of violations for each category of fleet size. Fleet size was strongly associated with inspection violations and OOS conditions. Carriers with one to eight trucks averaged 2.65 violations per inspection, compared with 1.45 violations per inspection for carriers with more than 1,000 trucks. Note that the spread was greatest for vehicle violations, where small carriers had over twice the average number of violations as the largest carriers. When driver-related violations are considered, the mean number of violations for small carriers was only about 18% higher. Small carriers may have less ability to do routine or frequent maintenance on their equipment, and they may also be using older equipment.

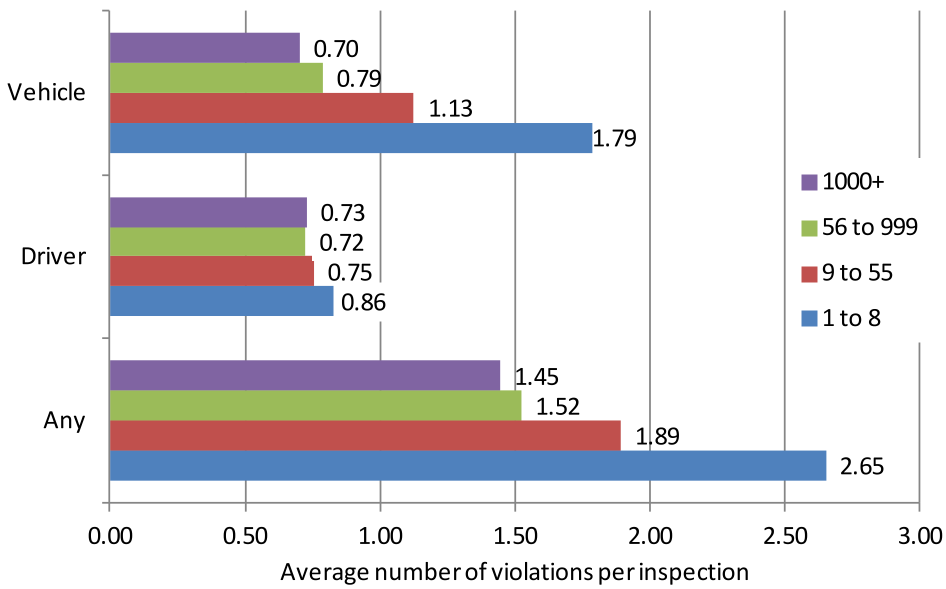


Figure 16 Violations by Type and Fleet Size, Level 1 Inspections

Figure 17 shows the average number of vehicle, driver, and any OOS condition per inspection by fleet size. Again, the average number of OOS conditions was strongly associated with fleet size, even more so than violations. CMVs operated by small fleets averaged almost three times as many vehicle and OOS conditions as CMVs operated by the largest carriers. Vehicle violations and OOS were more common than driver-related violations and OOS, overall and for each fleet size.

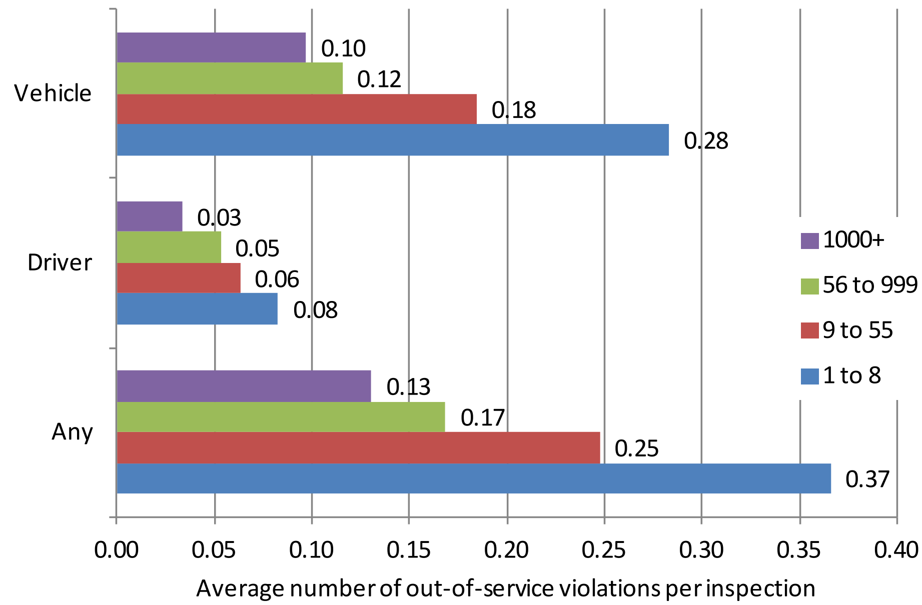


Figure 17 OOS by Type and Fleet Size, Level 1 Inspections

Figure 18 shows the percentage of inspections with vehicle, driver, or any violation and Figure 19 shows the percentage of inspections with vehicle, driver, or any OOS condition. Again, small carriers had a significantly higher percentage of vehicles and drivers with both violations and OOS conditions. Over 82% of small fleet CMVs had at least one violation, compared with 67.0% of the largest fleets and 68.3% of fleets with 56 to 999 trucks. These differences were both statistically significant and practically significant.

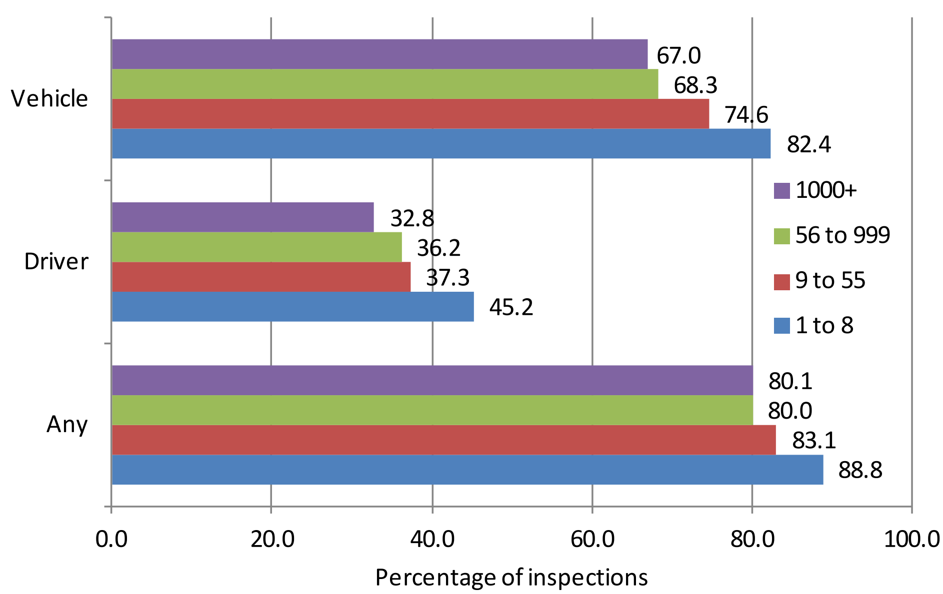


Figure 18 Percentage of Inspections with Violations by Fleet Size, Level 1 Inspections

The spread was even larger for OOS conditions. About 36.7% of the CMVs operated by small fleets were placed OOS by the inspection, compared with 21.1% of large fleet trucks. The pattern was very consistent across each fleet size category. This is a robust relationship.

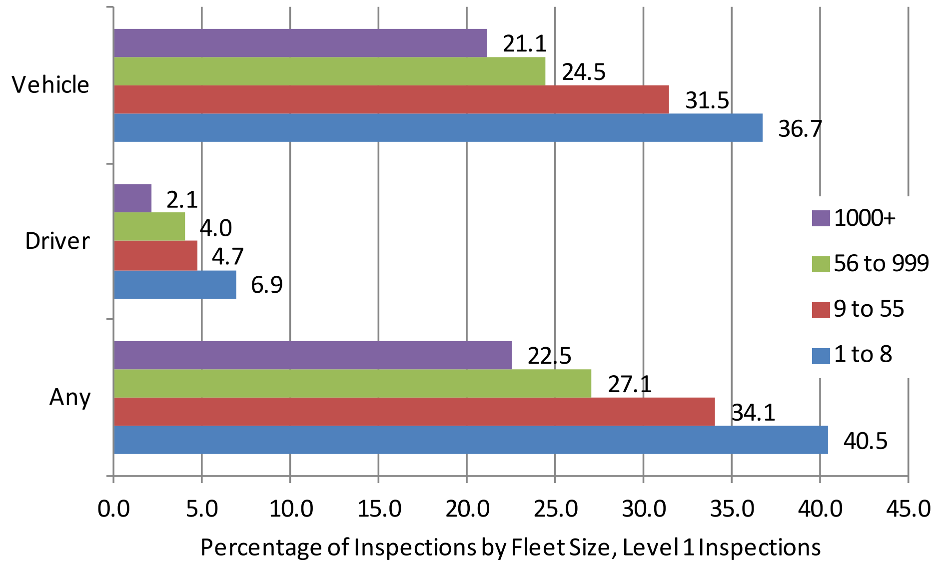
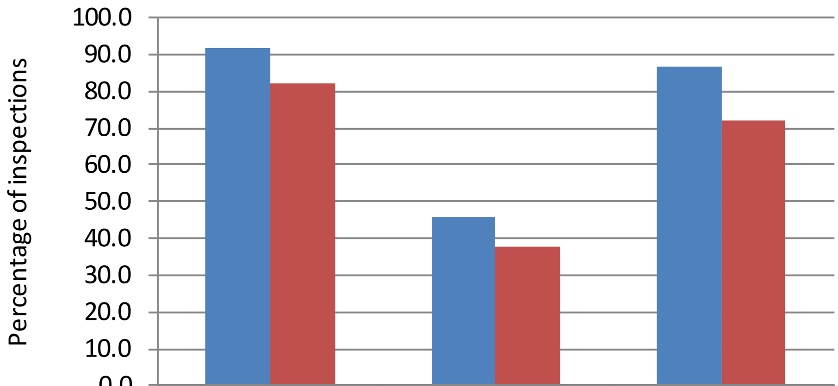


Figure 19 Percentage of Inspections with OOS Condition by Fleet Size, Level 1 Inspections

Differences were not as great when comparing inspection results of private and for-hire fleets. Private fleets had somewhat higher rates of violations in Level 1 inspections, but the differences were not large. Vehicle violations were recorded for about 79.4% of private fleet inspections, compared with 73.1% of the inspections of for-hire firms. Similarly, the percentage of inspections with driver violations was only a few points higher for private than for-hire carriers.

Figure 20 Percentage of Inspections with Violations by Carrier Type, Level 1 Inspections

Differences in inspection results between intrastate and interstate carriers were also not large. The percentage of inspections with violations was somewhat higher for intrastate carriers. Almost 87% of the inspections of CMVs operated by intrastate carriers had one or more violations, compared with 71.9% of interstate. This difference was statistically significant. Intrastate drivers were also more likely to have one or more violations, and this difference was also statistically significant. Overall, 91.7% of intrastate inspections had at least one violation, compared with 82.0% of interstate inspections. Both were very high.



	Any	Driver	Vehicle
Intrastate	91.7	45.8	86.9
Interstate	82.0	37.8	71.9

Figure 21 Percentage of Inspections with Violations by Area of Operation, Level 1 Inspections

Table 29 shows the average number of driver, vehicle, and any violation per inspection by carrier type and by area of operation. On average, for-hire carriers tended to have fewer violations recorded than private carriers. The differences were not huge but they were substantial and statistically significant in each case. Interstate carriers also tended to have fewer violations per inspection than intrastate carriers. The differences were somewhat larger, and also statistically significant. The average number of violations for private carriers was about 15% to 19% higher than for-hire carriers for each category. When the comparison was intrastate to interstate, intrastate carriers averaged 27% to 71% more violations per inspection.

