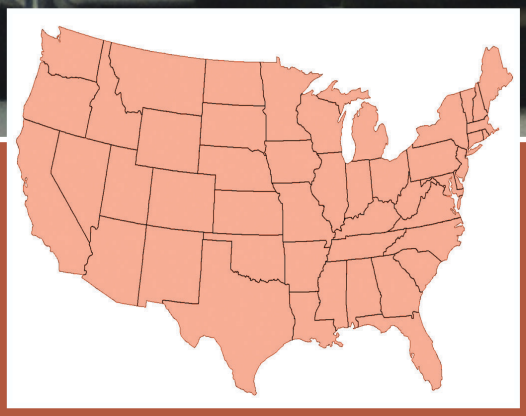
Evaluating the Impact of Commercial Motor Vehicle Enforcement Disparities on Carrier Safety Performance

July 2014



Prepared by the American Transportation Research Institute

ATRI American Transportation Research Institute

Evaluating the Impact of Commercial Motor Vehicle Enforcement Disparities on Carrier Safety Performance

July 2014

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LIST OF ACRONYMS

A&I	Analysis and Information
APU	Average Power Units
ARIES	Automated Reporting Information Exchange System
ATA	American Trucking Associations
ATRI	American Transportation Research Institute
BASIC	Behavioral Analysis and Safety Improvement Category
CDL	Commercial Driver's License
CDLIS	Commercial Driver License Information System
CMV	Commercial Motor Vehicle
CP	Crash Predictor
CSA	Compliance, Safety, Accountability
CVSA	Commercial Vehicle Safety Alliance
CVSP	Commercial Vehicle Safety Plan
D.C.	District of Columbia
FHWA	Federal Highway Administration
FMCSA	Federal Motor Carrier Safety Administration
FMCSR	Federal Motor Carrier Safety Regulation
FOIA	Freedom of Information Act
GPS	Global Positioning System
HazMat	Hazardous Materials
HOS	Hours-of-Service
IFTA	International Fuel Tax Agreement
ISS	Inspection Selection System
IUPPI	Indiana University Public Policy Institute
lbs	Pounds
MCMIS	Motor Carrier Management Information System
MCSAP	Motor Carrier Safety Assistance Program
MPH	Miles-per-Hour
MVMT	Million Vehicle Miles Traveled
NASI	North American Standard Inspection
NHTSA	National Highway Traffic Safety Administration
OHPI	Office of Highway Policy Information
OOS	Out-of-Service
PDO	Property Damage Only
PU	Power Unit
RAC	Research Advisory Committee
RF	Red Flag
RI	Roadside Inspection
SafeStat	Safety Status Measurement System
SMS	Safety Measurement System
STA	State Trucking Association
TACT	Ticketing Aggressive Cars and Trucks
TE	Traffic Enforcement
UF	Utilization Factor
U.S.	United States
VMT	Vehicle Miles Traveled

EXECUTIVE SUMMARY

The Federal Motor Carrier Safety Administration's (FMCSA) Compliance, Safety, Accountability (CSA) program is a national initiative to improve commercial motor vehicle safety by evaluating motor carriers using a uniform suite of safety metrics. A key component of this initiative is the Safety Measurement System (SMS) which analyzes data on motor carrier inspections, violations and operations in an attempt to calculate a score for each carrier in seven Behavior Analysis and Safety Improvement Categories (BASICs). The BASIC scores, five of which are visible to the public, are used to assess the safety performance of carriers relative to their peers and are often used by shippers and receivers to identify motor carriers they perceive to be more or less safe at some preconceived threshold.

Despite the uniformity of the SMS in its calculation of BASIC scores, the intensity and focus of enforcement activities is largely at the discretion of each state. This has resulted in 50 or more different enforcement programs and strategies that are used to populate a uniform score (within each BASIC) of nationwide performance. The American Transportation Research Institute (ATRI) investigated the impact of differing enforcement priorities on the trucking industry through four specific tasks.

Task 1: State Data Metrics Evaluation

Echoing the findings of previous research efforts, ATRI's analysis of state metrics has revealed that obvious enforcement disparities exist across a myriad of enforcement variables, and in some cases, the differences between states are extreme.

Task 2: Relationship Between Violations and Crash Risk

Moreover, ATRI's analysis revealed that certain violations suggested to have a stronger relationship to safety events may not be the best predictors of crash risk and that CMV enforcement strategies may need to shift focus to address other violations that may have stronger relationships to crash risk.

Task 3: Understanding State Enforcement Objectives: Case Study Approach

To further understand why these disparities exist, ATRI closely analyzed the state enforcement plans of several states to identify the impact of each state's enforcement priorities on actual enforcement and safety data. In many cases, ATRI found that state enforcement plans appeared to influence the top violations issued by state enforcement officers. Given that each state develops its own safety priorities, this resulted in a large variation in violation rates across states. Simply by crossing state lines, motor carriers are, in effect, subject to different enforcement emphases.

Task 4: Carrier Case Studies

ATRI's Research Advisory Committee (RAC) hypothesized that these differences in state enforcement priorities are leading to inequities in motor carrier BASIC scores. To ascertain the true impact of differing safety priorities on the single national CSA program, ATRI staff collected empirical safety and operational data from seven motor carriers and the SMS to analyze the impact of enforcement disparities on BASIC scores. Ostensibly, any one particular carrier's safety culture and behavior would not measurably vary from state to state, yet the review of

motor carrier safety data revealed that a carrier's violation rates often varied significantly across states. For example, one carrier had slightly less than 7 percent of its annual vehicle miles traveled (VMT) in a particular state, yet over 32 percent of that carrier's Unsafe Driving violation points were issued by that same state. If state enforcement disparities were minimal or violations were representative with VMT exposure, a carrier's share of VMT would more closely mirror its violation rates in any one state.

ATRI developed a model that assessed the impact of eliminating state enforcement disparities on SMS scores and found that scores would, in many cases, change markedly. Across the seven carriers and four public BASICs that ATRI analyzed, scores decreased by as much as 17.7 points and increased by as much as 12.2 points from the actual scores reported by the SMS. The impact of these disparities is highly dependent on the operational patterns and characteristics of each carrier. Carriers with a strong presence in states with violation rates significantly above or below the national average tended to see the largest impact in scores. Furthermore, the impact on SMS scores is greater on carriers that have their miles concentrated in fewer states. While safety culture within a particular carrier should not vary simply by crossing state lines, this analysis nevertheless has shown that enforcement disparities among states can lead to both inflated and deflated safety measures, obscuring the true safety record of carriers relative to their peers.

BACKGROUND

In 2010, the Federal Motor Carrier Safety Administration (FMCSA) replaced its previous safety program, Safety Status Measurement System (SafeStat), with Compliance, Safety, Accountability (CSA) which was intended to be a more targeted and robust system for monitoring high-risk carriers. While many in the industry have found CSA to be an improvement over SafeStat, there has been a significant amount of concern over CSA's accuracy in predicting crash risk, among other issues.[1] CSA has ranked at or near the top on the American Transportation Research Institute's (ATRI) annual survey of critical issues in the trucking industry since first appearing on the industry's radar in 2010, ranking as high as first place in 2012.[2]

In 2013, ATRI's Research Advisory Committee (RAC)[3] discussed the impact of state enforcement practices on CSA's ability to accurately measure the safety performance of carriers. The culmination of that discussion was a strong, formal recommendation that ATRI study state enforcement activities and analyze how varying priorities among states affect carrier operations, and determine the extent to which enforcement disparities may affect carrier BASIC scores.

Under CSA both carriers and drivers receive safety scores across seven Behavioral Analysis and Safety Improvement Categories (BASICs), as shown in Table 1.[4,5] Currently, only five of the seven BASICs are publicly available, as indicated in Table 1. Appendix A provides a detailed discussion on the calculation of carrier BASIC scores.

[1] Lueck, M.D. (2012). Compliance, Safety, Accountability: Analyzing the Relationship of Scores to Crash Risk. Arlington, VA: American Transportation Research Institute.
[2] Critical Issues in the Trucking Industry—2013. Arlington, VA: American Transportation Research Institute.
[3] ATRI's RAC is comprised of industry stakeholders representing motor carriers, trucking industry suppliers, labor and driver groups, law enforcement, federal government and academia. The RAC is charged with annually recommending a research agenda for the Institute.
[4] Carrier Safety Measurement System (CSMS) Methodology Version 3.0.1. (2013). Federal Motor Carrier Safety Administration. Available Online: http://csa.fmcsa.dot.gov/Documents/SMSMethodology.pdf
[5] Safety Measurement System. (n.d.). Federal Motor Carrier Safety Administration. Available Online: https://csa.fmcsa.dot.gov/about/basics.aspx

Table 1. CSA BASICs and Descriptions

BASIC	Description
Unsafe Driving BASIC	Operation of commercial motor vehicles (CMVs) in a dangerous or careless manner. Example violations: speeding, reckless driving, improper lane change, and inattention (FMCSR Parts 392 and 397).
Hours-of-Service Compliance BASIC	Operation of CMVs by drivers who are ill, fatigued, or in non-compliance with the Hours-of-Service (HOS) regulations. This BASIC includes violations of regulations pertaining to records of duty status (RODS) as they relate to HOS requirements and the management of CMV driver fatigue. Example violations: exceeding HOS, maintaining an incomplete or inaccurate logbook, and operating a CMV while ill or fatigued (FMCSR Parts 392 and 395).
Driver Fitness BASIC	Operation of CMVs by drivers who are unfit to operate a CMV due to lack of training, experience, or medical qualifications. Example violations: failing to have a valid and appropriate commercial driver's license and being medically unqualified to operate a CMV (FMCSR Parts 383 and 391).
Controlled Substances/Alcohol BASIC	Operation of CMVs by drivers who are impaired due to alcohol, illegal drugs, and misuse of prescription or over-the-counter medications. Example violations: use or possession of controlled substances or alcohol (FMCSR Parts 382 and 392).
Vehicle Maintenance BASIC	Failure to properly maintain a CMV and/or to properly prevent shifting loads. Example violations: brakes, lights, and other mechanical defects, and failure to make required repairs, and improper load securement (FMCSR Parts 392, 393 and 396).
Hazardous Materials Compliance BASIC*	Unsafe handling of hazardous materials on a CMV. Release of hazardous materials from package, no shipping papers (carrier), and no placards/markings when required (FMCSR Part 397 and Hazardous Materials Regulations Parts 171, 172, 173, 177, 178, 179, and 180).
Crash Indicator BASIC*	The Safety Measurement System (SMS) evaluates a carrier's crash history. Crash history is not specifically a behavior. Rather, it is a consequence of a behavior and may indicate a problem with the carrier that warrants intervention. It is based on information from State-reported crash reports and identifies histories or patterns of high crash involvement, including frequency and severity.

*Carrier scores not publicly available as of the time of this publication.

In response to critiques from industry and enforcement personnel, FMCSA has made a number of changes to CSA since its debut in 2010. Some of the changes included adjusting violation severity weightings, reorganizing two of the BASICs, and clarifying certain data inputs.[6] While FMCSA has worked to improve CSA's effectiveness in some areas, issues of enforcement uniformity remain.

[6] What's New: CSA News and Information. (2012). Federal Motor Carrier Safety Administration. Available Online: http://csa.fmcsa.dot.gov/Whats_new.aspx#ARCHIVE

PREVIOUS ENFORCEMENT DISPARITIES RESEARCH

While FMCSA sets guidelines on the adoption and enforcement of Federal Motor Carrier Safety Regulations (FMCSRs), each state enforcement agency has the discretion to emphasize specific enforcement foci and activities in order to accomplish FMCSA's overall safety goals, with this privilege extending even further to local jurisdictions.[7] For example, FMCSA acknowledges that different enforcement jurisdictions may utilize differing methods to select or screen a commercial motor vehicle (CMV) for inspection.[8] Likewise, it is the decision of the enforcement officer to issue a citation, violation, or both during a roadside inspection (RI).[9] Finally, states have the discretion to vary their enforcement foci, for instance taking a close look at driver issues as opposed to vehicle defects, or focusing more attention on certain failures (e.g., brakes) versus behaviors (e.g., speeding).

This flexibility in enforcement activities across the states has become a significant concern within the trucking industry, as research demonstrates that certain states issue citations, or otherwise note certain violations, more often than other states do for the same violations.[10,11,12] Furthermore, differences in state enforcement activities are further enhanced by constraints such as state budget limitations, available staff resources and enforcement program goals.[13] However, such disparities create problems in drawing accurate measures of comparative fleet safety performance, particularly since the plethora of CMV research supports the notion that CMV safety metrics differ considerably by state.

Enforcement Personnel Knowledge, Practices and Training Needs

Previous studies, including several published by ATRI, have identified enforcement issues that have significant implications for trucking industry safety and the effectiveness of FMCSA's CSA initiative. Of particular concern was a 2012 study that found that only 10.4 percent of roadside inspectors "almost always" completed a RI report when no violations were issued, while 6.8 percent "never" completed a RI report.[14] This was a troublesome finding since reporting clean inspections is critical to accurately documenting the safety history of a motor carrier. Enforcement personnel acknowledged the need for more training, with 73.5 percent of respondents in the study noting a need for increased training on properly documenting violations and understanding the impact of enforcement actions on carriers' CSA safety performance measurements.[15] As further evidence of the need for additional enforcement

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[7] About FMCSA.(n.d.). Federal Motor Carrier Safety Administration. Available Online: http://www.fmcsa.dot.gov/about/aboutus.htm
[8] Compliance, Safety and Accountability: Frequently Asked Questions. (n.d.). Federal Motor Carrier Safety Administration. Available Online: http://csa.fmcsa.dot.gov/FAQs.aspx
[9] Ibid.
[10] Brachman, J.M. (2013). Commercial Motor Vehicle Enforcement: Identifying Appropriate Levels. Upper Great Plains Transportation Institute, North Dakota State University. Available Online: http://www.ugpti.org/pubs/pdf/SP178.pdf
[11] CarrierWatch CSA Industry Report (2011).TransCore Freight Solutions. [White Paper]. Available Online: http://www.dat.com/Resources/~/media/8F7BC3C765DF4258B303A9A8B1194364.ashx
[12] Abbott, R. & P. S., Garney (2013). The Use of CSA Data to Judge the Safety Performance of Motor Carriers. [White Paper]. Arlington, VA: American Trucking Associations.
[13] Garry, P.M., Spurlin, C., & DeWaelsche. (2006). The Challenges to Harmonization of Inter-Jurisdictional Trade Laws: A Study of Transportation Regulation Disparities Within the Northern Great Plains Region. *South Dakota Law Review, 51,* 256-295. Available Online: http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1133129
[14] Lueck, M.D., & Brewster, R.M. (2012). Compliance, Safety, Accountability: Evaluating a New Safety Measurement System and Its Implications. Arlington, VA: American Transportation Research Institute.
[15] Ibid.

personnel training on CSA, a 2013 update of the same study found that, on average, enforcement personnel correctly answered 9.32 items on a 14-question CSA knowledge test (66.5% accuracy).[16] In comparison, the 2012 original study found that carriers correctly answered 10.21 items on the CSA knowledge test (72.9% accuracy). These findings further support that, to some degree, variability exists in the training and enforcement of FMCSRs among enforcement personnel across the United States (U.S.). Furthermore, variation exists in the corresponding impacts on the accuracy and reliability of carriers' scores and on CSA's ability to accurately identify the least safe carriers.

Disparate CMV Enforcement by State

Enforcement agencies contend such disparities are necessary and appropriate so that states can focus on areas and activities in their jurisdiction needing additional focus or attention. The conclusion that emphases exist in the enforcement of FMCSRs across the U.S. is supported by published findings among various trucking industry analysts.[17,18,19] For example, among all driver violations reported in 2010, the share of violations for speeding varied significantly from state to state, representing 31.7 percent of all driver violations in Indiana, 16.9 percent in Ohio and 4.2 percent in Arizona.[20]

Likewise, Vigillo – a third party safety data service provider to the trucking industry – examined 2012 data from the Motor Carrier Management Information System (MCMIS) database and found that the ratio of speeding violations to lighting violations varied markedly among states.[21] While the national average was 11.97 light violations for every speeding violation, the ratio varied from a low of 1.91 in Indiana to 321.02 in Texas.

Disparate CMV Enforcement by Region

In a 2011 report, TransCore Freight Solutions highlighted regional patterns of carrier alerts across four of the BASICs.[22] Among the findings were different rates of alerts between states in multiple BASICs, including Unsafe Driving, Controlled Substances/Alcohol, Hours-of-Service (HOS) Compliance, and Vehicle Maintenance. Similarly, results from another investigative analysis revealed that in 2012, carriers operating in Montana and North Dakota had lower Unsafe Driving BASIC scores than carriers based in Kentucky, Massachusetts, New Hampshire and West Virginia.[23] Further analyses indicated that HOS Compliance BASIC scores were

[16] Weber, A.J. (2014). Compliance, Safety, Accountability: Assessing the New Safety Measurement System and Its Implications—2013 Update. Arlington, VA: American Transportation Research Institute.
[17] Bryan, S. (2013). Is CSA Data Trustworthy? [Webinar]. In *ATA's Exploring the Reliability and Accuracy of CSA Data.* Available Online: http://www.truckline.com/Search.aspx?q=webinar
[18] Bordley, L., Cherry, C., Stephens, D., Zimmer, R., & Petrolino, J. (2012). Commercial Motor Vehicle Wireless Roadside Inspection Pilot Test Part B: Stakeholder Perceptions. Transportation Research Board Annual Meeting. Available Online: http://amonline.trb.org/1seccl/1seccl/1
[19] Patton, O.B. (2013).A Look at CSA After Two Years. Trucking Info. Available Online: http://www.truckinginfo.com/channel/safety-compliance/article/story/2013/01/a-look-at-csa-after-two-years.aspx?prestitial=1
[20] Anderson, D. (2011). Consistent CSA Enforcement Across State Lines: Putting a Goat on Neptune. Vigillo Blog. Available Online: https://vigillo.com/2011/04/consistent-csa-enforcement-across-state-lines-putting-a-goat-on-neptune/
[21] Bryan, S. (2013). Is CSA Data Trustworthy? [Webinar]. In *ATA's Exploring the Reliability and Accuracy of CSA Data.* Available Online: http://www.truckline.com/Search.aspx?q=webinar
[22] CarrierWatch CSA Industry Report. (2011). TransCore Freight Solutions. [White Paper]. Available Online: http://www.dat.com/Resources/~/media/8F7BC3C765DF4258B303A9A8B1194364.ashx
[23] Gimpel, J. (2012). Statistical Issues in the Safety Measurement System and Inspection of Motor Carriers. University of Maryland. Available Online: http://mcsac.fmcsa.dot.gov/Documents/Dec2012/Statistical%20Issues%20in%20Safety%20Measurement%20and%20Inspection%20of%20Motor%20Carriers.pdf

highest among carriers in Florida, Georgia, and Idaho, whereas reported Vehicle Maintenance violations were highest in Connecticut, Florida, South Carolina and Texas.[24]

Problem Statement

These findings are an ever-present issue for both drivers and carriers, given that under CSA both carriers and drivers receive BASIC scores.[25] Their scores in each of the BASICs can affect driver and carrier operating status, as well as their competitive edge within the industry.[26] If carriers or drivers operate within multiple states, the varying levels and type of enforcement activities may play a key role in their BASIC scores.[27] Based on this information, one could infer that carrier or driver safety scores may not truly reflect their actual, relative safety performance, presenting a more substantial issue for the trucking industry.

Research Objective

Therefore, while previous research has highlighted that differences in the enforcement of FMCSRs exist, the findings do not fully address *why* those differences exist nor do they discuss the impact that enforcement disparities have on a carrier's scores across the BASICs. Based on a review of previous studies, the hypothesis of this research is that supposedly standardized carrier BASIC scores are often influenced by the enforcement priorities of the states in which they operate, which obfuscates a carrier's actual safety performance relative to its peers. It also affects CSA's ability to accurately identify *marginally safe* carriers – hindering enforcement prioritization efforts and effective use of enforcement resources.

[24] Ibid.
[25] Safety Measurement System.(n.d.). Federal Motor Carrier Safety Administration. Available Online: http://csa.fmcsa.dot.gov/about/BASICs.aspx
[26] CSA Changes Draw Strong Commentary.(2012). *Heavy Duty Trucking.* Available Online: http://www.truckinginfo.com/channel/fuel-smarts/news/story/2012/08/csa-changes-draw-strong-commentary.aspx
[27] Bryan, S. (2013). Is CSA Data Trustworthy? [Webinar]. In *ATA's Exploring the Reliability and Accuracy of CSA Data.* Available Online: https://ata.webex.com/ec0606l/eventcenter/recording/recordAction.do?theAction=poprecord&AT=pb&isurlact=true&renewticket=0&recordID=7275807&apiname=lsr.php&rKey=bf80a92dbd0430b6&needFilter=false&format=short&&SP=EC&rID=7275807&siteurl=ata&actappname=ec0606l&actname=%2Feventcenter%2Fframe%2Fg.do&rnd=5179315667&entactname=%2FnbrRecordingURL.do&entappname=url0108l

METHODOLOGY

To test this hypothesis, ATRI evaluated the impact of CMV enforcement disparities on carrier safety performance across the 48 contiguous states[28] through a research approach focused on four primary tasks:

TASK 1. State Data Metrics Evaluation: Identifying the disparities found in previous studies and further investigating the impact of these among industry stakeholders.

TASK 2. Relationship Between Violations and Crash Risk: Understanding the impact that varying enforcement priorities may have on improving road safety.

TASK 3. Understanding State Enforcement Objectives - Case Study Approach: Evaluating the impact of specific state enforcement priorities on actual safety outcomes.

TASK 4. Carrier Case Studies: Quantifying the impact of state enforcement disparities on specific motor carrier safety measures within the SMS.

Note: Each section contains a standalone methodology that relates to that section's analysis, results and conclusions.

[28] For the remainder of this report all usage of the "U.S." or "states" will refer to the 48 contiguous states only, unless noted otherwise.

ANALYSIS AND FINDINGS

TASK 1. State Data Metrics Evaluation

In order to understand the relationships and contrasts of the various enforcement activities across states, ATRI developed a matrix of metrics, ratios and analytics that are standardized across states. Based on previous research findings ATRI developed a continuum of relevant variables that ostensibly relate to enforcement disparities (see Appendix B for a detailed review). The general variables included such things as the number of enforcement personnel, Motor Carrier Safety Assistance Program (MCSAP) grants, safety impacts (e.g., crashes), safety risk (e.g., violations) and geographical statistics. Selected findings from the State Data Metrics analyses are presented below; for all State Data Metrics analyses see Appendices D-J. Due to the availability of all necessary data inputs the analyses in this section were completed using 2011 data. The lone exception is the examination of state contributions to their CMV enforcement budgets relative to their respective federal funding, for which ATRI had access to 2012 data.