Table 29 Average Number of Violations by Type Carrier Type and Area of Operation Level 1 Inspections

	Driver	Vehicle	Any
Carrier type			
For-hire	0.53	2.97	3.56
Private	0.64	3.43	4.10
Area of operation			
Interstate	0.53	2.71	3.30
Intrastate	0.68	4.64	5.35

Brake and light systems had the highest rate of violations, followed by tires, load securement, and driver logs. Light systems include head-lights, tail-lights, marker, and identification lights. The next few figures compare the proportions of inspections by certain selected types of violations. Small fleets had the highest percentage of inspections with violation in light systems, tires, and load securement, and the second highest for brake systems. There was less variation across the fleet size categories in terms of HOS and driver log violations. Only about 1.4% of the inspections of large fleets had an HOS violation, which was the lowest rate. However, the rates were similar for the other three fleet-size categories. The largest carriers also had the lowest rates of driver log violations, but, again, rates were similar for the other groups.

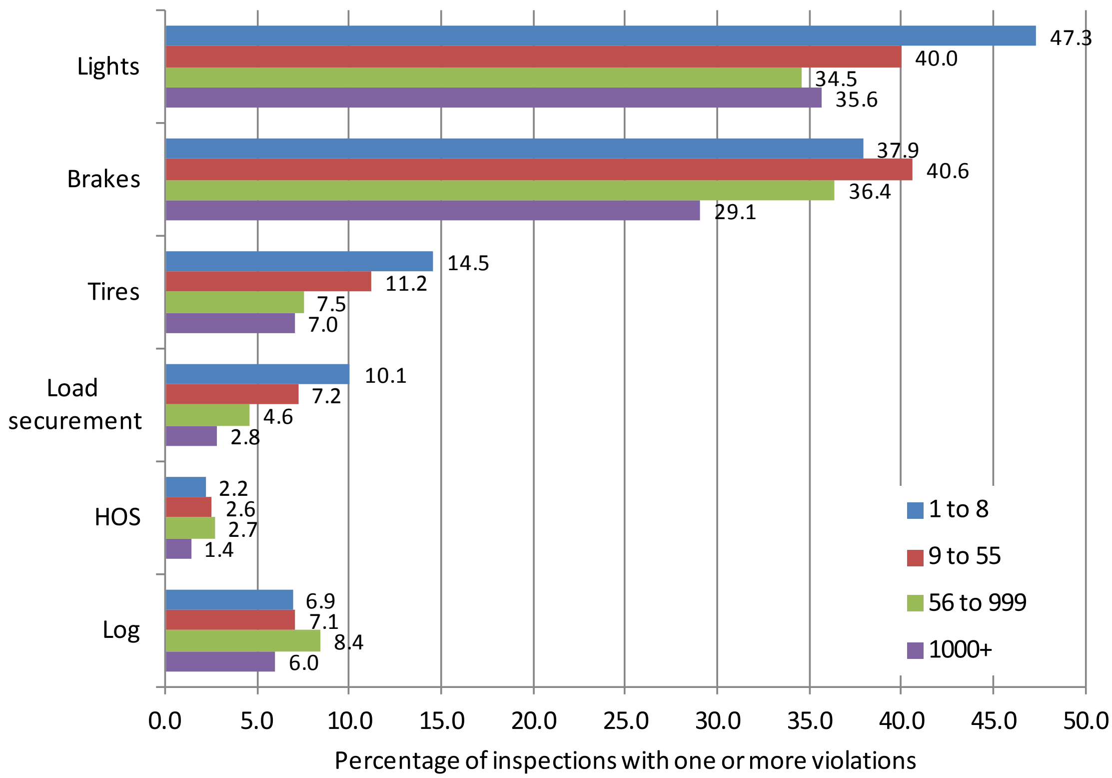


Figure 22 Percentage of Inspections with Selected Violation Types, by Fleet Size Level 1 Inspections

In terms of carrier type, for-hire carriers had higher percentages of inspections with violations for brakes, driver logs, and HOS, while private carriers had higher percentages for lights and load securement. These relationships were exactly what were observed in the previous report. However, in the previous report, for-hire firms had more inspections with tire violations, while in the present analysis, the percentages were identical. Some of the differences between private and for-hire carriers may be the product of operational differences. Private carriers may have shorter hauls and more routine daily operations, which would help reduce HOS and driver log issues. In contrast, cargo securement was an issue primarily for certain cargo types such as lumber or coils of steel, which may be hauled more often as part of a private operations business than as a for-hire haul.

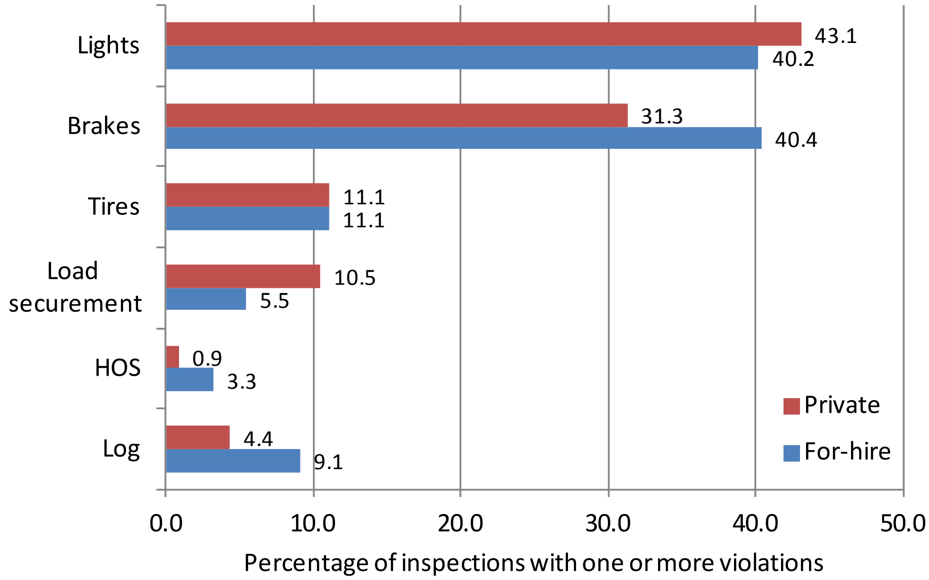


Figure 23 Percentage of Inspections with Selected Violation Types, by Carrier Type Level 1 Inspections

2.8. Geographic distribution of crashes and inspections

Virtually all crashes in the Michigan crash data were geolocated, meaning the latitude and longitude of each crash was determined. This information was used to locate the crashes on a map and study the geographic distribution of the crashes. One purpose of geolocating crashes was to identify clusters of crashes. The clusters may indicate some factor that increased crash risk, or may result from higher exposure. Either way, it may be useful to deploy enforcement tools such as patrols and vehicle inspections in such areas.

Of the approximately 74,000 CMVs involved in a crash over the period of data used for this report, a valid latitude and longitude was available for all but 0.3%. This must be acknowledged as an amazing feat. Moreover, although it was not possible to validate the accuracy of location in the current project, prior experience with these data showed that crash locations relative to a base map were quite consistent within a few tens of feet.

With such a large number of located crashes, pin-mapping crash locations over six years would essentially cover the map. Instead, after some experimentation, it was decided to limit the maps to just crashes with fatal or A-injuries. This gives about 2,200 crashes over the period, more than enough to illustrate the general pattern of crashes.

Figure 24 shows the location of all fatal or A-injury CMV crashes in Michigan from 2006 to 2011. The largest cluster was in the Detroit area, a major industrial area, the largest population center in the state, and a primary point of entry for international trade into Michigan. Other clusters were observable in the Flint and Lansing areas, the Grand Rapids region, the Kalamazoo/Battle Creek area, and around Port Huron. Note also that the crashes essentially trace the primary CMV (truck) routes in Michigan. Most of the crashes occurred along the main roads and highways; those roads are readily identifiable even at this scale. In the Upper Peninsula, virtually all CMV crashes on the map fell on the main highways. Relatively few of the most serious crashes occurred off the main arteries of travel.

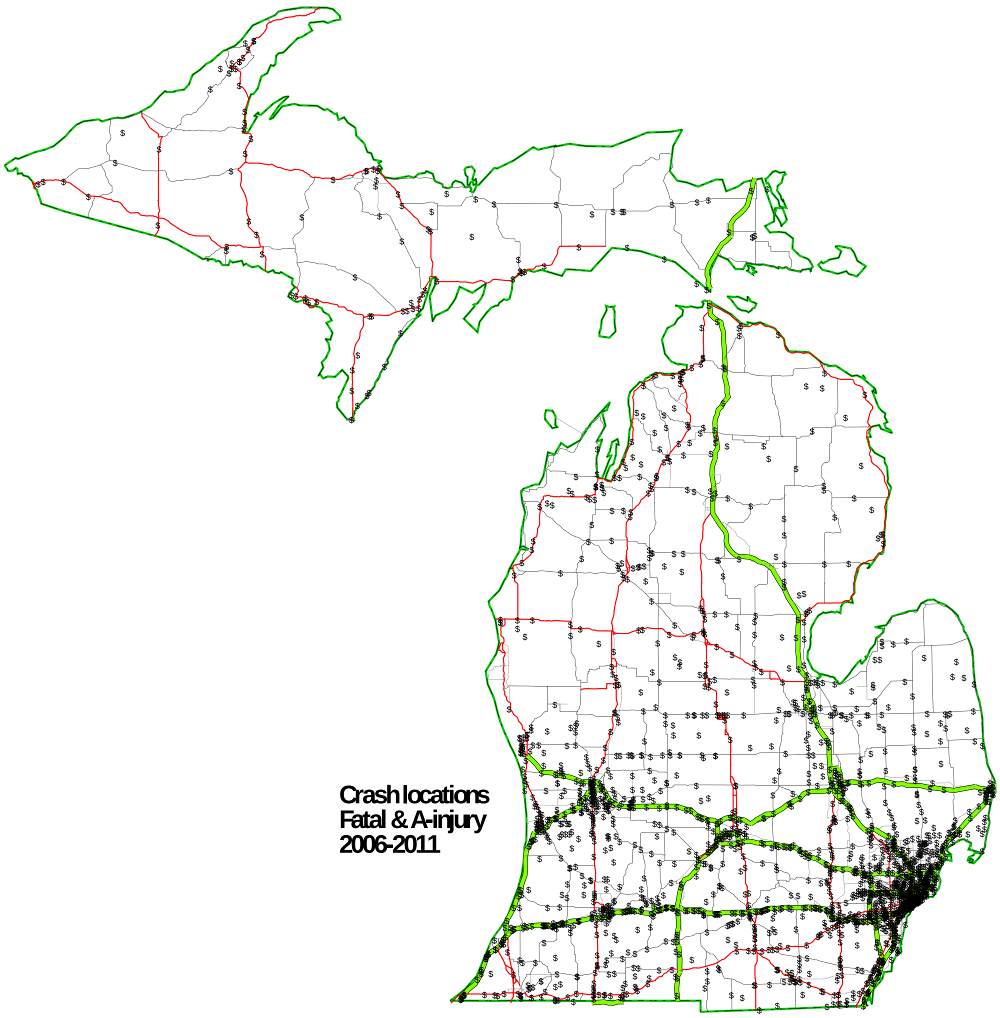


Figure 24 Location of Fatal and A-injury CMV Crashes, 2006-2011

Figure 25 shows a detailed view of fatal and A-injury CMV crashes in southeastern Michigan. The patterns were very similar to those observed in the previous study. In the Detroit area, crashes occurred throughout the city, not just on the major roads in and through the city. Outside of Detroit, the crashes tended to follow the major routes in Michigan. A series of crashes traced the routes of M 24 and M 53 north into Macomb County. There was also a series along US 127 south from Jackson, as well as a series on I-496 through Lansing. In addition, there was a large number on US 223 between US 12 and US 23. This stretch of road apparently was used as a connector by CMVs between I-94 and US 23 and points south, avoiding traffic in the Ann Arbor and Detroit areas. Alternatively, the pattern of crashes may be related to the agriculture in the region, given the cluster around Adrian. In addition, there was a string of serious CMV crashes on US 12 from I-94 near Ann Arbor to I-69 at Coldwater, and the parallel route to the north of M 60 from Jackson all the way to Three Rivers and beyond to the Indiana border at South Bend.