1.1 Methodology

ATRI gathered state-specific data from multiple sources to complete the state data metrics analyses. Table 2 identifies the various data sources used for each metric. Appendix C contains a detailed review of the process by which these data sources were derived.

Table 2. State Data Metrics Database Sources

Metric	Source
Commercial Vehicle Safety Alliance (CVSA) Certified Inspectors	CVSA-Certified Inspectors by State spreadsheet, 2011[29]
MCSAP Grants	FMCSA[30,31,32]
Number of Fixed Weigh Stations	Rand McNally Carriers' Road Atlas, 2011[33,34]
Probable Cause for Truck Inspections	Partnership between CVSA and the American Trucking Associations—Probable Cause Policies by State, 2010[35]
Truck Vehicle Miles Traveled (VMT)	Federal Highway Administration Highway Statistics Series[36], 2010-2012
RIs and violations	FMCSA Analysis & Information database[37,38]
Truck Crashes	MCMIS Crash File[39]
Regions	U.S. Census Bureau[40]

To meaningfully examine state safety data metrics, ATRI researchers computed ratio analyses between two or more specific variables and then developed a national average or baseline for each unique metric. For example, ATRI researchers computed a ratio for the number of RIs conducted per million vehicle miles traveled (MVMT) per state as well as a national average. To illustrate the range of differences between states for the number of RIs per MVMT, ATRI rank-ordered each state from the most to least RIs per MVMT and compared the state ratios to the national average. Only the findings presented in the subsequent Results section were rank-ordered from most to least, the data presented in Appendices D-J are ordered alphabetically by state.

[29] State Program Information Spreadsheet. (2011). Greenbelt, MD: Commercial Vehicle Safety Alliance.
[30] MCSAP Basic and Incentive Grant Awards by Fiscal Year (n.d.). Federal Motor Carrier Safety Administration. Available Online: http://www.fmcsa.dot.gov/mcsap-basic-incentive-grant/motor-carrier-safety-assistance-program-basic-and-incentive-grant-fiscal
[31] MCSAP New Entrant Grant Awards by Fiscal Year. (n.d.). Federal Motor Carrier Safety Administration. Available Online: http://www.fmcsa.dot.gov/new-entrant-safety-assurance-program-grant/motor-carrier-safety-assistance-program-new-entrant
[32] MCSAP High Priority Grant Awards by Fiscal Year. (n.d.). Federal Motor Carrier Safety Administration. Available Online: http://www.fmcsa.dot.gov/mcsap-high-priority-grant/motor-carrier-safety-assistance-program-high-priority-grant-fiscal-year
[33] Deluxe Motor Carriers' Road Atlas. (2011). Rand McNally.
[34] Rand McNally was used as a source for permanent weigh station information in a previous FHWA publication. Cambridge Systematics Incorporated. (2009). Concept of Operations for Virtual Weigh Station. Federal Highway Administration. Available Online: http://ops.fhwa.dot.gov/publications/fhwahop09051/virtual_weigh_stn.pdf
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[36] Highway Statistics Series. (n.d.). Office of Highway Policy Information, Federal Highway Administration. Available Online: http://www.fhwa.dot.gov/policyinformation/statistics.cfm
[37] Analysis and Information Online. (n.d.). Safety Programs and Program Effectiveness. Federal Motor Carrier Safety Administration. Available Online: http://ai.fmcsa.dot.gov/SafetyProgram/Home.aspx
[38] SMS Appendix A: Violations List. (2013). Federal Motor Carrier Safety Administration, United States Department of Transportation. Available Online: http://csa.fmcsa.dot.gov/documents/sms_appendixa_violationslist.xlsx
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[40] Census Regions and Divisions of the United States. (n.d.). United States Census Bureau. Available Online: http://www.census.gov/geo/maps-data/maps/pdfs/reference/us_regdiv.pdf

1.2 Results

RIs, Violations and Large Truck Crashes by Truck VMT

ATRI ran statistical tests comparing the relationship between vehicle miles traveled (VMT), RIs and violations and found that statistically significant, positive correlations existed between RIs and VMT ($r = 0.82$, $p < .01$) and violations and VMT ($r = 0.89$, $p < .01$). These results indicate that as overall large truck (gross vehicle weight rating 26,001+ pounds) VMT increase so do RIs and as overall large truck VMT increase so do violations. Most importantly, these strong correlations validate the use of VMT as a method for normalizing the differences between states. In other words, reporting rates of RIs and violations over VMT is a valid mechanism for comparing safety performance metrics across states. This is further documented in the literature whereby VMT are used by FMCSA, the National Highway Traffic Safety Administration (NHTSA) and others as a method of normalizing data in a variety of national safety metrics.

In 2011, on average, CMV enforcement personnel conducted 12.2 RIs per MVMT and issued 22.8 violations per MVMT. As reported in Table 3, Maryland had the highest inspection rate with 27.9 RIs per MVMT, which was 128.7 percent greater than the national average. In comparison, Oklahoma conducted the fewest RIs with 3.7 per MVMT, which was 69.7 percent less than the national average. In terms of violations, Connecticut issued the most with 52.2 per MVMT, which was 129.0 percent greater than the national average. North Dakota issued the fewest violations with 5.8 per MVMT, which was 74.6 percent less than the national average.

Table 3 highlights the relatively wide range of differences found when comparing the RI rates and violation rates across states. These results echo the findings of aforementioned research studies that identified disparities in state enforcement practices.

Table 3. Top and Bottom 10 States for Conducting RIs and Issuing Violations per MVMT, 2011

Roadside Inspections		
Top 10		
Rank	**State**	**RI/ MVMT**
1	Maryland	27.9
2	Montana	24.7
3	California	23.9
4	South Dakota	21.8
5	Kentucky	21.5
6	Mississippi	21.4
7	Nevada	20.4
8	Washington	18.8
9	New Mexico	18.3
10	West Virginia	17.7
NATIONAL AVERAGE		**12.2**
Bottom 10		
39	Ohio	7.2
40	Illinois	7.1
41	North Dakota	6.9
42	Pennsylvania	6.4
43	Utah	6.3
44	Alabama	5.9
45	Delaware	5.9
46	Wisconsin	4.5
47	Idaho	4.4
48	Oklahoma	3.7

Violations		
Top 10		
Rank	**State**	**Violations/ MVMT**
1	Connecticut	52.2
2	Maryland	47.5
3	Rhode Island	45.9
4	Arizona	42.2
5	Iowa	37.9
6	Texas	36.8
7	Nevada	34.0
8	Kansas	31.2
9	Montana	29.3
10	New Hampshire	29.0
NATIONAL AVERAGE		**22.8**
Bottom 10		
39	Florida	14.0
40	Utah	13.7
41	North Carolina	13.3
42	Pennsylvania	12.9
43	Illinois	11.3
44	Alabama	9.6
45	Tennessee	8.5
46	Oklahoma	8.0
47	Delaware	7.2
48	North Dakota	5.8

ATRI also studied the relationship of large truck VMT to crash rates. Not surprisingly, a statistically significant, positive relationship was observed between large truck crashes and VMT, meaning that as VMT increased so did large truck crashes ($r = 0.93$, $p < .01$). This finding gives added weight to reporting crashes on a per-mile basis as is done by most, and justifies the use of VMT as a denominator throughout this report.

ATRI's computation of the large truck crash rate only included truck crashes reported to MCMIS involving trucks with gross vehicle weight ratings of 26,001 pounds or greater and normalized the crashes by ATRI's in-house calculation of 2011 truck VMT (see Appendix C for more information on ATRI's VMT calculations).

As highlighted in Table 4, the national average for large truck crashes per MVMT in 2011 was 0.26. Wyoming had 0.52 large truck crashes per MVMT, which was twice the national average and ranked first nationally. Conversely, New Mexico had the lowest rate with 0.08 large truck crashes per MVMT, which was 69.2 percent less than the U.S. average. Table 4 highlights one of the most important performance metrics in safety research – crash rates. These variations in crash rates reveal that even neighboring states can have very different crash rates. While topography and roadway characteristics may play a role in these differences, it is also probable that institutional issues, such as posted speed limits, infrastructure design and quality, and varying enforcement strategies, may also contribute to differences in crash rates.

Table 4. Top and Bottom 10 States for Large Truck Crashes per MVMT, 2011

Crash Rates		
Top 10		
Rank	**State**	**Crashes/ MVMT**
1	Wyoming	0.52
2	New Jersey	0.48
3	Kansas	0.41
4	Colorado	0.40
5	Virginia	0.39
6	Montana	0.37
7	Kentucky	0.35
8	Minnesota	0.34
9	Iowa	0.32
10	Michigan	0.31
NATIONAL AVERAGE		**0.26**
Bottom 10		
39	Washington	0.20
40	South Dakota	0.19
41	Georgia	0.19
42	Oregon	0.18
43	Idaho	0.16
44	Pennsylvania	0.16
45	Mississippi	0.14
46	Florida	0.12
47	Utah	0.11
48	New Mexico	0.08

MCSAP Funds & Safety Metrics

Next, ATRI analyzed the relationship of MCSAP funding to RIs, traffic enforcement (TE) and large truck crashes. A statistically significant, positive correlation was observed between RIs and MCSAP funds, meaning that as MCSAP funds increased so did RIs ($r = 0.69$, $p < .01$). This is an intuitive finding, as one would expect states that received more funding would conduct more RIs with that funding. Similarly, a statistically significant, positive correlation was observed between TEs and MCSAP funds, meaning that as MCSAP funds increased so did TEs ($r = 0.60$, $p < .01$). A further analysis revealed that a statistically significant, positive correlation existed between MCSAP funds and large truck crashes ($r = 0.88$, $p < .01$). This means that as large truck crashes increased, so did MCSAP funds. This finding may be explained in part by the fact that states with higher crash rates may receive a higher level of MCSAP funding to assist in crash reduction efforts.

In 2011, on average, CMV enforcement personnel conducted 14.8 RIs for every $1,000 in MCSAP funds. As shown in Table 5, California generated the most RIs per funds with 48 inspections for every $1,000 in funds, which was 224.3 percent greater than the national average. Conversely, Rhode Island conducted 4.1 RIs per $1,000 in MCSAP funds, which was 72.3 percent less than the national average and ranked 48th nationally. Of course it should be noted that most states contribute additional funds to CMV enforcement activities; nevertheless, these metrics may act as important surrogates for both comparative state efficiency and/or state support for CMV enforcement resources.

Using the same MCSAP funding denominator, in 2011, CMV enforcement personnel conducted 2.7 TEs for every $1,000 in MCSAP funds. New Mexico conducted 9.6 TEs per $1,000 in MCSAP funds, which was 255.6 percent greater than the national average and ranked first nationally. In comparison, Mississippi conducted 0.58 TEs per $1,000 in MCSAP funds, which was 78.5 percent lower than the national average and ranked 48th nationally.