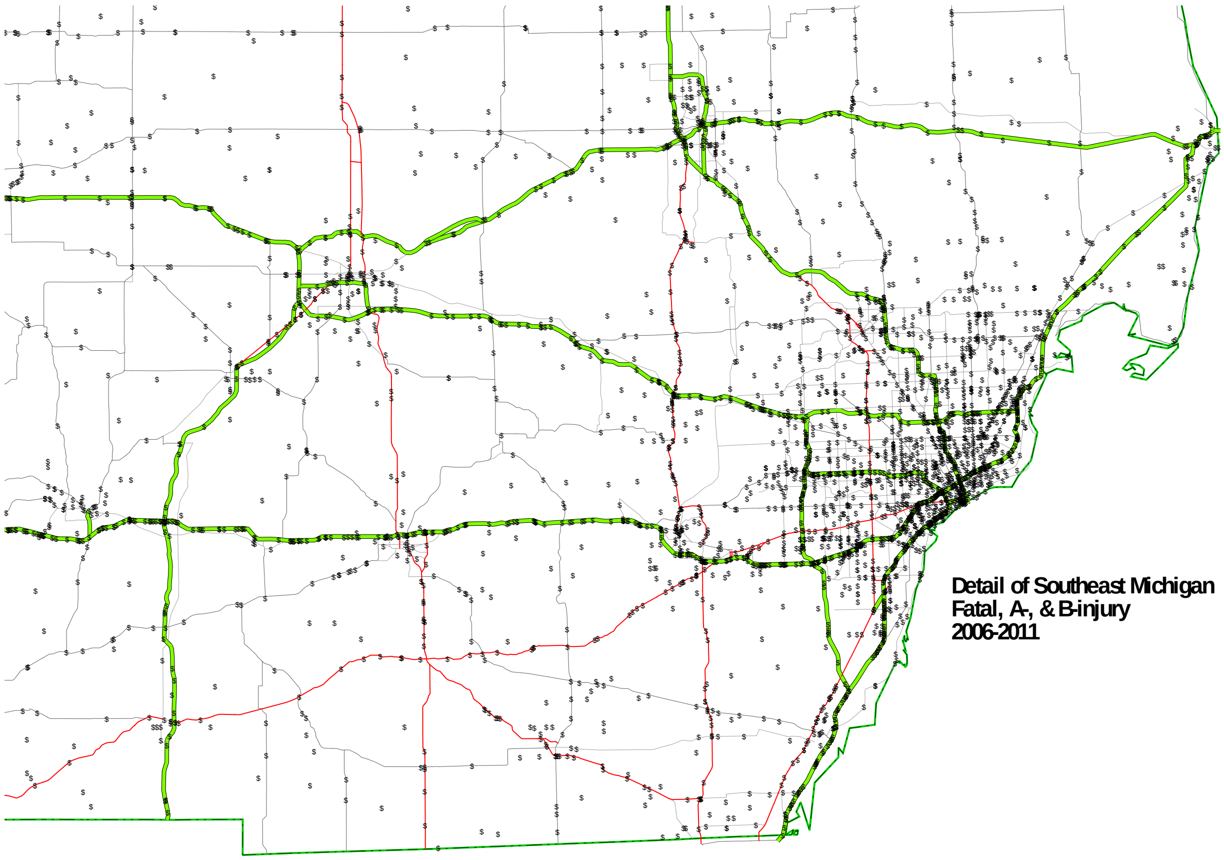


Figure 25 Location of Fatal and A--Injury CMV Crashes, Southeastern Michigan, 2006-2011

Figure 26 shows detail of CMV crashes in southwestern Michigan, from the cluster in Kent and Ottawa Counties down to the Indiana border. US 131 was clearly marked. In Berrien County, the crashes followed along I-94. The string of fatal and A-injury CMV crashes on I-94 extends to the Kalamazoo/Battle Creek area and further past Jackson to the east. There was also a number of crashes off the Interstates, but closer inspection shows that the crash involvements primarily occurred on major routes, such as US 131, M 60, US 12, and US 31 up to the Muskegon area.

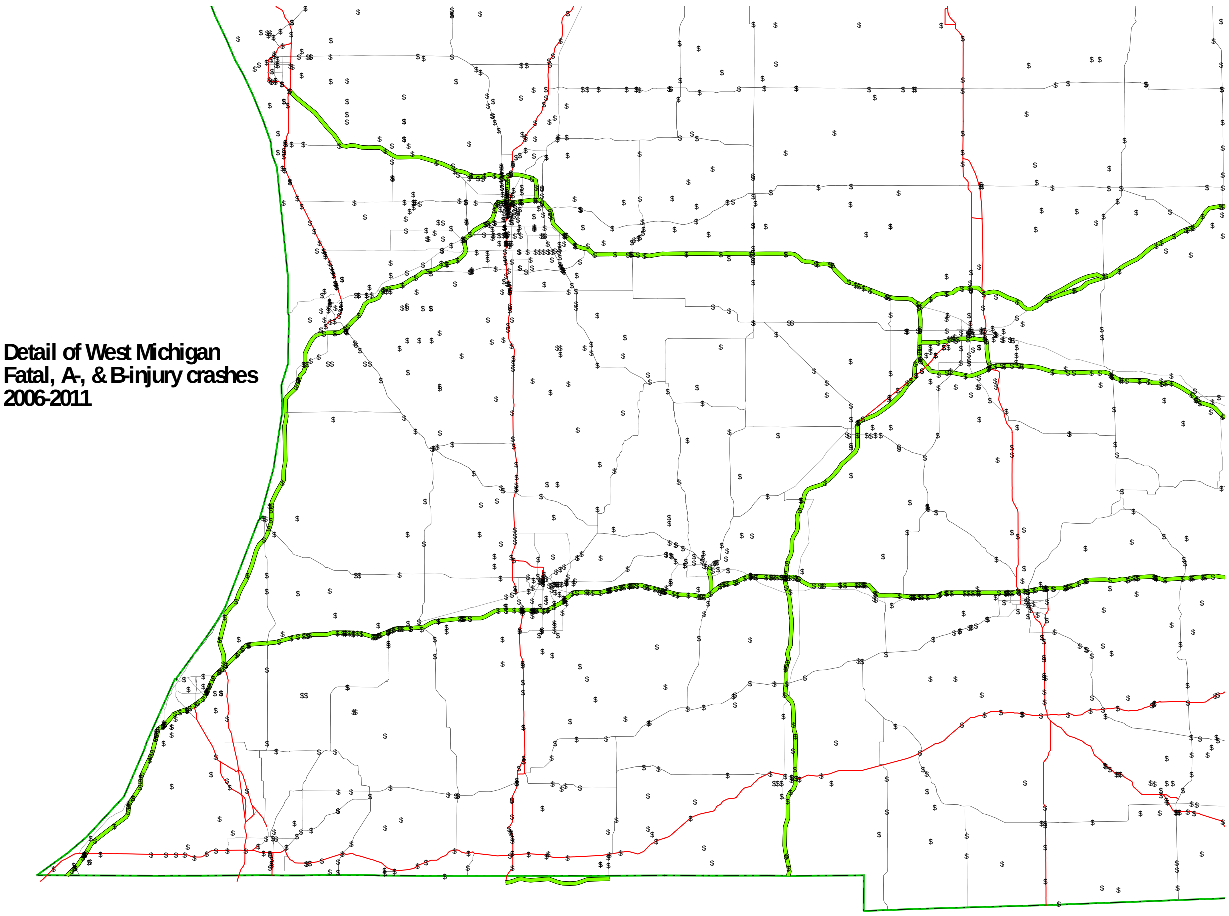


Figure 26 Location of Fatal and A--Injury CMV Crashes, Southwestern Michigan, 2006-2011

Crash costs were computed by county to estimate the geographic distribution of the burden of CMV crashes. These costs included all crash severities, of course, not just the fatal and A-injury crashes shown in the pin maps. The county-level maps identify where the crash costs were incurred. These may be areas where countermeasures such as enforcement of traffic and other CMV regulations may have the most impact.

Figure 27 shows the distribution of CMV crash costs by county. Annual costs ranged from a low of about $382,000 in Luce County in the Upper Peninsula and $596,000 in Alpena County in the Lower Peninsula to a high of over $182 million in Wayne County. The range of crash costs was so great that the scale used in Figure 27 to display the data was roughly geometric, with the range of costs nearly doubling with each step up the scale. Most of the impact of CMV crashes was felt in the southern half of the Lower Peninsula. Wayne County accounted for the highest proportion of CMV crash costs, with about 20.5% of the total, up by 1.3% from the previous report. Oakland, Macomb, and Kent Counties formed the next tier, with annual crash costs ranging from $66 million in Oakland to $48 million in Kent County. The top eight counties in terms of crash costs—Wayne, Oakland, Macomb, Kent, Washtenaw, Genesee, Kalamazoo, and Monroe—accounted for 51.8% of all annual CMV crash costs.

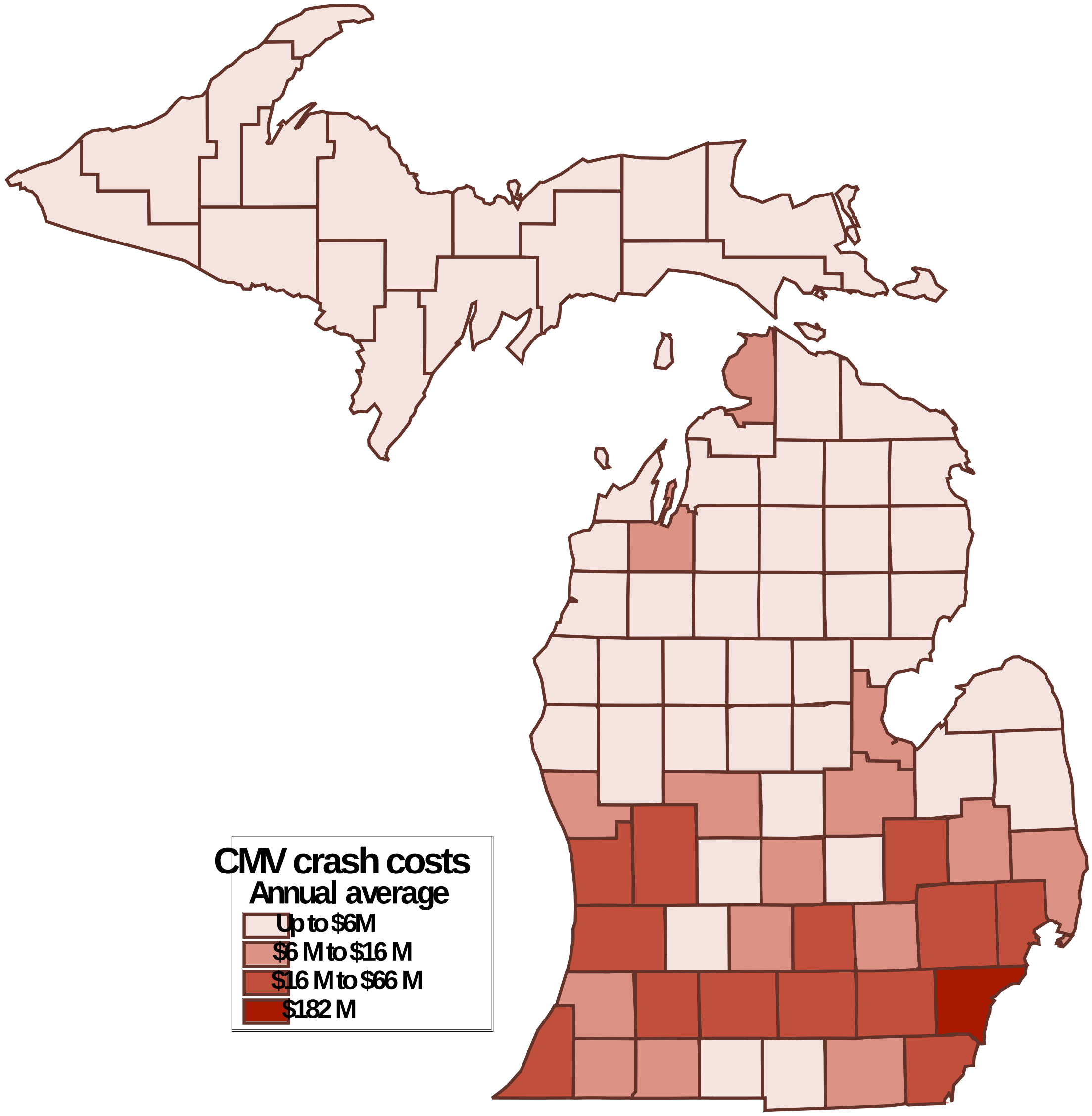


Figure 27 Annual Average CMV Crash Costs by County, 2006-2011

Figure 28 shows total inspections from 2006 to 2011 by county. The distribution matches the distribution of crashes (see Figure 24) fairly well, with the exception of the large number of inspections in Mackinaw and Chippewa Counties in the Upper Peninsula. This concentration may be related to the presence of the Mackinaw Bridge and the International Bridge in Sault Ste. Marie.