Table 5. Top and Bottom 10 States for RIs and TEs per $1,000 MCSAP Funds, 2011

Roadside Inspections		
Top 10		
Rank	**State**	**RI/ $1,000 MCSAP Funds**
1	California	48.0
2	New Mexico	39.2
3	South Dakota	34.1
4	Maryland	33.9
5	Mississippi	29.0
6	Kentucky	26.6
7	Texas	25.3
8	Maine	23.6
9	Washington	23.2
10	Montana	19.0
NATIONAL AVERAGE		**14.8**
Bottom 10		
39	Virginia	7.1
40	Wisconsin	6.6
41	Vermont	6.4
42	Minnesota	6.2
43	New Jersey	6.0
44	Idaho	5.9
45	Massachusetts	5.7
46	Oklahoma	5.7
47	Delaware	5.4
48	Rhode Island	4.1

Traffic Enforcements		
Top 10		
Rank	**State**	**TE/ $1,000 MCSAP Funds**
1	New Mexico	9.6
2	Indiana	7.7
3	California	7.1
4	Maryland	5.6
5	Washington	5.5
6	Missouri	5.3
7	Massachusetts	3.7
8	Kentucky	3.6
9	Wyoming	3.6
10	Arizona	3.5
NATIONAL AVERAGE		**2.7**
Bottom 10		
39	Texas	1.4
40	North Carolina	1.4
41	New York	1.4
42	Montana	1.3
43	New Jersey	1.3
44	Wisconsin	1.2
45	Virginia	1.2
46	Alabama	1.0
47	North Dakota	0.99
48	Mississippi	0.58

CMV Enforcement Budgets in Relation to RIs and TEs

The previous analysis demonstrated the relationship between MCSAP funds and RIs and TEs; however a state's total CMV enforcement budget is often a combination of federal funds (including MCSAP grants) and state contributions. In certain instances a state's own contribution may substantially exceed their federal funding, and account for the majority of its total enforcement budget. In other instances the majority of a state's enforcement budget is generated from federal funds, with a significantly smaller portion generated by the state's own contribution. A statistically significant, positive correlation was observed between state contributions and RIs, meaning that as state contributions increased so did RIs ($r = 0.87$, $p < .01$). Likewise, a statistically significant, positive correlation was observed between state contributions and TEs, meaning that as state contributions increased so did TEs ($r = 0.84$, $p < .01$).

To investigate the impact that state contributions relative to federal funds have on a state's ability to conduct RIs and TEs, ATRI researchers first computed a ratio of state contributions to federal funds for each state. For this particular analysis ATRI had access to 2012 data for the state contributions. Therefore this analysis was completed using 2012 state contribution data and 2012 MCSAP data. In 2012, the median average of state contributions to federal funds was $0.70 for every dollar, with 24 states that contributed less than the median average (Table 6). In 2012, North Dakota's state contribution was $0.17 for every dollar in federal funds, which was 75.7 percent less than the national median average. In comparison, California contributed $11.00 for every dollar in federal funds, which was 1,471.4 percent greater than the national median average (see Appendix D).

While it is recognized that there are numerous other direct and indirect cost centers associated with state-level CMV enforcement programs, calculating median costs of RIs and TEs across states can present another indicator of efficiency and/or focus (based on RIs and TEs tying closely to crash rates). In 2012, the median total cost per RI was $175.13 and the median total cost per TEs was $975.48. Finally, the researchers calculated the number of additional RIs and TEs that could be completed among the 24 states if they increased their state contributions to match the national median average of $0.70. Each of the states displayed in Table 6 could substantially increase the number of RIs and TEs completed which could further enhance traffic safety and enforcement efforts.

As this is just one of many metrics analyzed for illustrative purposes, ATRI recognizes that numerous factors can influence a state's contribution to their CMV enforcement budget.

Table 6. State Enforcement Budget Contributions and Additional RIs and TEs, 2012

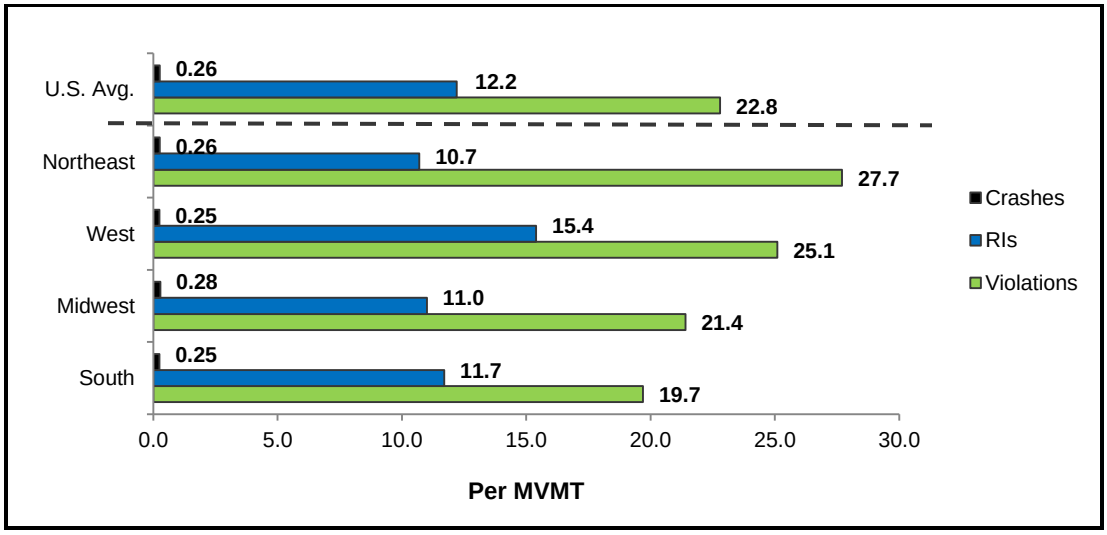
	State	State /Federal Fund Ratio	Additional RIs	Additional TEs
1	Kentucky	$0.66	15,876	2,850
2	Oklahoma	$0.63	17,201	3,088
3	Georgia	$0.62	31,031	5,571
4	Minnesota	$0.61	19,093	3,428
5	Texas	$0.57	128,226	23,021
6	Arkansas	$0.52	12,302	2,209
7	Arizona	$0.52	37,805	6,787
8	Indiana	$0.50	25,326	4,547
9	Illinois	$0.49	34,157	6,132
10	Iowa	$0.46	13,528	2,429
11	North Carolina	$0.45	25,192	4,523
12	New Hampshire	$0.42	4,267	766
13	Kansas	$0.39	15,523	2,787
14	Colorado	$0.37	16,304	2,927
15	Wyoming	$0.33	4,371	785
16	Nebraska	$0.29	11,324	2,033
17	Wisconsin	$0.26	18,187	3,265
18	Alabama	$0.25	21,004	3,771
19	Rhode Island	$0.23	4,181	751
20	Delaware	$0.21	3,486	626
21	Montana	$0.21	9,234	1,658
22	Vermont	$0.20	3,830	688
23	New Mexico	$0.18	13,359	2,398
24	North Dakota	$0.17	8,218	1,475

Safety Metrics by Region

ATRI organized the states by the regional categories determined by the U.S. Census Bureau, which include the Northeast, South, Midwest and West (see Appendix K for region distributions).[41] As depicted in Figure 1 northeastern states issued 27.7 violations per MVMT, which was 21.5 percent greater than the national average. Likewise, western states issued 25.1 violations per MVMT, which was 10.1 percent greater than the national average. In comparison, the southern states issued 19.7 violations per MVMT and the midwestern states issued 21.4 violations per MVMT, which were both less than the national average (13.6% & 6.1% fewer, respectively). The West was the only region with a RI rate higher than the national average with 15.4 RIs per MVMT (26.2% greater). The Midwest had a crash rate of 0.28 large truck crashes per MVMT and was the only region with a crash rate higher than the national average of 0.26 large truck crashes per MVMT (7.7% greater).

Since the analyses shown in Figure 1 were based on population data (i.e. calculated using a complete census of crashes, RIs, and violations) it was not necessary to run any statistical tests on the regional differences (any differences shown are the actual differences). Figure 1 indicates that the Northeast issued the highest number of violations relative to truck VMT while the West had the highest inspection rate.

Figure 1. Average RIs, Violations, and Crashes by Region, 2011



Rather than being a result of enforcement disparities, one explanation why certain states or regions issue violations at significantly higher or lower rates than national averages may be that carriers in certain states are more or less likely to commit certain violations. To test this hypothesis, ATRI researchers evaluated the extent that drivers are exceeding speed limits on roadways in Indiana, Massachusetts, North Dakota and Texas (see Appendix J for detailed findings). The results of the analysis indicated that drivers drove at speeds ranging from two to more than 16 miles-per-hour (MPH) below the maximum speed limit in each state. Furthermore, across each of the states and roadways the average truck speed was relatively

[41] Census Regions and Divisions of the United States. (n.d.). United States Census Bureau. Available Online: http://www.census.gov/geo/maps-data/maps/pdfs/reference/us_regdiv.pdf

consistent with a mean speed of 62.8 MPH. Therefore, these findings suggest that drivers are not necessarily more or less likely to violate speeds in specific states, but rather other factors are influencing the number of speeding violations, such as enforcement strategies.

RIs and Violations by Probable Cause Requirements

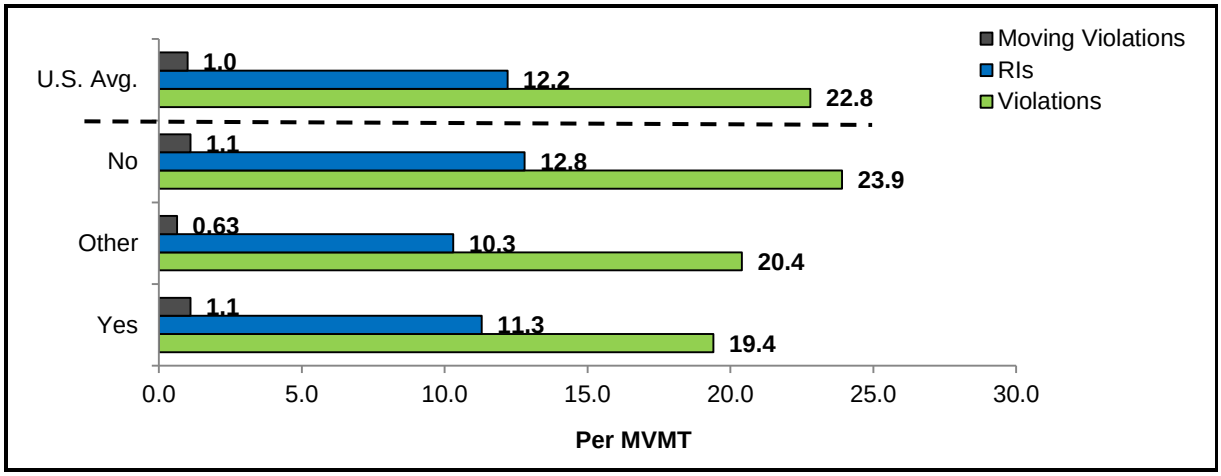
A common anecdotal concern raised in several venues is the impact of probable cause policies on the number of RIs and violations issued to carriers and drivers. More specifically, that states with probable cause policies issue more moving violations to drivers than states without probable cause policies. In this particular instance probable cause is defined as "probable cause of a traffic violation or obvious vehicle defect is necessary in order to conduct a RI." According to research conducted by the Commercial Vehicle Safety Alliance (CVSA) and the American Trucking Associations (ATA) in 2010, 34 states did not require probable cause to conduct a RI, five states required probable cause to conduct a RI, and nine states required probable cause under special circumstances (other). Appendix L provides a detailed list of the probable cause policies by state.[42]

In 2011, states that *did not require* probable cause conducted 12.8 RIs per MVMT, which was 4.9 percent greater than the national average of 12.2. In addition, states that *did not require* probable cause issued 23.9 violations per MVMT, which is 4.8 percent greater than the national average of 22.8. Moreover, states that *did not require* probable cause issued 1.1 moving violations per MVMT which was 10.0 percent greater than the national average (Figure 2). Conversely, states that *did require* probable cause conducted 11.3 RIs per MVMT, which was 7.4 percent fewer than the national average. Furthermore, states that *did require* probable cause issued 19.4 violations per MVMT, which was 14.9 percent fewer than the national average. States that *did* require probable also issued 1.1 moving violations per MVMT.

Again, since this analysis was completed using population data, it was unnecessary to perform any statistical tests on the differences. Therefore, the findings suggest that states that *did not require* probable cause conducted more RIs per MVMT and issued more violations per MVMT than states that *did require* probable cause. Furthermore, the results demonstrate that moving violations were issued at an equal rate among states *with* probable cause policies and among states *without* probable cause policies.

[42] States that Require Probable Cause (PC) to Conduct Truck Inspections—Chart. (2010). Greenbelt, MD: Commercial Vehicle Safety Alliance; Arlington VA: American Trucking Associations.

Figure 2. Average RIs and Violations by Probable Cause Policy, 2011



RIs and Violations by Level of CSA Implementation

A recent audit conducted by the Office of Inspector General noted that only 10 states have fully implemented CSA enforcement interventions.[43] The remaining 40 states and the District of Columbia (D.C.) have yet to implement off-site investigations and cooperative safety plans. In addition, these states and D.C. have yet to receive and deploy Sentri, which is enforcement intervention software designed to be a central reporting database for carrier and driver information as well as FMCSA data on RIs, investigations, and enforcements. FMCSA noted that Sentri will be released in 2015 and will be accessible by all 50 states and FMCSA Division Offices.[44]

The lack of full implementation of CSA interventions across the nation may also influence enforcement disparities. Therefore, ATRI researchers investigated average performance metrics among the nine states that have fully deployed CSA and the remaining 39 states that have not (Alaska and Hawaii were excluded from these analyses).

States with Fully Implemented CSA Interventions

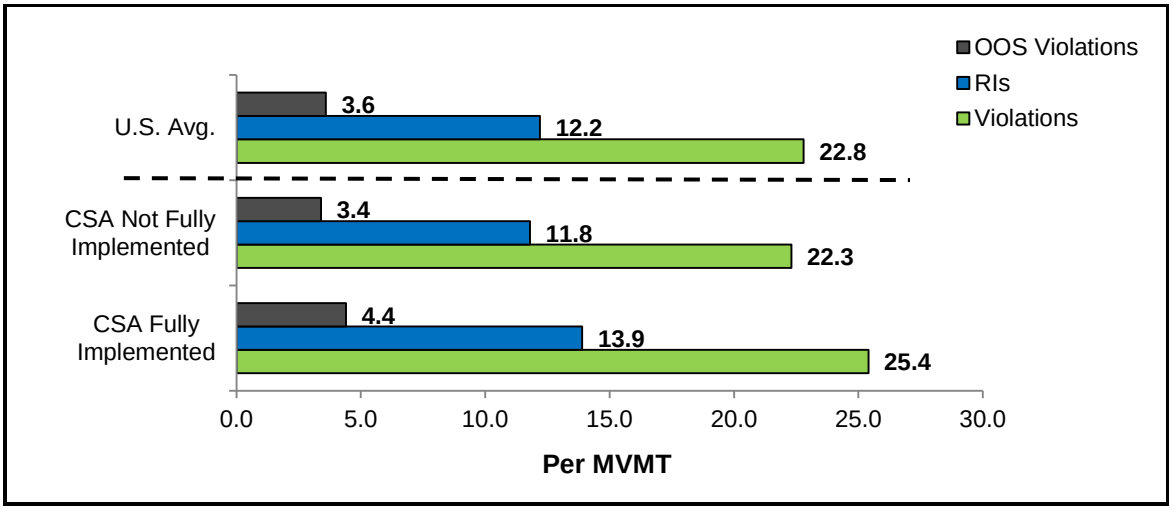
In 2011, the states that *have* fully implemented CSA interventions conducted 13.9 RIs per MVMT, which was approximately 14 percent greater than the national average of 12.2. In addition, these "fully implemented" states issued 25.4 violations per MVMT, which was 11.4 percent greater than the national average of 22.8. Moreover, the fully implemented states issued 4.4 out-of-service (OOS) violations per MVMT which was 22.2 percent greater than the national average of 3.6 (Figure 3).

[43] States that have fully implemented CSA interventions: Colorado, Delaware, Georgia, Kansas, Maryland, Minnesota, Missouri, Montana, New Jersey and Alaska.
[44] Office of Inspector General Audit Report: Actions are Needed to Strengthen FMCSA's Compliance, Safety, Accountability Program. (2014). Report No.: MH-2014-032, United States Department of Transportation, Office of the Secretary of Transportation, Office of Inspector General. Available Online: http://www.oig.dot.gov/sites/dot/files/CSA%20Report.pdf

States without Fully Implemented CSA Interventions

Conversely, states that *have not* fully implemented CSA interventions conducted 11.8 RIs per MVMT, which was 3.3 percent lower than the national average. Furthermore, states that *have not* fully implemented CSA interventions issued 22.3 violations per MVMT, which was 2.2 percent lower than the national average. Finally, states that *have not* fully implemented CSA interventions issued 3.4 OOS violations per MVMT which was 5.6 percent lower than the national average. These findings illustrate that states that *have* fully implemented CSA interventions conducted more RIs and issued more violations per MVMT than states that *have not*.

Figure 3. Average RIs and Violations by Degree of CSA Implementation, 2011



Violation Types & Relation to Relevant RIs

The previous analyses demonstrate that enforcement disparities exist across multiple safety metrics normalized by VMT and other factors. However, it might be argued that since the BASIC measures are calculated using a ratio of violations to relevant RIs (with the exception of Unsafe Driving and Crash Indicator) there would be no impact from disparate enforcement activities. Relevant RIs are any RI that would result in the issuance of particular violation for each BASIC, even those that do not result in a violation being issued ("clean inspection").[45] Relevant RIs are further dependent upon the RI level which varies from a full vehicle and driver inspection to driver-only or vehicle-only inspections; therefore only certain RIs are applicable and relevant when calculating BASIC measures. Table 7 displays the North American Standard Inspection (NASI) levels and describes what each entails.[46] For the Vehicle Maintenance

[45] Carrier Safety Measurement System (CSMS) Methodology Version 3.0.1. (2013). Federal Motor Carrier Safety Administration. Available Online: http://csa.fmcsa.dot.gov/Documents/SMSMethodology.pdf
[46] North American Standard Inspection Levels. (n.d.). Greenbelt, M.D.: Commercial Vehicle Safety Alliance. Available Online: http://www.cvsa.org/programs/nas_levels.php

BASIC all relevant RIs are Levels 1, 2, 5 and 6. For the Driver Fitness, HOS Compliance and Controlled Substances/Alcohol BASICs the relevant RIs include Levels 1, 2, 3 and 6.[47]

Table 7. North American Standard Inspection Levels

Inspection Level	Description
1	This is the most comprehensive inspection level which examines both driver and vehicle compliance with FMCSRs.
2	Walk-around driver/vehicle inspection which examines both driver and vehicle compliance with FMCRs, but the inspector will not inspect the underside of the vehicle.
3	Driver/credential inspection which only examines driver compliance with FMCSRs such as logbook entries, medical certificates and commercial driver's license.
4	Special inspection which is typically a one-time examination of a specific item in order to support study findings or verify or refute a suspected trend.
5	Vehicle-only inspection which includes all vehicle inspection items under the Level 1 inspection and may occur at any location and without a driver present.
6	NASI for radioactive shipments which includes enhanced Level 1 inspection procedures for select radioactive materials.

To investigate whether enforcement disparities exist when analyzing the relationship between violations and relevant RIs, ATRI researchers selected violations with a severity weight of one (as these violations are likely to be more common and occur across all 48 states) from the Driver Fitness, HOS Compliance and Vehicle Maintenance BASICs and computed a ratio of violations per 100 relevant RIs.[48] As displayed in Table 8, the national violation average for "not possessing a medical certificate" (medical certificate) was 5.2 per 100 relevant RIs in 2011. Rhode Island issued 21.3 medical certificate violations per 100 relevant RIs, which was 309.6 percent greater than the national average and ranked first nationally. In comparison, California issued 0.49 medical certificate violations per 100 relevant RIs, which was 90.6 percent lower than the national average and ranked 48th nationally.

In 2011, the national average for the log violation "general/form and manner" per 100 relevant RIs was 7.1. Arizona issued 35.6 general/form and manner violations per 100 relevant RIs, which was 401.4 percent greater than the national average and ranked first nationally. Conversely, Delaware issued 0.62 general/form and manner violations per 100 relevant RIs, which was 91.3 percent lower than the national average and ranked 48th nationally.

[47] Carrier Safety Measurement System (CSMS) Methodology Version 3.0.1. (2013). Federal Motor Carrier Safety Administration. Available Online: http://csa.fmcsa.dot.gov/Documents/SMSMethodology.pdf

[48] The Controlled Substances/Alcohol BASIC was not examined in this analysis due to the rare occurrence of violations, resulting in a small data set which could result in potentially misleading findings.

Table 8. Top and Bottom 10 States for Specific Driver Fitness and HOS Compliance Violations by Relevant RIs, 2011

Driver Fitness		
Driver Not In Possession Of Medical Certificate		
Top 10		
Rank	**State**	**Viol/100 RIs**
1	Rhode Island	21.3
2	Massachusetts	20.1
3	Michigan	10.6
4	New Jersey	9.8
5	Minnesota	9.1
6	New Hampshire	9.1
7	Connecticut	9.0
8	Oklahoma	8.5
9	Georgia	7.7
10	South Carolina	7.1
NATIONAL AVERAGE		**5.2**
Bottom 10		
39	Tennessee	2.6
40	Nebraska	2.5
41	Washington	2.3
42	New Mexico	2.0
43	Montana	2.0
44	Colorado	2.0
45	Maine	1.7
46	Mississippi	1.3
47	Oregon	1.2
48	California	0.49

HOS Compliance		
Log Violation (General/Form and Manner)		
Top 10		
Rank	**State**	**Viol/100 RIs**
1	Arizona	35.6
2	Connecticut	16.0
3	Wisconsin	15.5
4	Utah	15.2
5	Vermont	14.4
6	Georgia	13.9
7	New Mexico	13.8
8	Wyoming	12.4
9	Idaho	12.3
10	Iowa	11.8
NATIONAL AVERAGE		**7.1**
Bottom 10		
39	Oklahoma	2.1
40	West Virginia	2.0
41	Kentucky	1.8
42	Florida	1.7
43	Maryland	1.6
44	Tennessee	1.4
45	Louisiana	1.4
46	California	1.2
47	Michigan	0.99
48	Delaware	0.62

Finally in 2011, the national average for "windshield wipers inoperative or defective" (windshield) violations per 100 relevant RIs was 2.0 (Table 9). Texas issued 12.2 windshield violations per 100 relevant RIs, which was 510.0 percent greater than the national average and ranked first nationally. In comparison, North Dakota issued 0.19 windshield violations per 100 relevant RIs, which was 90.5 percent lower than the national average and ranked 48th nationally. The findings presented in Tables 8 and 9 illustrate that disparate enforcement across states does exist when evaluating specific violations by relevant RIs. This suggests that carriers *are* likely to be impacted by enforcement strategies when traveling from one state to another rather than carriers being more likely to violate certain FMCSRs when traveling in a particular state.