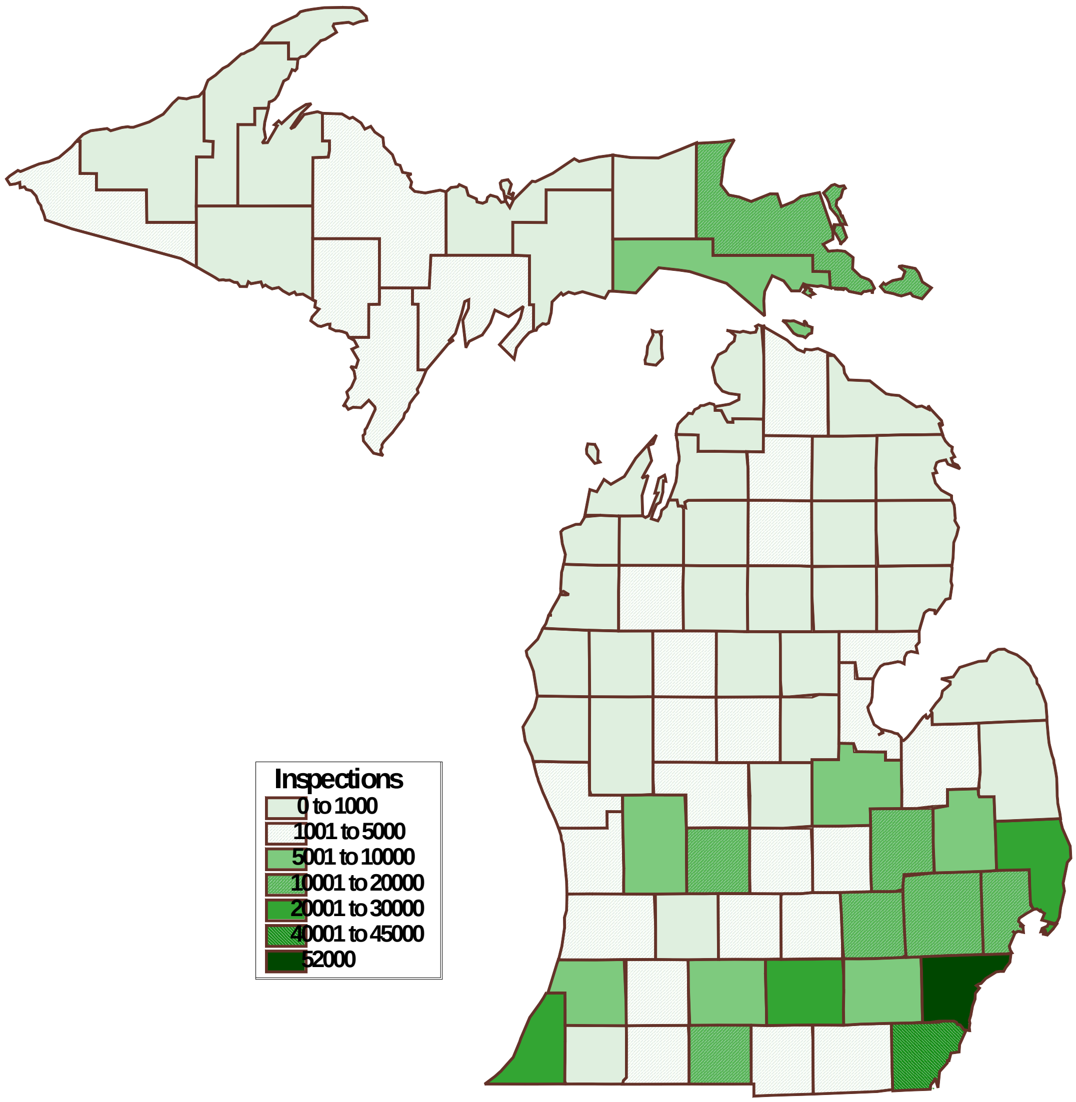


Figure 28 All Inspections by County, 2006-2011

Figure 29 shows the number of Level 1 inspections by county from 2006 to 2011. Only Level 1 inspections were included because they are the most thorough. Again, the distribution reasonably followed the distribution of serious CMV crashes. Counties with the highest average number of Level 1 inspections were Monroe, Wayne, Genesee, Berrien, Oakland and Jackson. Monroe County averaged about 1,650 per year, Wayne 1,300, and Genesee almost 800. These were all counties either where large numbers of CMV crashes occurred, or there was a major truck routes running through them. Both Monroe and Berrien Counties had among the highest number of Level 1 inspections, which was reasonable because they were located at primary entry points of CMVs into Michigan: I-94 from the Chicago area and I-75 from the Toledo area. Inspections were also concentrated in Jackson, Oakland, Genesee, and Wayne Counties, along I-94, I-96, and I-75. Kent and Ottawa Counties were identified in the last report because of their high rank in terms of CMV crash costs, but with relative few inspections. For the period 2006-2011, Kent and Ottawa ranked 4th and 10th in terms of crash costs and 11th and 16th in terms of inspections.

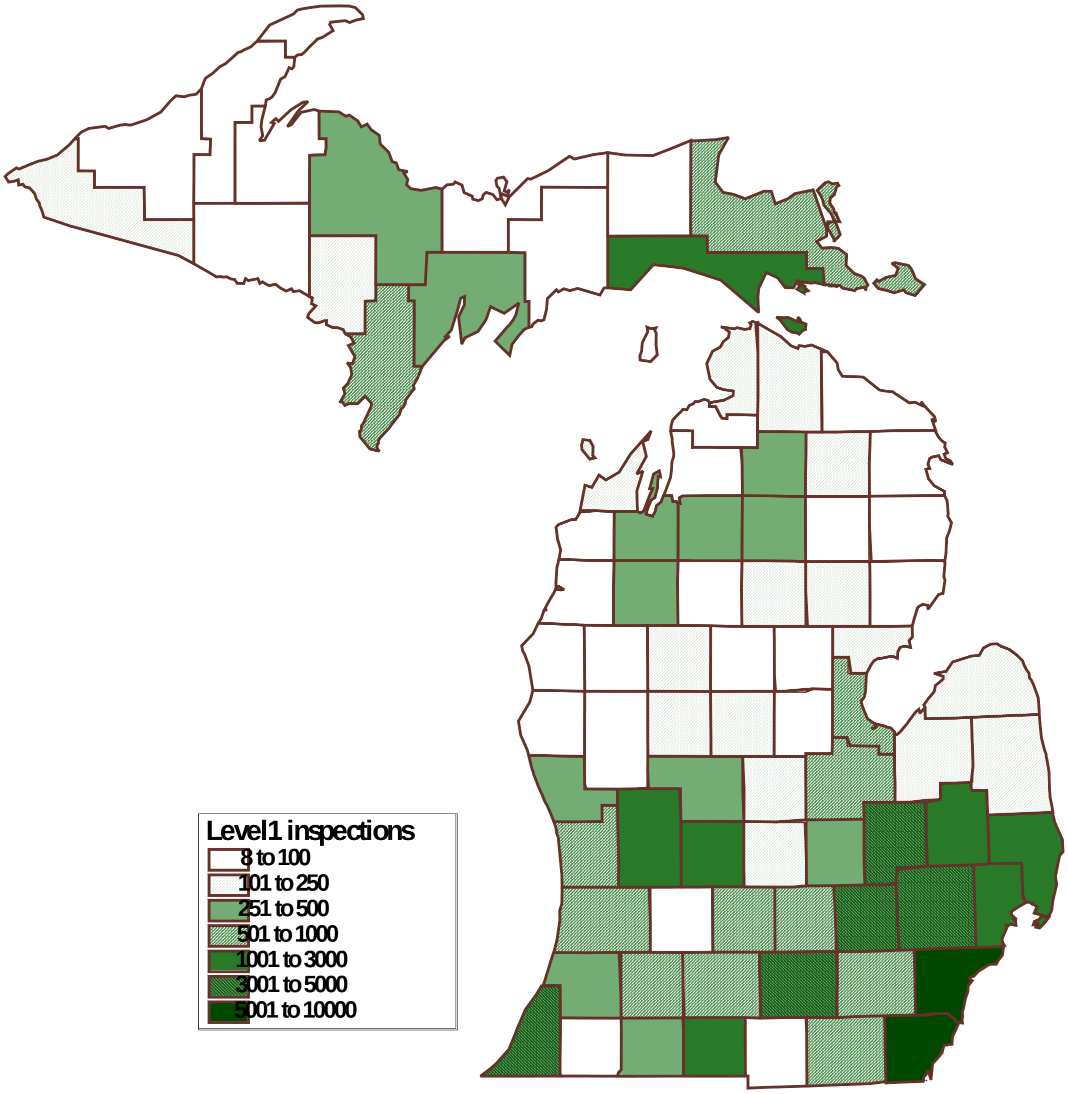


Figure 29 Level 1 Inspections by County, 2006-2011

Table 30 shows the top 10 counties in terms of the frequency and severity of CMV crashes, as measured by crash costs. The table also shows the ranking of the counties in the 2007 report. All but one were in the top 10 in the earlier report, showing long-term stability in terms of where CMV crashes happened. These 10 counties accounted for 57.0% of the estimated CMV crash costs in Michigan. The table also shows their rank in terms of the number of all CMV inspections and CVSA Level 1 inspections. Most also ranked high in terms of the number of inspections that occurred in the county. Moreover, these counties were located along routes where most of the CMV inspections occurred in Michigan, showing that, for the most part, CMV inspection resources were reasonably allocated.

Table 30 Top Counties in Crash Costs, Level 1 Inspections, & All Inspections, 2006-2011

County name	Rank in crash costs	Rank in 2007 report	Annual crash costs	% of total costs	Rank in Level 1 inspections	Rank in all inspections
Wayne	1	1	$182,329,514	20.5	2	1
Oakland	2	2	65,898,143	7.4	5	10
Macomb	3	4	53,443,912	6.0	12	11
Kent	4	3	47,869,760	5.4	11	16
Washtenaw	5	6	33,156,762	3.7	19	19
Genesee	6	7	28,288,359	3.2	3	6
Kalamazoo	7	10	25,335,006	2.8	24	22
Monroe	8	11	24,581,485	2.8	1	2
Berrien	9	5	23,831,018	2.7	4	3
Ottawa	10	8	22,309,864	2.5	16	27

Costs in 2012 dollars.