Table 9. Top and Bottom 10 States for Specific Vehicle Maintenance Violation by Relevant RIs, 2011

Vehicle Maintenance		
Windshield Wipers Inoperative/Defective		
Top 10		
Rank	**State**	**Viol/100 RIs**
1	Texas	12.2
2	Arizona	11.1
3	Connecticut	7.1
4	Arkansas	6.3
5	Utah	6.2
6	Minnesota	4.6
7	Colorado	3.0
8	Kansas	2.9
9	Idaho	2.7
10	Rhode Island	2.4
NATIONAL AVERAGE		**2.0**
Bottom 10		
39	Oregon	0.47
40	New Hampshire	0.47
41	Wyoming	0.45
42	Iowa	0.34
43	Kentucky	0.33
44	California	0.30
45	Delaware	0.30
46	South Dakota	0.28
47	Tennessee	0.26
48	North Dakota	0.19

1.3 Conclusion: State Data Metrics

The data presented in this section (and Appendices D-J) document that differences exist across states and regions for a range of safety metrics. ATRI's research corroborates the findings of previous research discussed in the literature review that also found differences in state enforcement statistics.

A strong, positive statistical correlation was found between the number of violations and truck VMT, suggesting that normalizing the number of violations by truck VMT (i.e. calculating the violation rate per MVMT) is a valid way of assessing violation rate variability across states. For example, while Connecticut issued 52.2 violations per MVMT, North Dakota only issued 5.8 violations per MVMT. Therefore if a carrier operates in both Connecticut and North Dakota, the carrier is approximately nine times more likely to receive a violation in Connecticut than in North Dakota. Since violations are a primary component of SMS calculations, these differences create implications for the ostensibly standardized carrier BASIC scores.

Furthermore, these findings along with previous research illustrate that regional enforcement patterns exist. For example, northeastern states issued the most violations per MVMT compared to other regions. Western states conducted the most RIs per MVMT. Additionally,

there are legislative, financial and policy factors that may be influencing enforcement disparities. States that *do not require* probable cause conducted more RIs and issued more violations per MVMT than states that *did require* probable cause for performing RIs, but moving violation rates between these two groups were equal.

In addition, a state's financial contribution level to enforcement could significantly affect their ability to conduct additional enforcement activities. This is an issue that should be further discussed by state and national stakeholders, and could become the basis for developing alternative enforcement strategies that are not closely tied to funding, or for strengthening arguments for enforcement funding. Moreover, states that have fully implemented all CSA interventions conducted more RIs and issued more violations and OOS violations per MVMT than states that have not fully implemented all CSA interventions. Finally, states *do* issue violations at varying rates when normalized by MVMT and/or relevant RIs. This suggests that carrier BASIC scores are likely to be influenced by their geographic operating ranges and differing state enforcement priorities.

Overall, findings from the State Data Metrics Evaluation reinforce that differences exist between states across a number of safety metrics associated with enforcement and CMV safety. Subsequent sections of this research will further demonstrate these differences are closely associated with variability in state enforcement priorities and strategies. While it is arguably important for states to tailor their CMV enforcement to meet unique needs, the Task 2 analyses demonstrate that some state enforcement strategies may not appropriately align with behavior that is most predictive of crash risk.

TASK 2. Relationship Between Violations and Crash Risk

Task 2 of this study evaluates state safety performance relative to the issuance of specific violations. Both FMCSA and ATRI have compiled industry-recognized lists of the top violations suggested to have greater influence on safety events. FMCSA has designated a list of 16 violations considered to the most egregious to safety as "Red Flag" (RF) violations.[49] ATRI has developed a list of driver violations or convictions most statistically associated with future crash risk, which are informally referred to as "Crash Predictor" (CP) violations.[50] To better understand the relationship these lists have to law enforcement activities ATRI investigated the prevalence of RF and CP violations issued across states. Due to the availability of all necessary data inputs the analyses in this section are based on 2011 data.

Red Flag Violations

Table 10 displays FMCSA's list of 16 RF violations, however the list is subject to change and updates. A Safety Investigator always examines RF violations during a carrier investigation and whether a carrier has corrected any RF violations on record.[51]

Table 10. Red Flag Violations

FMCSR Code	Description	BASIC	Severity Weight
392.4A	Driver uses or is in possession of drugs	Controlled Substances/Alcohol	10
395.13D	Driving after being declared OOS	HOS Compliance	10
396.9C2	Operating an OOS vehicle	Vehicle Maintenance	10
383.21	Operating CMV with more than one driver's license	Driver Fitness	8
383.23A2	Operating a CMV without a valid commercial driver's license (CDL)	Driver Fitness	8
383.51A	Driving a CMV (CDL) while disqualified	Driver Fitness	8
383.51A-SIN	Driving a CMV while CDL is suspended for a safety-related or unknown reason and in the state of driver's license issuance	Driver Fitness	8
383.91A	Operating a CMV with improper CDL group	Driver Fitness	8
391.11	Unqualified driver	Driver Fitness	8
391.11B5	Driver lacking valid license for type of vehicle being operated	Driver Fitness	8
391.11B7	Driver disqualified from operating CMV	Driver Fitness	8
391.15A	Driving a CMV while disqualified	Driver Fitness	8
391.15A-SIN	Driving a CMV while disqualified. Suspended for safety-related or unknown reason and in the state of driver's license issuance.	Driver Fitness	8
383.51A-SOUT	Driving a CMV while CDL is suspended for safety-related or unknown reason and outside the driver's license state of issuance.	Driver Fitness	5
391.15A-SOUT	Driving a CMV while disqualified. Suspended for a safety-related or unknown reason and outside the driver's license state of issuance.	Driver Fitness	5
392.5A	Possession/use/under influence of alcohol less than 4 hours prior to duty	Controlled Substances/Alcohol	5

[49] Frequently Asked Questions. (n.d.). Federal Motor Carrier Safety Administration. Available Online: http://csa.fmcsa.dot.gov/FAQs.aspx?faqid=1409
[50] Lueck, M.D., & Murray, D.C. (2011). Predicting Truck Crash Involvement: A 2011 Update. Arlington, VA: American Transportation Research Institute.
[51] Frequently Asked Questions. (n.d.). Federal Motor Carrier Safety Administration. Available Online: http://csa.fmcsa.dot.gov/FAQs.aspx?faqid=1409

Crash Predictor Violations

ATRI first analyzed the relationship between MCMIS inspection data, Commercial Driver License Information System (CDLIS) records and crash risk in 2005.[52] Based on the results of this analysis, ATRI developed a list of the top 10 CP violations or convictions most likely to contribute to future crash risk. Using the same methodology as in 2005, ATRI researchers updated the top 10 CP violations or convictions in 2011.[53] Of the 2011 CP top 10 violations or convictions, seven map to specific FMCSRs (Table 11). The three violations or convictions that do not map to a specific FMCSR include a past crash, any conviction, and failure to use or improper signal conviction.[54]

Table 11. Crash Predictor Violations

FMCSR Code	Description	BASIC	Severity Weight
392.2R	Reckless Driving	Unsafe Driving	10
392.2-SLLS4	State/Local Laws - Speeding 15 or more miles per hour over the speed limit	Unsafe Driving	10
392.2C	Failure to obey traffic control device	Unsafe Driving	5
392.2LC	Improper lane change	Unsafe Driving	5
392.2P	Improper passing	Unsafe Driving	5
392.2T	Improper turns	Unsafe Driving	5
392.2LV	Lane restriction	Unsafe Driving	3

Differences between FMCSA's RF and ATRI's CP lists include:

- The RF violations map to four BASICs, while the CP violations map to one BASIC.
- The RF list primarily addresses driver qualification issues and commercial driver's license (CDL) status, while the CP list addresses unsafe driving behaviors.
- The RF and CP violations do not overlap between lists.

2.1 Methodology

ATRI calculated RF and CP violation rates per MVMT across all states (see Appendices M-N). Based on the violation rates ATRI developed lists of the top 10 states issuing the most RF and/or CP violations per MVMT, as well as the bottom 10 states issuing the fewest RF and/or CP violations per MVMT. ATRI then analyzed the aggregated safety performance among the top and bottom 10 states across both the RF and CP lists.

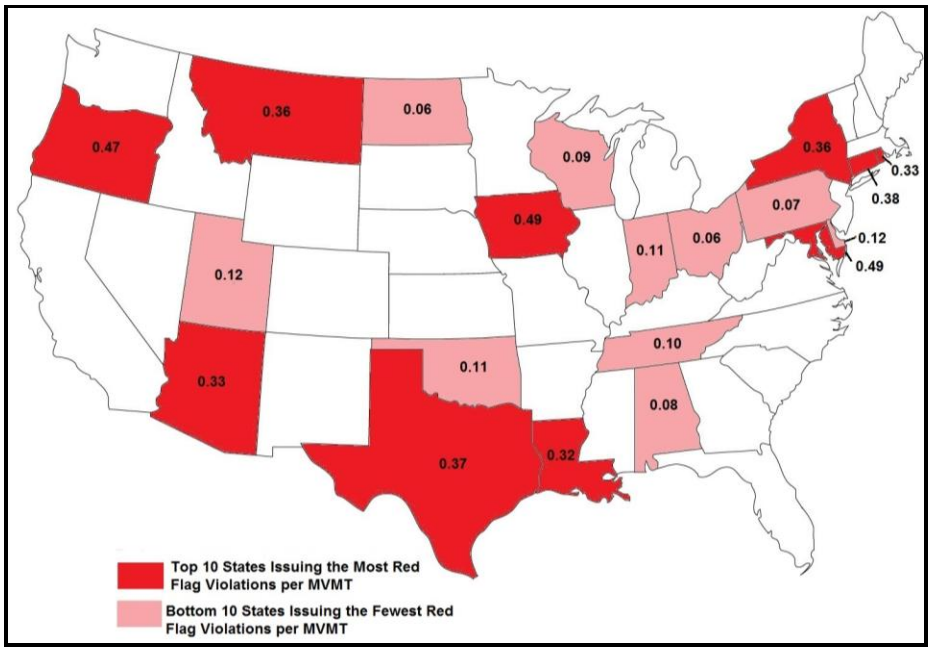
[52] Murray, D.C., Lantz, B., & Keppler, S.A. (2005). Predicting Truck Crash Involvement: Developing a Commercial Driver Behavior-Based Model and Recommended Countermeasures. Alexandria, VA: American Transportation Research Institute.
[53] Lueck, M.D., & Murray, D.C. (2011). Predicting Truck Crash Involvement: A 2011 Update. Arlington, VA: American Transportation Research Institute.
[54] ATRI verified that while "failure to use or improper signal" does not map to a specific FMCSR, it is addressed within a subset of violations in 49 CFR 392.2. Email correspondence with Dan Drexler, Minnesota Division Administrator, FMCSA. February 25, 2014.

2.2 Results

Red Flag Analyses

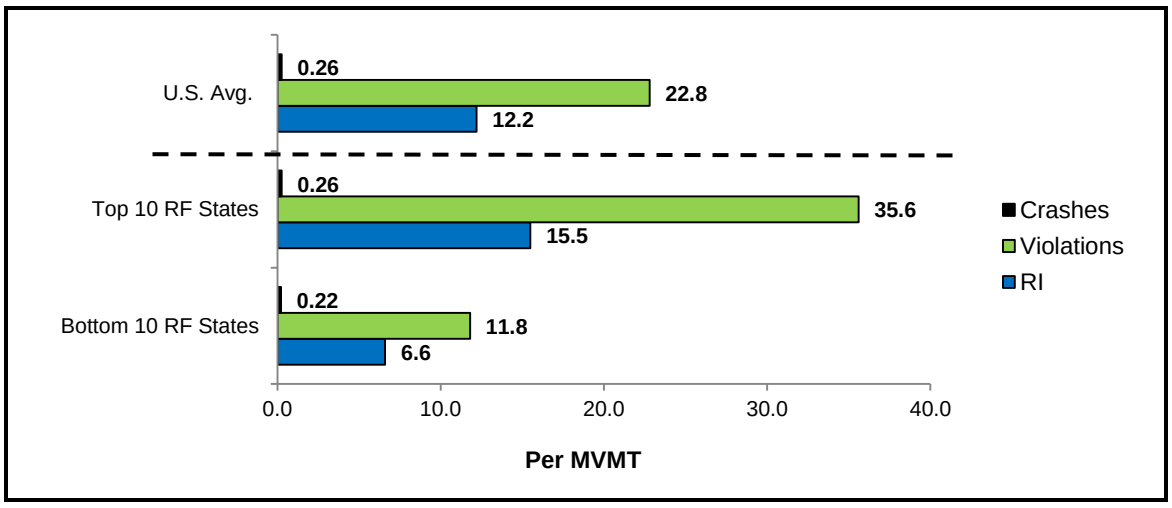
Across all states, enforcement personnel issued an average of 0.22 RF violations per MVMT in 2011. Figure 4 displays the 10 states issuing the most and the 10 states issuing the fewest RF violations per MVMT. Among the 10 states for most RF violations issued Maryland ranked highest (0.49 violations per MVMT) and among the bottom 10 states for fewest RF violations North Dakota ranked the lowest (0.06 violations per MVMT).

Figure 4. Top and Bottom 10 States Issuing RF Violations, 2011



In 2011, on average, the top 10 RF states conducted 15.5 RIs per MVMT, which was 134.9 percent greater than the bottom 10 RF states' RI rate of 6.6 (Figure 5). Likewise, the top 10 RF states issued 35.6 violations per MVMT, which was 201.7 percent greater than the bottom 10 RF states' violation rate of 11.8. Moreover, on average, the top 10 RF states had 0.26 large truck crashes per MVMT, which was 18.2 percent greater than the bottom 10 RF states' large truck crash rate of 0.22. These findings may indicate that the states that issue more RF violations do so because they experience more safety issues than states that issue fewer RF violations.

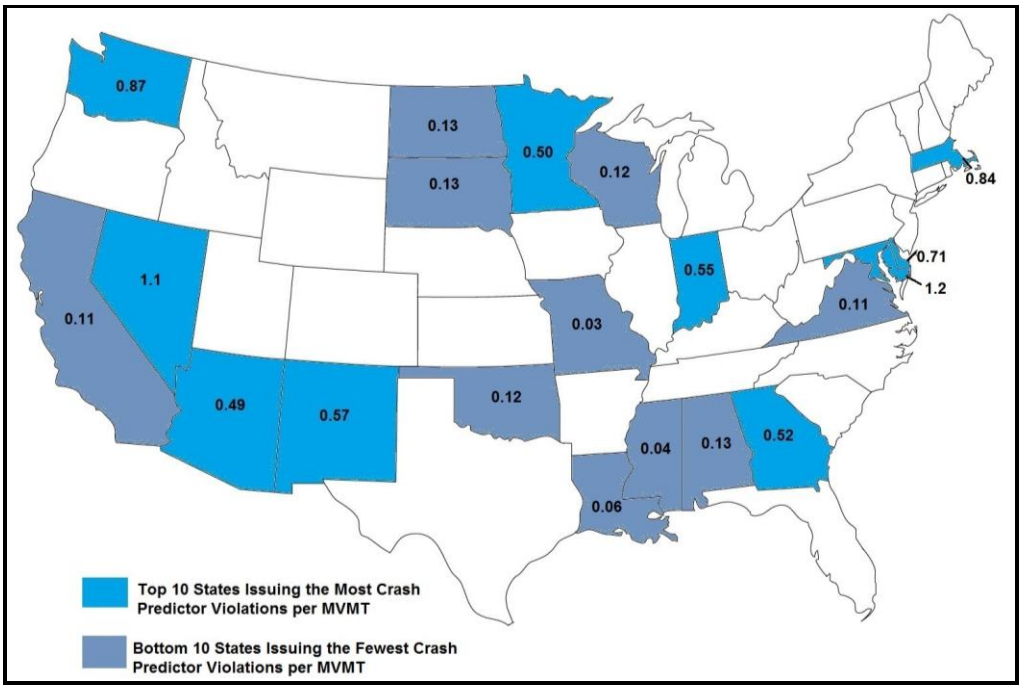
Figure 5. Average Enforcement and Safety Rates of the Top and Bottom 10 RF States, 2011



Crash Predictor Analyses

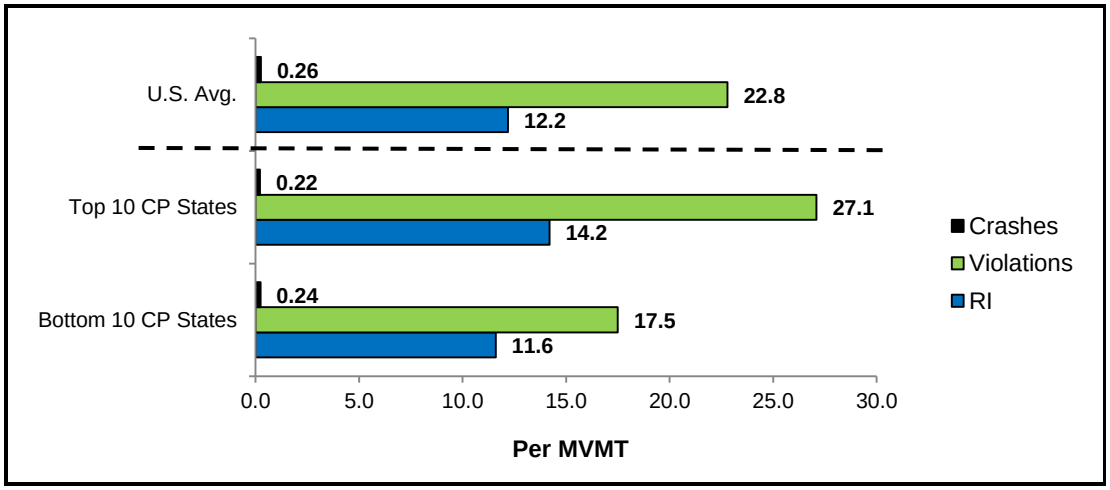
In 2011, enforcement personnel issued an average of 0.33 CP violations per MVMT. Figure 6 displays the top and bottom 10 states issuing the most and fewest CP Violations per MVMT. Rounding out the top 10 states for most CP violations issued was Maryland (1.2 violations per MVMT) and rounding out the bottom 10 states for fewest CP violations issued was Missouri (0.03 violations per MVMT).

Figure 6. Top and Bottom 10 Sates Issuing CP Violations, 2011



In 2011, on average, the top 10 CP states conducted 14.2 RIs per MVMT, which was 22.4 percent greater than the bottom 10 CP states' RI rate of 11.6 (Figure 7). Likewise, the top 10 CP states issued 27.1 violations per MVMT, which was 54.9 percent greater than the bottom 10 CP states' violation rate of 17.5. Moreover, on average, the top 10 CP states had 0.22 large truck crashes per MVMT, which was 8.3 percent lower than the bottom 10 CP states' large crash rate of 0.24.

Figure 7. Average Enforcement and Safety Rates of the Top and Bottom 10 CP States, 2011

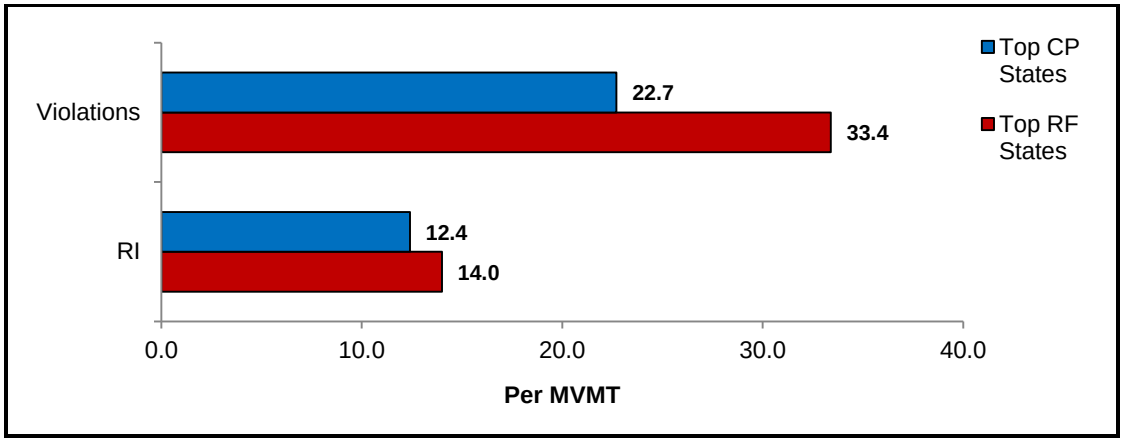


Comparing Operational and Safety Rates Between the Top RF and Top CP States

As both the RF and CP lists are recognized as industry standards for evaluating crash risk, the final step for Task 2 was the comparison of operational and safety rates among the top states issuing the most RF and CP violations. As Arizona and Maryland appear on both the top 10 RF and top 10 CP lists it was necessary to remove them from the following analyses in order to make accurate comparisons between the two lists.

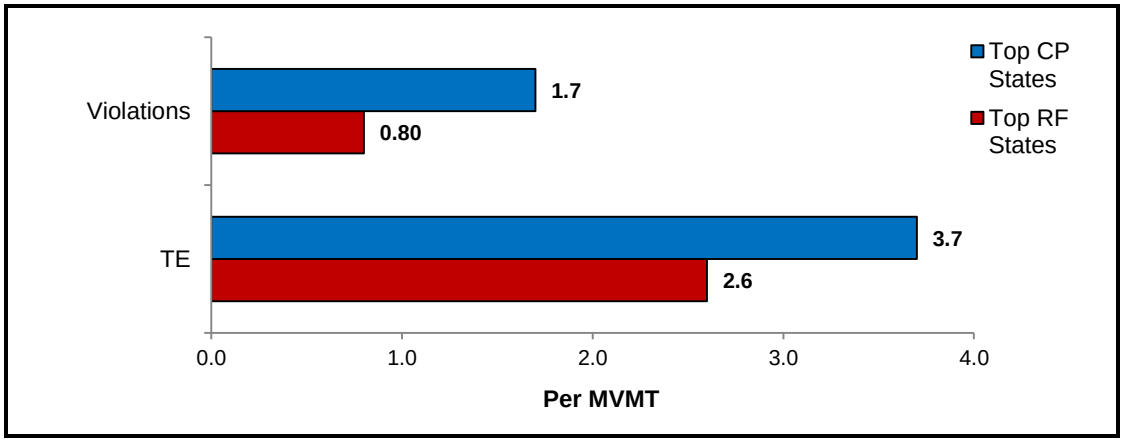
In 2011 on average, the top RF states conducted 14.0 RIs per MVMT, which was 12.9 percent greater than the top CP states' RI rate of 12.4 (Figure 8). In addition, the top RF states issued 33.4 violations per MVMT, which was 47.1 percent greater than the top CP states' violation rate of 22.7.

Figure 8. Average RI and Violation Rates of the Top RF and Top CP States, 2011



In 2011 on average, the top CP states conducted 3.7 TEs per MVMT, which was 42.3 percent greater than the top RF states' rate of 2.6 (Figure 9). In addition, in 2011 the top CP states issued 1.7 violations per MVMT during TEs, which was 112.5 percent greater than the top RF states' rate of 0.80.