2.9. Summary and conclusions

There was a welcome decline in the number of CMV involvements, fatalities and injuries over the 2006-2011 period. The average number of fatal involvements declined by almost 30% from the 2001-2005 period to the 2006-2011 period, and the combination of fatal and A-injury involvements declined by almost 47%. Much of the drop in crashes and casualties was explained by a 15% drop in CMV travel in the recession year of 2009, but crash rates per mile traveled also declined, indicating an increase in CMV safety.

Despite the reduction in the number of CMV crash involvements and decline in crash rates, CMV safety issues remained stable over the period. This updated analysis has identified the same set of issues as the prior analysis. There has been some evolution in specific areas. For example, fatal involvements in the current analysis do not account for more than half of CMV crash costs, as was the case in the prior analysis. However, the combination of fatal and A-injury crash involvements still accounted for about 60% of all crash costs. The following were the main CMV safety issues identified for the 2006-2011 period.

- Crashes with fatalities or A-injuries accounted for about 60% of the crash costs, a measure of social harm, in CMV crashes. Crash involvements that resulted in either a fatality or an A-injury were only about 3.1% of all CMV involvements.
- Angle crashes, head-on crashes, and rear-end crashes accounted for most of the harm in CMV crashes.
- When crashes of all severity levels were considered, rear-end, angle, head-on, same direction sideswipe and single-vehicle crashes, in that order, contributed most to overall CMV crash costs. In the previous report, the first two crash types were reversed, but the remainder were in the same order.
- In Level 1 inspections, about 84% of CMVs inspected had one or more violations and about 40% of drivers had violations.
- In Level 1 inspections, about 33% of vehicles had an OOS condition; and 5% of drivers had an OOS condition.

- Brake and lighting system violations were the most frequent violations in CMV inspections, and both have been associated with higher crash rates.
- Violation rates in inspections were highest for CMVs from small fleets.
- CMVs from intrastate carrier's fleets had higher violation rates and more serious violations in inspections than CMVs from interstate carrier fleets.
- The CMV driver hazardous actions that contribute most to overall CMV crash costs were unable to stop in assured distance (i.e., following too closely), failure to yield, speed too fast, careless/negligent, and disregard for traffic control. This is the same list, and in the same order, as in the previous report.
- The most common individual CMV driver hazardous actions in fatal crashes were: unable to stop (following too close), careless/negligent, failure to yield, disregard traffic control, and speed too fast.
- Younger crash-involved CMV drivers were more likely to be with coded with hazardous actions, particularly unable to stop in assured distance (following too closely), improper backing, failure to yield, and speed too fast. The previous list did not include backing and had speeding higher on the list.
- Younger CMV drivers were significantly more likely to be involved in backing-up crashes than older drivers. Older drivers tended to have more same-direction sideswipe crashes.
- In approximately one-half of CMV crashes, no hazardous action was coded for the CMV driver.
- The incidence of fatigue/asleep crashes was slightly lower but statistically indistinguishable from the previous report. Fatigue-related CMV crashes tended to be severe single-vehicle crashes in which the CMV ran off the road, or rear-end crashes. Most CMV fatigued driver crashes occurred at night, between midnight and 6 am, and on Interstate roads.
- Fatigue/asleep-related crashes were likely underreported in the crash data.
- Nine of the top 10 counties in terms of crash costs were also in the top 10 in the previous report. Eight counties (Wayne, Oakland, Macomb, Kent, Washtenaw, Genesee, Monroe, and Kalamazoo) accounted for over one-half of Michigan's annual CMV crash costs. Wayne County alone accounted for 20.5% of the costs.

  Four of the above eight counties were not among the top eight counties when CMV inspections were considered.

3. Evaluate and update recommended strategies

3.1. Strategies recommended

The 2007 report recommended several strategies, which remain valid. (Blower and Kostyniuk 2007)

Improve maintenance of CMVs

Targeted enforcement, mandating maintenance programs, and improving fleet safety management were all recommended as strategies to reduce CMV crashes and casualties.

With regard to targeted enforcement, the Michigan State Police (MSP) Commercial Vehicle Enforcement Division (CVED) has utilized a portion of the Truck Safety Fund Grant in five of the top eight counties identified in the previous report (Wayne, Oakland, Kent, Genesee, and Macomb) based on truck-related fatalities in FY07-FY11. Districts covering these counties dedicated an additional 50 regular hours per quarter to Specialized Truck Enforcement Teams (STETs).

The previous report pointed to a program in New York State aimed at proactively addressing safety and compliance problems. The state used a "compliance letter," requiring carriers with records of violations to state in writing that they were aware of the problem and also outline a plan of improvement.

While Michigan has not itself adopted this approach, it is similar to aspects of the national Compliance, Safety, and Accountability (CSA) program that FMCSA implemented in 2010. CSA includes a "warning" letter for carriers found with relatively minor violations. A study of the pilot implementation of CSA showed that warning letters were among the most effective of the tools to bring carriers into compliance. The CSA process is designed to identify more carriers with safety problems, and to intervene earlier, before a compliance review is necessary. Evaluation of the Pilot rollout of CSA showed that it was more effective at identifying unsafe carriers and effective at bringing them back into compliance through a series of graded interventions. (Green and Blower 2011)

The 2007 report also identified educational training and consultation as ways to improve fleet safety management. The Colorado Circuit Rider program, an industry-based initiative to provide free consultation from veteran motor carrier safety managers, was described as a model. While there have been no new programs like this introduced in Michigan, either from FMCSA or elsewhere, the MCTS makes available "Safety Management Specialists" who consult on-site with carriers who may be experiencing problems. The Director of the MCTS indicated that most of the requests for safety management specialists come from small fleets, which is appropriate in light of the finding in the Inspection data that small fleets tended to have higher rates of violations.

Deployment of truck safety technologies: The previous report described several safety-related technologies that could improve truck safety, including improved brakes, electronic braking systems, and collision avoidance technologies, such as forward crash warning, electronic stability control (ESC), and lane departure warning. Promoting these technologies through tax incentives was recommended.

There have been no changes in the tax law to encourage the adoption of these technologies. Nevertheless, many of them are beginning to show up on trucks. NHTSA is considering a rulemaking to require ESC on new truck-tractors and certain buses. Several large carriers are already buying ESC as optional equipment on new tractors and studies have shown its effectiveness. Similarly, carriers are buying collision mitigation braking systems and adaptive cruise control, which studies have shown can significantly reduce truck-striking rear-end crashes. One truck manufacturer reported that almost 50% of new tractor sales in 2012 included ESC and 25% included forward collision warning system with active braking. Another truck manufacturer offers disc brakes as standard equipment, and at another truck manufacturer, almost a third of some tractor models are equipped with disc brakes. Disc brakes offer better stopping power with lower out-of-adjustment rates than conventional air brakes. While surveys show that the overall penetration of safety technologies has been slow (other than speed limiters, which are probably on half over-the-road tractors), the pace is accelerating and many carriers have plans to add these technologies in the future. (Woodrooffe, Blower et al. 2009; Woodrooffe, Blower et al. 2012; Belzowski, Blower et al. 2009)

Increase Knowledge of Sharing the Road: The MCTS manages the *Share the Road* public information and education program in Michigan, and continues to do so. The MCTS also provides online videos and supplies DVDs to promote the “share-the-road” message. In addition, OHSP is conducting a TACT (Ticketing Aggressive Cars and Trucks) program in Michigan. This program includes a targeted media campaign to spread the message about safe driving around trucks, along with stepped-up traffic enforcement to reduce unsafe driving around trucks, by both car and truck drivers. The program has been used successfully in several other states. It has evolved into a continuing program in the State of Washington.

Strengthen CDL program: Fraudulent issuance of CDLs was identified as a concern throughout the United States, including Michigan. The Michigan Secretary of State has recently increased staff focus on detecting fraud by more aggressively monitoring testing in the field. There has been better communication with third-party testers to alert them about suspicious activities by CDL applicants and facilitators. In addition, the examiners are subject to criminal history searches, with regular follow-ups every five years, and their own driving history is monitored.

Improve Crash Data: Several issues were identified with respect to the identification of trucks and buses in the Michigan crash data. These include changes to the way vehicle type is captured, so trucks can be distinguished from buses, directly on the form; adopting a standard classification for truck configuration into common types; and a simplification of the way truck configuration is recorded.

The information captured in the crash data has not been changed since the prior analysis. However, a working group has been established to make the Michigan Traffic Crash Report more compliant with the Model Minimum Uniform Crash Criteria (MMUCC). The MMUCC is a voluntary national standard, developed and promoted by NHTSA and the Governors Highway Safety Association. Adoption of the MMUCC guidelines would significantly improve the usefulness of the Michigan crash data.

3.2. Assessment of continuing relevance.

Updating the crash analysis from the 2007 Report showed that there has been no fundamental change in the nature of the CMV safety problem in Michigan. There has been a trend toward a decline in the number of CMV crashes, fatalities, injuries, and associated crash costs. There also has been a general improvement in the truck safety climate over the last decade. Beginning in 2002, there was a gradual decline in crashes, fatal and non-injuries. The decline accelerated in 2008 and 2009 with the recession, and then returned to the general downward trend even as the economy recovered.

Despite this welcome improvement in the CMV safety climate, many of the primary safety issues identified in the previous study remain.

- Vehicle maintenance continues to be an issue with relatively high rates of driver and vehicle violations and OOS conditions. Brake and light systems continue to be the primary vehicle condition issues. HOS and logbook violations were identified at roughly the same levels as previously.
- Fleet size was strongly associated with rates of violations. Small carriers had higher rates of driver and especially vehicle violations than large fleets. Intrastate carriers had higher rates of driver and vehicle violations than interstate.
- Younger CMV drivers were coded with hazardous actions that contribute to crashes at a significantly higher rate than older drivers. Younger drivers were over-represented in crashes related to vehicle control, such as rear-end and backing crashes.
- Certain crash types tended to account for most fatalities and injuries, such as head-on, angle, and rear-end crashes. Crash type distributions in the 2006-2011 period were very similar to those identified in the 2001-2005 period.
- The primary hazardous actions by CMV drivers that contributed to crashes were following too close, failure to yield, improper turns, and improper lane use. These same actions were also identified for CMV drivers in the 2007 report.

3.3. Recommended strategies going forward

In light of the updated findings and the assessment of the implementation of the strategies recommended last time, it is clear that the same areas need to be addressed. There has been progress on improving CMV safety in Michigan. Some of the recommendations, such as deploying advanced crash avoidance technologies, are happening, albeit slowly, because of a national focus on increasing truck safety. To accelerate positive trends, the following strategies are recommended:

Improve the compliance of drivers and vehicles with Federal Motor Carrier Safety Regulations: Analysis of the inspection data showed that violations and OOS conditions for both drivers and vehicles continued at relatively high rates. These violations clearly reduced the safety of truck and bus operations. The implementation and refinement of the CSA program should contribute to improving safe operations.

The additional hours of STET operations in Wayne, Oakland, Kent , Genesee, and Macomb counties should continue. These five counties accounted for about 42% of total CMV crash costs. While additional resources have been allocated to five of these counties, it should be noted that Berrien, Ottawa, and Washtenaw should also be included for special consideration.

Encourage the use of advanced safety technologies: NHTSA is actively investigating a variety of technologies and considering rulemakings. Technology manufacturers continue to improve and aggressively market them, and an increasing number of truck buyers are ordering them because of their favorable cost/benefit profiles. Tax incentives would help increase the rate at which advanced safety technologies are spreading across the industry.

Share the Road: There is a continued need for a broad-based public understanding of the hazards associated with driving too close to large trucks. Public information and education (PI & E) campaigns and driver manuals and handbooks as well as CDL licensure can increase this understanding. The MCTS should continue to devote resources on the internet for *Share the Road* and supply brochures and information packets to driver training programs.

The Ticketing Aggressive Cars and Trucks (TACT) program of publicity and media blitz together with high visibility enforcement has been developed to change driver behavior near trucks. It was modeled after the "Click-it or Ticket" seat-belt campaigns that helped change safety-belt use in the US. TACT has been implemented in 16 states and will be implemented in Michigan during October, November, and December 2013.

The TACT program has been highly successful in the State of Washington. Washington was the site of the first TACT program about 10 years ago, and has since developed it into an ongoing program. Washington has run TACT operations on freeways and two lane roads, and other problem locations, and even has a permanent TACT unit within its state police agency. An ongoing TACT program modeled after the Washington program could be considered in Michigan.

Strengthen the CDL program, education, and outreach to truck drivers: While light vehicle drivers tended to contribute disproportionately to truck-light vehicle crashes, CMV drivers continued to commit the same hazardous actions in crashes. The driver continues to be the most important safety system on the vehicle.

FMCSA provides educational and outreach programs targeted for small motor carriers that cover the full range of safety practices that fleet owners can implement to reduce crashes. These programs stress the high costs of crash involvement and the benefits of crash prevention. This material is usually distributed to the motor carriers through the MSP, the MCTS, and other organizations.

The MCTS also provides free and low-cost training to truck drivers. Training includes Decision Driving courses (conducted on skid pad to teach drivers dynamic safety maneuvers such as pulling out of a jackknife), Defensive Driving, Fatigue Management, Inspection Training, Cargo Securement, and Safety Management Training. MTSC also provides assistance to carriers regarding maintenance issues. A safety management specialist will visit a company that is experiencing problems and review their files, recordkeeping, and safety practices.

MTCS also organizes an Annual Truck Exposition and Safety Forum, and makes presentations at trade shows and truck driving schools. The MCTS programs of outreach, education, and training for drivers should be continued and supported.

Improve crash data: There is a continuing need to improve the identification of trucks and buses in crashes in the Michigan crash data system. This includes improving the accuracy and completeness of recording VINs, possibly through the use of scanners or bar-code readers. It also includes improving the accuracy of recording driver license numbers, using the same technologies. These identifiers are important because they permit linking crash records to administrative files or information. As this analysis has shown, linking crash data to information from driver history files or decoded from VINs uncovers relationships that could not otherwise be identified.

Consideration should be given to a simpler but more useful approach to capturing vehicle type information on the UD-10. The vehicle type variable on the UD-10 combines trucks and buses into a single category. There is no other information that can be used to discriminate between the two vehicle types. Data from the CMV supplemental area of the UD-10 has the potential to distinguish trucks from buses, but the supplemental area is supposed to be filled out only for crashes meeting certain severity thresholds, not all crashes, and that variable has problems of its own. A simple change in the vehicle type variable on the main page of the UD-10 would improve the situation. A simpler approach that breaks out the different dimensions of information collected into separate variables would be easier for the reporting officer to complete accurately and also provide more detailed descriptive information. Adoption of the MMUCC guidelines is recommended.

4. Analysis of the impact of Public Act 231

Public Act 231 of 2012, which went into effect on June 29, 2012, exempted intrastate medium duty trucks (GWV 10,000 to 26,000 lb.) from compliance with certain regulations that govern medium duty interstate CMVs and all heavy duty CMVs (GVW over 26,000 lb.). As noted earlier, there have been no comparisons of the crash and safety records of CMVs classified by size and by interstate/intrastate that could be used to form estimates of the law's implications for CMV safety. The objective of this task is to estimate the probable effects of this change in regulation on CMV safety. It will do so through a comparative analysis of crash data, driver history records, and inspection data of medium and heavy duty intrastate and interstate CMVs and drivers.

4.1. Method and data

The Michigan crash data were supplemented by adding a GVWR classification of the trucks to the record for each vehicle. The GVWR class of each CMV was determined from VINs. The VINs were decoded by David Hetzel of NISR, Inc. Of the 73,000 CMVs in the Michigan crash data, VINs for 38,703 could be decoded and assigned to GVWR classes 3 through 8. Table 31 provides the weight range for each GVWR class. Public Act 231 exempted class 3 to 6 trucks from certain regulatory requirements. These trucks will be termed medium-duty trucks or medium trucks in this analysis. Trucks with a higher GVWR (class 7 and 8) are referred to as heavy trucks.

Table 31 GVWR Class and Weight Range

Truck type	GVWR class	GVWR range (lbs.)
Medium-duty	Class 3	10,001 to 14,000
	Class 4	14,001 to 16,000
	Class 5	16,001 to 19,500
	Class 6	19,501 to 26,000
Heavy-duty	Class 7	26,001 to 33,000
	Class 8	33,001 or more

There did not appear to be any systematic bias to the truck records that could be decoded and assigned as medium or heavy. Distributions of the decoded records were compared with the same distributions for all CMVs and found to be similar. CMVs with known and unknown VINs were compared for crash severity, time of day, light and weather condition, crash type, and day of week. In general, the distributions differed only by a few tenths of percent. It was therefore concluded that missing data on VIN does not bias the results in any material way.

Carriers operating the trucks were classified as interstate or intrastate using data in the Michigan crash file. This information was collected on the UD-10 as part of the supplemental data collected for the MCMIS crash file. This data element records whether the carrier had interstate operating authority, not whether the particular trip at the time of the crash was interstate or intrastate.(FMCSA 2006) Using the carrier type classification and the categorization of the trucks as medium or heavy, it was possible to identify in the Michigan crash data the medium-duty intrastate trucks specified in Public Act 231.

Table 32 shows the distribution of the decoded trucks by GVWR size and operating authority of the truck. Heavy/interstate trucks accounted for over 50% of the total number of trucks classified. The medium/intrastate trucks were those affected by Public Act 231, and accounted for about 12% of the total.

Medium/interstate and heavy/intrastate accounted for 8.1% and 28.7%, respectively. The sample sizes here were sufficient to provide statistically-reliable comparisons.

Table 32 Classification of Trucks by Size and Operating Authority

Size/authority	N	Percent
Medium intrastate	4,478	11.6
Medium interstate	3,149	8.1
Heavy intrastate	11,125	28.7
Heavy interstate	19,944	51.5
Total	38,696	100.0

The Act affects the regulation of medium/intrastate trucks in four ways: 1) they are not required to obtain or display a US DOT number; 2) they are exempt from hours-of-service regulations; 3) they are exempt from regulations related to knowledge of and compliance with the inspection or maintenance of commercial motor vehicles; and 4) they are exempt from the requirement to provide certain safety-related documents to enforcement personnel.

Exemption from HOS and the vehicle inspection and maintenance requirements regulations have the most direct relationship to traffic safety. The HOS regulations are intended to reduce fatigue in truck drivers and fatigue-related truck crashes. More broadly, the HOS regulations are intended to help drivers remain alert and attentive to the driving task, and thus reduce crashes overall.

Vehicle inspection and maintenance regulations are intended to ensure that trucks are mechanically sound, and to reduce crashes related to defective equipment. Recent studies have shown that violations of the FMCSRs related to vehicle condition were related to higher crash rates. In a study that included the relationship of safety and compliance with various FMCSRs, vehicle condition was one of the factors most strongly correlated with crash rates. (Green and Blower 2011) Another study showed that violations of the brake adjustment criteria were related to higher crash risk. (Blower and Green 2009)

The first part of the analysis presents descriptive statistics on crash types and crash circumstances. All of the data presented are in the form of percentages of crashes. Frequencies are not shown because only a subset of the vehicles, about 38,000 out of 73,000, had sufficient information to decode VINs and classify vehicles as either medium or heavy trucks. Reporting frequencies for this subset could be confusing. Moreover, it is not necessary because the critical point is to compare the crash experience of medium and heavy trucks, not raw frequencies.

Overall, the distribution of crash severity was roughly similar for the four groups of trucks. (Table 33) Heavy trucks operated by interstate carriers had a higher proportion of fatal involvements compared with the other categories, but within the category of medium-duty trucks, intrastate trucks were reasonably similar to interstate, although the latter had somewhat higher proportion of injury involvements and the former somewhat higher proportion of PDO involvements.

Table 33 Percent Distribution of Crash Severity by Truck Size/Authority Michigan 2006-2011

Crash severity	Medium intrastate	Medium interstate	Heavy intrastate	Heavy interstate
Fatal	1.0	0.9	1.1	1.6
Injury	19.0	22.1	17.7	20.4
PDO	80.0	77.0	81.3	78.0
Total	100.0	100.0	100.0	100.0

4.2. Crash type and environment

The analysis compared the crashes of medium/intrastate trucks to the other three truck classifications by weather, light, and road condition; time of day and crash type; driver condition and hazardous actions. Overall, the four groups had similar results across each of those dimensions. If anything, it was the heavy/interstate group that stands out in some respects. (Table 34.) Heavy/interstate truck crashes occurred more often in snowy weather; on icy or slushy roads; and in dark, lighted or unlighted conditions. Insofar as these distributions reflect how the trucks were operated, the medium/intrastate group was operated more like medium/interstate and heavy/intrastate than heavy/interstate. All medium-duty trucks were more likely to be used in local operations, whether inter- or intrastate, so their operations were more likely to occur during the day. They may also be more likely to reduce travel in adverse conditions.

Table 34 Percent Distribution of Crash Environment by Truck Size/Authority Michigan 2006-2011

Crash environment	Medium intrastate	Medium interstate	Heavy intrastate	Heavy interstate
Weather				
Clear	49.8	49.7	51.5	48.7
Cloudy	31.7	30.2	30.9	27.8
Rain	8.6	9.2	7.7	9.8
Snow/sleet	8.3	9.7	8.4	12.2
Other adverse	0.6	0.5	0.7	0.9
Road condition				
Dry	67.9	66.7	68.8	65.1
Wet	17.0	17.5	15.4	17.1
Icy/snow/slush	13.9	14.7	14.0	16.6
Other adverse	0.1	0.2	0.3	0.1
Light condition				
Daylight	82.8	81.8	84.2	71.7
Dark, not lighted	6.9	7.1	6.7	15.1
Dark, lighted	5.7	6.4	4.7	8.1
Dawn/dusk	3.8	4.1	3.8	4.5

Table 35 shows the distributions of crash-involvements by time of day. Again, the heavy/interstate group differed from the other three. This group had more involvements overnight and in the evening. Only 15% of the crashes of medium/intrastate trucks occurred between 6 pm and 6 am, compared with almost 25%

for heavy/interstate trucks. Only about 11.4% of heavy/intrastate crash involvements were in the evening or overnight.

Table 35 Percent Distribution of Crash Time by Truck Size/Authority Michigan 2006-2011

Time of day	Medium intrastate	Medium interstate	Heavy intrastate	Heavy interstate
Midnight-6 am	4.6	4.8	5.0	10.6
6 am to noon	41.1	37.7	44.9	38.2
Noon to 6 pm	45.5	46.6	43.7	37.6
6 pm to midnight	8.9	10.9	6.4	13.6
Total	100.0	100.0	100.0	100.0

There appeared to be no significant difference across the four truck classes by the month of crash. Seasonal factors affected the different truck classes in the same way. Percentages of crashes were low in March and April and higher in summer months. Similarly, there were no significant differences in the distributions by day of week. Only 9 to 10% of crashes occurred on the weekend, with about 18% on each weekday, Monday through Friday.

Operational differences were also reflected in the distribution of crash involvements by road type. Almost 57% the crash involvements of medium/intrastate trucks occurred on local, county, or city streets, compared with about 50% for medium/interstate and heavy/intrastate trucks, and only 29.8% for heavy/interstate. (Table 36) Heavy/interstate trucks are most commonly used for long-distance freight, while medium/intrastate and indeed the other two groups are likely more frequently used locally. Almost 36% of the crash involvements of the heavy/interstate group were on Interstate highways, compared with only 11.1% of medium/intrastate and about 16% for the other two groups.

Table 36 Percent Distribution of Road Type by Truck Size/Authority Michigan 2006-2011

Highway class	Medium intrastate	Medium interstate	Heavy intrastate	Heavy interstate	Total
Interstate route	11.1	15.5	15.8	35.9	25.6
U.S. route	7.9	8.3	10.5	13.1	11.4
Michigan route	21.2	20.8	22.2	18.0	19.8
Other business/connector	2.7	4.5	2.3	2.9	2.9
Other road, city street	56.8	50.7	48.8	29.8	40.1
Unknown/missing	0.3	0.2	0.3	0.2	0.3
Total	100.0	100.0	100.0	100.0	100.0

Table 37 shows the distribution of crash type for medium/intrastate trucks and the three comparison groups. The classification of crashes by type was explained in section 2.2 and will not be repeated here, except to say that the head-on crash type here includes both the head-on and head-on, left turn crash types. There were so few head-on, left turn crashes that it did not make sense to show them as a separate type.

Table 37 Percent Distribution of Crash Type by Truck Size/Authority Michigan 2006-2011

Crash type	Medium intrastate	Medium interstate	Heavy intrastate	Heavy interstate
Single vehicle	11.5	13.0	15.7	19.1
Head on	1.8	2.0	1.8	1.7
Sideswipe opposite	4.0	4.5	4.9	4.0
Sideswipe same	20.2	19.7	23.2	28.3
Angle	17.5	19.5	16.6	13.9
Turning related	4.2	4.1	3.1	2.5
Rear-end	30.3	27.6	22.5	20.2
Other/unknown	10.5	9.7	12.1	10.3
Total	100.0	100.0	100.0	100.0

A few points stand out. Medium/intrastate trucks had the lowest percentage of single-vehicle crashes and the highest percentage of rear-end crashes. Only 11.5% of medium/intrastate crash involvements were single-vehicle, compared to 19.1% of heavy/interstate involvements. This difference probably in part reflects operational differences. Heavy/interstate trucks had more over-the-road travel and travel at night; while medium/intrastate trucks operated more during the day in dense traffic on city and county roads. Single-vehicle crashes were more likely on long over the road trips, particularly at night. Collisions with other vehicles were more likely in higher traffic density situations. Over 30% of medium/intrastate truck crashes were rear-end collisions, compared with only 20.2% for heavy/interstate. The crash distribution for medium/intrastate trucks was very similar to medium/interstate trucks, which was likely because they were operated in similar ways.

Cargo body type reflects how trucks were used and implies certain things about their operations. More than half of both medium/- and heavy/interstate truck crash involvements had a van cargo body. (Table 38.) This reflects the fact that interstate carriers were substantially involved in transporting general freight. Intrastate trucks were different. Medium intrastate trucks had a substantial proportion of vans (44.6%), but almost 17% were flatbed/platform vehicles. This likely reflected the fact that many were in local service industries such as local landscapers or construction firms that do not operate across state lines. About 8.3% had dump cargo bodies and 9.2% were grain, wood chip, or gravel bodies, which were all used in local operations by farms, construction firms, and loggers. There was no identification of the industry for which the trucks were used, but the distribution of cargo body types strongly suggests local small businesses.

Table 38 Percent Distribution of Cargo Body Type by Truck Size/Authority Michigan 2006-2011

Cargo body	Medium intrastate	Medium interstate	Heavy intrastate	Heavy interstate
Van (enclosed box)	44.6	50.3	20.8	51.9
Cargo tank	1.3	1.4	7.5	5.7
Flatbed/platform	16.8	11.7	11.9	11.1
Dump	8.3	2.6	25.5	6.4
Concrete mixer	0.1	0.0	2.2	0.4
Auto transporter	1.4	1.9	0.5	1.5
Garbage/refuse	0.6	0.3	8.4	2.2
Grain, chips, gravel	9.2	14.2	10.3	9.2
Other/unknown	17.8	17.5	12.8	11.7
Total	100.0	100.0	100.0	100.0

4.3. Driver condition and hazardous actions

Driver condition at the time of the crash gets to the heart of one of the requirements from which medium/intrastate carriers are exempt: the HOS rules. Acknowledging that fatigue and asleep were probably underreported in the crash data, these conditions were reported the least frequently for medium/intrastate carriers. (Table 39.) Only 0.06% of medium/intrastate drivers were coded as fatigued or asleep. The percentage was low for each of the four types of truck operations, but the lowest for medium/intrastate. The fatigue/asleep proportion was over twice as high for heavy/intrastate and seven to eight times higher for the two interstate carrier types. Table 35 showed that the interstate carriers, particularly heavy/interstate had higher proportions of crashes in evening and during the night. Although fatigue/asleep crashes were probably not well-identified, they appear to be substantially less of an issue for medium/intrastate carriers than for the other types, particularly heavy/interstate.

It can also be observed that the incidence of illegal drug use was low for medium/intrastate drivers; alcohol use was low (0.3%) but higher than heavy/interstate truck drivers (0.2%).

Table 39 Percent Distribution of Driver Condition by Truck Size/Authority Michigan 2006-2011

Driver condition	Medium intrastate	Medium interstate	Heavy intrastate	Heavy interstate
Appeared normal	90.20	87.81	92.91	93.49
Had been drinking	0.29	0.16	0.17	0.28
Illegal drug use	0.07	0.06	0.11	0.10
Sick	0.13	0.13	0.08	0.15
Fatigue	0.02	0.25	0.06	0.29
Asleep	0.04	0.32	0.09	0.21
Medication	0.02	0.00	0.04	0.04
Driver distracted	0.63	0.64	0.31	0.42
Driver using cell phone	0.20	0.10	0.05	0.05
Unknown	2.93	2.99	2.62	2.26

In crashes, about 50% of medium/intrastate drivers were coded with a hazardous action, compared with 44.2% of heavy/interstate drivers, 46.1% of medium/interstate, and 49.4% of heavy/intrastate drivers. The medium/- and heavy/intrastate groups were somewhat more likely to commit hazardous actions that contributed to crashes than interstate drivers. Table 40 shows the distribution of the types of hazardous actions each group commited. (Cases with no hazardous actions were excluded from calculating the percentages.) Following too close (unable to stop), failure to yield, and improper backing were the most common actions identified for medium/intrastate drivers. These were all consistent with operations in higher traffic density on local roads. In contrast, the top hazardous actions for the heavy/interstate group were speeding (12.2%), improper lane use (11.1%), improper turn (9.4%) and careless/negligent (6.8%).

Table 40 Percent Distribution of Driver Hazardous Action by Truck Size/Authority Michigan 2006-2011

Hazardous action	Medium intrastate	Medium interstate	Heavy intrastate	Heavy interstate	Total
Speed too fast	4.0	6.7	6.5	12.2	9.0
Speed too slow	0.2	0.2	0.1	0.2	0.2
Failed to yield	14.4	16.6	11.8	11.1	12.1
Disregard traffic control	2.7	4.7	2.2	2.7	2.7
Drove wrong way	0.0	0.3	0.2	0.2	0.2
Drove left of center	0.7	1.5	1.1	1.0	1.0
Improper passing	1.7	1.0	1.0	1.1	1.1
Improper lane use	8.3	6.9	8.4	11.1	9.6
Improper turn	3.2	5.0	6.3	9.4	7.4
Improper/no signal	0.7	0.4	0.4	0.6	0.5
Improper backing	13.3	12.0	12.2	8.0	10.3
Unable to stop	29.2	21.9	22.4	17.4	20.7
Reckless driving	0.3	0.1	0.2	0.2	0.2
Careless/negligent	4.9	5.0	4.7	6.8	5.8
Other	16.4	17.7	22.6	18.0	19.2

4.4. Driver record

The Michigan Driver History files were used to extract information about the overall driving record of the four groups. Matching crash data to the Driver History files had the effect of restricting the analysis just to drivers with Michigan driver licenses. Some cases also dropped out because of missing or invalid driver license numbers.

The files contain records of all licensed drivers in the state of Michigan. The database itself is an active administrative database, with new records added continuously and old records deleted periodically. Records for most drivers contain information going back seven years. However, convictions for serious offenses are kept in the file indefinitely. The violations analyzed here were limited to those that occurred in the five years prior to a driver's earliest crash in the crash data. In addition, the analysis here focuses on violations charged, not the ultimate convictions. Charges can be pled down to lesser offenses. The original charge reflects the police officers' original judgment of the nature of the offense.

Table 41 shows counts and percentages of drivers with various charge types. The charges recorded may be in any vehicle type, light vehicles or CMVs. All the drivers represented in the table had been involved in a crash as a CMV driver; thus, they were not a random sample of CMV drivers.

Similar percentages of each group had no charges in the five years prior to their earliest crash in the crash data. About 44.1% of medium/intrastate drivers had no charges, compared with 44.3% of medium/interstate drivers, 49.6% of heavy/intrastate and 46.0% of heavy/interstate. However, there were some differences in terms of the types of charges in their driving histories. Medium-duty drivers tended to have higher rates of prior alcohol-related charges. About 6.2% of medium/intrastate and 5.8% of medium/interstate drivers had an alcohol charge on their records. Only 3.7% of heavy/interstate drivers had an alcohol charge. The medium-duty group also was more likely to be charged with violations related to vehicle licensing. The most frequent charges, however, were speeding and other moving violations. Over 37% of medium/intrastate drivers had a prior speeding charge, and 29.5% had prior other moving violations. However, both medium-duty groups were similar to each other and in fact had somewhat lower percentages of speeding and other moving violations than heavy/interstate truck drivers. One would expect heavy/interstate drivers to have higher rates for speeding and moving violations because they likely drive many more miles. Overall though, the medium/intrastate group did not stand out as significantly different from the other groups.

Table 41 Counts of Drivers by Charge & Truck Size/Authority
Charges within Five Years Prior to Crash

Prior charge	Medium intrastate	Medium interstate	Heavy intrastate	Heavy interstate	Total
No charges	1,470	906	3,798	3,966	10,140
Alcohol	208	118	360	317	1,003
Speed	1,239	767	2,672	3,586	8,264
Other moving	983	670	1,758	2,757	6,168
Licensing	236	167	260	357	1,020
Felony/misdemeanor	65	31	55	58	209
Other	336	227	593	885	2,041
Total drivers	3,331	2,045	7,660	8,615	21,651
			Column percentages		
No charges	44.1	44.3	49.6	46.0	46.8
Alcohol	6.2	5.8	4.7	3.7	4.6
Speed	37.2	37.5	34.9	41.6	38.2
Other moving	29.5	32.8	23.0	32.0	28.5
Licensing	7.1	8.2	3.4	4.1	4.7
Felony/misdemeanor	2.0	1.5	0.7	0.7	1.0
Other	10.1	11.1	7.7	10.3	9.4
Total	100.0	100.0	100.0	100.0	100.0

Considering just prior charges while operating CMVs, medium/intrastate drivers had zero alcohol charges (0.1% for heavy/interstate drivers); lower rates of prior speeding (7.7% to 14.1%); and lower rates of prior other moving violations (7.2% to 9.3%). (Table 42.) Overall, prior records in a CMV for both categories of medium truck drivers were very similar. Around 83% of medium-duty truck drivers had no prior charge in a CMV, compared with 76.2% of heavy/intrastate and 62.7% of heavy/interstate drivers. Again, heavy/interstate drivers probably accumulate many more miles driving a truck than medium/intrastate drivers, just because of operational differences. (A large number of cases with unknown vehicle types could not be assigned as either a truck or a light vehicle. These cases were omitted from the tables.)

Table 42 Percentage of Crash-Involved CMV Drivers by Truck Size/Authority Charges While Driving a Truck within 5 Years Prior

Charge type	Medium intrastate	Medium interstate	Heavy intrastate	Heavy interstate
No charges	83.4	82.5	76.2	62.7
Alcohol	0.0	0.1	0.1	0.2
Speed	7.7	8.9	14.1	23.9
Other moving	7.2	7.1	9.3	17.2
Licensing	1.4	1.5	1.2	1.4
Felony/misdemeanor	0.0	0.0	0.0	0.0
Other	1.6	1.6	0.3	3.9
Any charge in a truck	16.6	17.5	23.8	37.3
Total drivers	100.0	100.0	100.0	100.0

The situation was nearly reversed when prior charges incurred while driving a light vehicle were considered. (Table 43.) Only about 50% of medium-duty truck drivers had no charges in the five years prior to their CMV crashes, while 61.6% of heavy/intrastate drivers and 58.4% of heavy/interstate drivers had no prior charges in a light vehicle. Interstate drivers may simply drive less when off-duty because they drive so much while on duty. In contrast, intrastate drivers, when in light vehicles, had higher rates of prior alcohol, speeding, and other moving violations.

Table 43 Percentage of Crash-Involved CMV Drivers by Truck Size/Authority Charges While Driving a Light Vehicle within 5 Years Prior

Charge type	Medium intrastate	Medium interstate	Heavy intrastate	Heavy interstate
No charges	49.7	48.3	61.6	58.4
Alcohol	4.8	4.5	3.5	2.9
Speed	31.7	32.2	24.6	26.8
Other moving	24.2	26.8	15.0	17.8
Licensing	5.6	6.7	2.3	2.8
Felony/misdemeanor	0.7	0.3	0.2	0.2
Other	8.2	9.5	4.9	6.7
Any charge in a truck	50.3	51.7	38.4	41.6
Total drivers	100.0	100.0	100.0	100.0

Prior serious charges were also examined for the four sets of truck drivers. A serious charge was defined as a charge that resulted in 3 or more points on the license. Table 44 shows the percentage of drivers with prior serious charges while in a CMV, in a light vehicle, and in any vehicle, for each group of truck drivers. When driving trucks, the medium-duty drivers had significantly lower rates of prior serious charges: Only 2.7% of intrastate and 2.9% interstate medium-duty drivers had prior serious charges in a truck. These results compare with 4.7% for heavy/intrastate drivers and 9.0% for heavy/interstate drivers. Whether it was exposure or some other reason, medium-duty drivers tended not to be charged with serious violations while driving a truck. The situation was different when driving light vehicles. In light vehicles, medium-duty drivers tended to have rates of serious charges that were 1.4 times higher than heavy truck drivers. About 16.9% of medium/intrastate drivers had prior serious charges in light vehicles, compared with 11.7% of heavy/intrastate drivers and 12.6% of heavy/interstate truck drivers.

Table 44 Percentage of Crash-Involved CMV Drivers by Truck Size/Authority With Serious (>= 3 points) Charges within 5 Years Prior to Crash

Vehicle type when charged	Medium intrastate	Medium interstate	Heavy intrastate	Heavy interstate
In truck	2.7	2.9	4.7	9.0
In non-truck	16.9	18.5	11.7	12.6
In any vehicle	20.4	21.8	16.8	21.1

4.5. Vehicle and driver inspection results

This section uses vehicle and driver inspection records to examine the possible effect of exempting medium/intrastate carriers from vehicle inspection and maintenance requirements. Vehicle defects were not well-measured in crash data because trucks generally were not subjected to a comprehensive inspection to identify mechanical problems after crashes. However, inspection records provide a comprehensive view of compliance with vehicle and driver regulations.

It was likely that only the most obvious problems were identified and coded on crash reports. Overall, across all trucks, mechanical problems were only identified in 1.7% of involvements in the Michigan crash data. Results from crash data seemed to show that medium/intrastate trucks were similar to the other categories. Vehicle defects were recorded for 1.7% of medium/intrastate, 1.4% of medium/interstate, 2.2% of heavy/intrastate, and 1.7% of heavy/interstate trucks. The slightly higher rate for heavy/intrastate was probably accounted for by operational factors. Many were dump trucks or other working trucks that were in severe service. Medium/intrastate trucks, though, appeared not to be much different from other truck categories, at least as reflected in the crash data.

Inspection records in Michigan were obtained for CMVs for the four classifications of truck size and operating authority. The inspection records were not necessarily linked to the specific trucks found in the Michigan crash data. Instead, they recorded inspections of CMVs operated by the carriers that operated the crash-involved trucks. The CMVs were classified in the Michigan crash data as medium or heavy duty and by whether they were operated by an inter- or intrastate carrier. The crashes were joined to the MCMIS crash file in order to determine the US DOT number of the CMV's carrier. All inspections for those carriers were extracted from the MCMIS inspection files and analyzed. It was not possible to determine from the inspection records whether the inspected trucks were themselves medium or heavy duty. They were classified by the carrier type of crash-involved CMVs.

A total of 30,550 inspection records were obtained and classified as medium/intrastate, medium/interstate, heavy/intrastate, and heavy/interstate. Only Level 1 inspections were used in the analysis, so the inspections provided comprehensive review of vehicle and driver compliance with applicable standards. The overwhelming majority of inspections extracted were for CMVs operated by heavy/interstate carriers, amounting to 83.1% of all inspections analyzed. There were only 790 inspections for medium/intrastate carriers. This small number was not unexpected. Heavy/interstate carriers operate most big trucks and most inspections take place on or near major highways, which were primarily used by the big carriers. In contrast, medium/intrastate trucks probably travel mostly on local roads and city streets, away from truck inspection locations.

Table 45 shows the overall inspection results for drivers and vehicles. Drivers for medium/intrastate carriers had violations at a higher rate than any of the other three truck groups. Almost 43% of medium/intrastate drivers had at least one violation, while the percentages for the other three ranged between 35.2% and 36.9%. On the other hand, the percentage of medium/intrastate drivers with OOS conditions was similar to heavy/inter- and intrastate carriers, and lower than medium/interstate carriers. In terms of vehicles, the percentage of medium/intrastate inspections with violations was well within the range of the other carrier types at 75.9%. The percentage of medium/intrastate vehicles with OOS conditions was also within the range of the other carrier types, if not on the low end of the range. Thus, while medium/intrastate carriers may have higher rates of driver violations, they do not stand out when it comes to driver OOS conditions and they fall within the range of other carriers in terms of vehicle violations and OOS.

Table 45 Percentage of Inspections with Vehicle/Driver Violation or OOS CMVs Operated by Crash-Involved Carriers Classified by Truck Size/Authority

Violation or OOS	Medium intrastate	Medium interstate	Heavy intrastate	Heavy interstate	Total
Driver violation	42.7	36.1	36.9	35.2	35.6
Driver OOS	3.9	5.4	3.7	3.6	3.7
Vehicle violation	75.9	64.7	87.3	72.6	73.6
Vehicle OOS	24.4	16.9	46.8	29.0	29.9

Table 46 breaks out specific vehicle and driver violation types. In Level 1 inspections, only 2.3% of medium/intrastate drivers had HOS or log violations, compared with 9.5% of heavy/interstate drivers and 6.6% of medium/interstate trucks. It seems likely that this reflects differences in operations, consistent throughout this analysis. Medium/intrastate trucks likely operate primarily locally, during the usual daytime work hours. If this is true, they were unlikely to come up against the limits of the HOS regulations or even need to keep formal logbooks. Compliance with the HOS regulations was apparently not a significant issue for most medium/intrastate truck drivers. The top driver violation listed was “other driver violation,” which does not specify the nature of the violation. Violation of the medical certification regulation was the most common specific driver violation for the medium-intrastate carriers.

Vehicle condition was a different matter. Medium/intrastate trucks had significantly lower rates of brake violations (14.8%) than heavy/interstate (41.8%), though this could reflect the higher incidence of hydraulic brakes on medium-duty trucks, which typically do not need much adjustment and function more like brakes on light vehicles. In other systems, however, trucks operated by medium/intrastate carriers had rates of violations similar to and sometimes higher than other carrier types. Lighting violations were recorded in 43.5% of medium/intrastate inspections compared with 38.3% of heavy/interstate and 35.7% of medium/interstate. Only heavy/intrastate had a higher incidence (50.1%) of lighting system violations, and these trucks are often in very severe service. Fifty-seven percent of the inspections of medium/intrastate trucks had one or more other vehicle violations, compared with only 37.3% of heavy/interstate and 41.9% of medium/interstate. Again, heavy/intrastate had the highest rates of other vehicle violations.

Table 46 Violation Types, CMVs Operated by Crash-Involved Carriers Classified by Truck Size/Authority

Violation type	Medium intrastate	Medium interstate	Heavy intrastate	Heavy interstate	Total
Lighting	344	558	1,405	9,728	12,035
Brakes	117	210	1,575	10,608	12,510
Other vehicle	450	656	1,742	9,483	12,331
HOS/logs	18	104	95	2,415	2,632
Moving violation	63	117	160	1,340	1,680
Other driver	362	547	1,301	9,085	11,295
Hazmat	7	17	49	388	461
Total	790	1,564	2,802	25,394	30,550
			Column percentages		
Lighting	43.5	35.7	50.1	38.3	39.4
Brakes	14.8	13.4	56.2	41.8	40.9
Other vehicle	57.0	41.9	62.2	37.3	40.4
HOS/logs	2.3	6.6	3.4	9.5	8.6
Moving violation	8.0	7.5	5.7	5.3	5.5
Other driver	45.8	35.0	46.4	35.8	37.0
Hazmat	0.9	1.1	1.7	1.5	1.5
Any violation	84.4	75.6	91.8	82.9	83.4

4.6. Summary and conclusions

Several different data sources were analyzed to characterize the operations and safety of medium/intrastate carriers. In the crash data, medium/intrastate trucks did not differ significantly from medium/interstate and heavy/intrastate trucks. Most of their crashes occurred during the day, in good road and weather conditions. Their crashes were primarily on county roads and local streets, consistent with local operations. In terms of crash types, medium/intrastate trucks had proportionally fewer single vehicle, and more rear-end crashes than the other truck groups, consistent with operations during the day in dense traffic. Medium/intrastate drivers were coded with hazardous actions at a somewhat higher rate than other truck/carrier types. The most common hazardous actions for medium/intrastate carriers were following too close (unable to stop), failure to yield right-of-way, and improper backing. Their rate of speeding was significantly less than other truck types, particularly heavy/interstate drivers.

In terms of prior driving record, medium/intrastate drivers had higher rates of prior alcohol charges and higher rates of licensing violations than other drivers. However, their rates of prior speeding charges were about the same, as were their rates of other moving violations. Overall, their driving records were reasonably similar to the drivers of other carrier types, with the exception of alcohol charges. However, considering their prior driver record while driving a CMV, there were no cases of a prior alcohol charge (though the rates in CMVs for other carriers were either 0.1% or 0.2%), and the proportion with prior speeding or other moving violations in CMVs were significantly lower than heavy-truck drivers.

Overall, it appears that medium/intrastate trucks, because they tended to be operated during the daytime in the workweek and because they were used in businesses where the primary activity was not driving, had substantially less tendency to be in violation of HOS regulations. In terms of vehicle condition, truck inspections showed comparable overall rates of vehicle violations and OOS conditions, with the exception of brakes where their violation rates were significantly lower. This may be due, however, to the fact that many medium duty trucks were equipped with hydraulic brakes, which are less susceptible to adjustment problems.

Accordingly, it appears that, possibly because of the nature of their operations, compliance with the HOS regulations was not a significant safety issue for medium/intrastate carriers in general. Inspections showed very low rates of HOS or driver log violations, significantly lower than other truck operators. The crash analysis also showed that fatigue/asleep was only very rarely coded for drivers of medium-duty/intrastate trucks. Fatigue was seldom identified in police reported crashes, but it was significantly less likely to be identified for medium/intrastate drivers than for other truck sizes and operation types. Thus, there was no evidence that exempting these operations from HOS regulations would have a significant safety effect for most medium/intrastate carriers.

However, the situation was different with respect to the vehicle condition. Medium-duty trucks in general had low rates of brake violations, probably because most use hydraulic brakes. However, their rates of violations in other systems were the same as if not higher than those of other carrier classes. Medium/intrastate inspections showed higher rates of light system violations and higher rates of other vehicle violations than either medium/interstate trucks or heavy/interstate trucks. Brakes are a primary safety system on trucks, but there was evidence that vehicle condition as such was correlated with safety. Exempting medium/intrastate trucks from compliance with inspection and maintenance regulations may have a negative impact on the safety of medium/intrastate carriers.

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