Figure 9. Average TE and Violation Rates of the Top RF and Top CP States, 2011



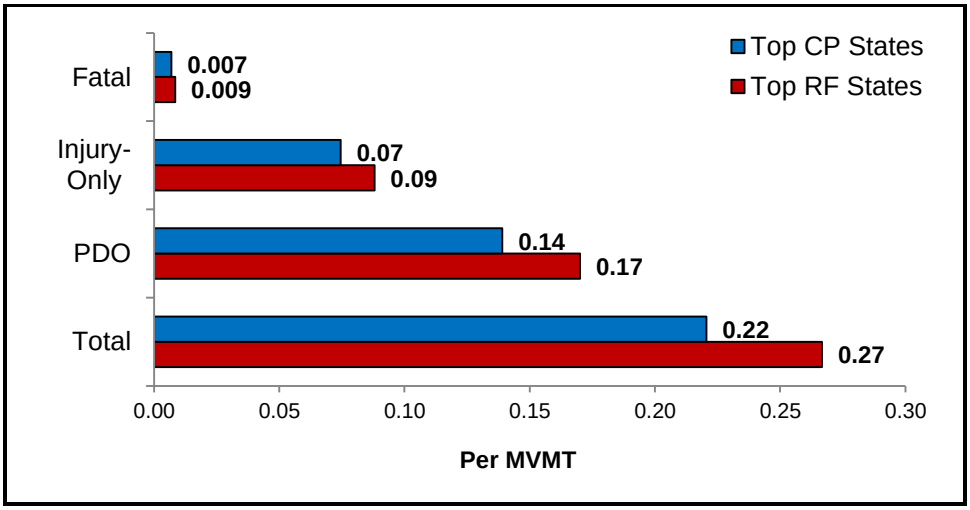
That the top RF states had greater RI and total violation rates, but the top CP states had greater rates of TEs and violations issued during TEs may be due to the nature of the violations across the RF and CP lists. As the CP violations are included within the Unsafe Driving BASIC and are considered "moving violations" it seems logical that the top CP states would have greater TE rates than the top RF states, given that TEs typically occur when a driver exhibits unsafe driving behaviors.

Likewise, it seems logical that the top RF states would have greater RI rates than the top CP states as the RF violations do not address driver behavior, but rather driver qualification issues which are identified during RIs. In addition, while RF violations may be issued during RIs that resulted from TEs, they are also issued during random RIs and at fixed inspection locations.

These factors may also contribute to the finding that the Top RF states have higher rates of RIs and violations as CP violations would not typically be issued during a random RI or at a fixed inspection site.

As displayed in Figure 10, the top CP states had lower total, property damage only (PDO), injury-only, and fatal large truck crash rates than the top RF states. Examination of other metrics reveal that in 2011, the top RF states expended an average of $1,280.38 per MVMT in MCSAP funds whereas the top CP states expended an average of $995.88 per MVMT in MCSAP funds. Likewise, in 2011 the top RF states had more CVSA inspectors per MVMT than top CP states. Furthermore, in 2011, the top RF states issued 39.1 percent fewer Unsafe Driving violations per MVMT than CP states.

Figure 10. Average Crash Rates of the Top RF and Top CP States, 2011



These findings may suggest that while FMCSA considers RF violations as the most egregious to safety, RF violations may not map closely to crash risk. As noted earlier a positive correlation existed between the amount of MCSAP funds and large truck crash rates suggesting that states with higher large truck crash rates receive larger grants in order to increase crash reduction effectiveness. Likewise, that top RF states have a greater number of CVSA inspectors may indicate that these states need more enforcement personnel to enforce regulations and promote traffic safety. Finally, previous research published by FMCSA suggested that TEs prevent approximately 4.5 times as many truck crashes as do RIs per 1,000 interventions.[55] Since the top RF states issued fewer Unsafe Driving violations and conducted fewer TEs per MVMT, it may suggest that they are catching fewer drivers that engage in unsafe driving behaviors, thus leading to higher large truck crash rates. Finally, the findings suggest that a greater focus on moving violations and corresponding enforcement activities may be more effective in promoting traffic safety.

[55] Gillham, O., Horton, S., & Schwenk, J. (2013). FMCSA Safety Program Effectiveness Measurement: Intervention Model Fiscal Year 2009. Report No.: RRA-13-039, Federal Motor Carrier Safety Administration. Available Online: http://ntl.bts.gov/lib/48000/48100/48198/FMCSA-Intervention-FY-2009.pdf

2.3 Conclusion: Relating Violations to Crash Risk

The top RF states had higher RI and violation rates as compared to the top CP states. However, the top CP states had higher rates of TEs and violations issued during TEs than the top RF states. These findings generally relate to the nature of the violations on the RF and CP lists. Additionally, the safety performance assessment between the top RF and top CP states reveals that the RF states had higher large truck crash rates than the CP states. This finding, coupled with the finding that the top RF states had higher large truck crash rates than the bottom RF states, may suggest that the RF list should be reevaluated as to the degree that the current RF violations have strong, positive relationships to crash risk. Likewise, these findings may also suggest that the RF list should be updated to include other violations, such as those that appear on the CP list.

TASK 3. Understanding State Enforcement Objectives: Case Study Approach

The third task in the examination of state enforcement disparities involved the review of states' 2011 MCSAP Commercial Vehicle Safety Plan (CVSP). ATRI conducted a review of state CVSPs to quantify how these plans were influencing the number and type of violations being issued within a state. Included within each state case study is a brief overview of the state's CMV enforcement priorities and activities outlined in their CVSP and should not be interpreted as representing the entire enforcement strategies outlined in their CVSP. Due to the availability of all necessary data inputs the analyses in this section were completed using 2011 data.

3.1 Methodology

Since it was challenging to access even a plurality of CVSPs, ATRI obtained a generally representative (by attributes noted in Table 13) subset of state CVSPs. To account for variations among state demographics the researchers developed selection criteria based on a state's geographical location, size, population, transportation infrastructure, and trucking industry presence (Table 12).[56,57,58,59]

Table 12. State Case Study Selection Criteria

Selection Criteria	Description
Geographical Distribution	There are four major regions distributed across the contiguous U.S.: West, Midwest, South, and Northeast (see Appendix K).
Land Area	States were classified as large (>100,000 square miles), medium (50,000-100,000 square miles), or small (<50,000 square miles).
Population	States were grouped into sets of high (>15 million residents), medium (5-15 million residents), and low (<5 million residents).
Transportation Infrastructure	States were categorized as either having a prominent (>=5 corridors) or limited (<5 corridors) interstate systems.
Industry Presence	States were categorized as either having have a strong (>=100 trucking companies) or weak (<100 trucking companies) trucking presence.

After developing the case study selection criteria, the researchers selected 24 states for possible inclusion in the case study analysis and contacted each state's enforcement agency for assistance in obtaining the CVSP. Of the 24 states contacted only nine provided their CVSPs.

[56] Census Regions and Divisions of the United States. (n.d.). United States Census Bureau. Available Online: http://www.census.gov/geo/maps-data/maps/pdfs/reference/us_regdiv.pdf
[57] State and County Quick Facts. (n.d.). United States Census Bureau. Available Online: http://quickfacts.census.gov/qfd/index.html#
[58] U.S. DOT Trucking Company Directory. (n.d.). TruckDriver.com. Available Online: http://www.truckdriver.com/trucking-company-directory/
[59] Eisenhower Interstate Highway System. (n.d.). Federal Highway Administration. Available Online: http://www.fhwa.dot.gov/interstate/homepage.cfm.

Unfortunately, these nine states were lacking in diversity across the selection criteria.[60] Therefore, ATRI submitted a Freedom of Information Act (FOIA) request to FMCSA for 15 additional CVSPs in order to meet the diversity requirements for the case study analyses. After ATRI received the 15 additional CVSPs from FMCSA, the researchers reviewed all 24 states against the selection criteria to determine which to include in the case study analysis. The following six states were selected: California, Indiana, Massachusetts, Minnesota, Texas and Washington (Table 13).

Table 13. Representativeness of Case Study States

Selection Criteria	Geographical Distribution			
	West	Midwest	South	Northeast
Land Area				
Large (>100,000)	CA		TX	
Medium (50,000-100,000)	WA	MN		
Small (<50,000)		IN		MA
Population Count				
High (>15 million)	CA		TX	
Average (5-15 million)	WA	IN, MN		MA
Low (< 5M residents)				
Transportation Infrastructure				
Prominent (>=5)	CA,WA	IN	TX	
Limited (<5)		MN		MA
Industry Presence				
Strong (>=100)	CA, WA		TX	
Weak (<100)		IN, MN		MA

As the overarching hypothesis was that state CVSPs form the basis for enforcement variability of targeted violations, ATRI identified the top five violations per MVMT for each publicly available BASIC, with the exception of the Controlled Substances/Alcohol BASIC (in 2011 this BASIC had a total of three violations). ATRI researchers cross-referenced the top violations to CVSP strategies, calculated the difference between state and national violation rates for the top violations across each publicly available BASIC and determined the state's violation rate ranking relative to all other states. Finally, ATRI analyzed the relationship between select moving violations relative to the percentage of crash factors attributed to CMVs. For each of the case studies the crash factors represent the percentage of crash-contributing circumstances or behaviors that were attributed to the truck or truck driver. In addition, the crash factor percentages are not wholly representative of all truck crash factors within each state, but rather those that align with moving violations.

[60] ATRI did receive FY 2013 MCSAP CVSPs from two states, however could not analyze these CVSPs due to the time period and availability of data.

3.2 Results by State

California CVSP Case Study Findings

Relating CVSP Strategies to Violations

In their CVSP, California identified a list of the primary causal crash factors attributable to commercial trucks. Among the identified primary causal crash factors were speeding, improper lane change, improper turns, driving under the influence of drugs or alcohol, failure to yield to right-of-way, following too closely and improper passing. In order to mitigate the number of crashes due to these factors an increased emphasis was placed on driver-focused inspections. In addition, California CMV enforcement personnel indicated that in addition to strike force operations targeting the primary causal crash factors, they would focus on CMV driver seat belt use and CDL status. Among other CMV enforcement strategies were increased TE within the counties identified as having high-risk corridors and the reduction of CMV drivers circumventing inspection stations.[61]

The results of ATRI's California case study analysis demonstrate that enforcement of certain violations may be related to specific strategies outlined in a state's CVSP. For example, in 2011 California enforcement personnel specifically focused enforcement efforts on improper lane change, speeding, and seat belt violations. In 2011, these three violations were among the top three Unsafe Driving violations issued in California. Likewise, California CMV enforcement personnel targeted driver CDL status and in 2011 two of the top five Driver Fitness violations addressed this issue (see Appendix O for the top violations by BASIC).

According to the SMS, violation severity weights represent the relationship between the crash risk of a specific violation relative to all other violations within that BASIC. Furthermore, violation severity weights range from 1 (lowest crash risk) to 10 (highest crash risk), with 5 representing the midpoint.[62]

Though the SMS indicates that the severity weights of violations should not be compared across BASICs, it is interesting to note that several of the top five violations across the BASICs had severity weights of less than five. These findings may suggest that while California CMV enforcement personnel are targeting specific behaviors, driver qualifications, or vehicle defects they may not necessarily be targeting the violations that have a greater relationship to crash risk (based on severity weights). Alternatively, it may also indicate that minor violations, such as "log form and manner" are far more common than more serious violations and that these are frequently identified during RIs conducted for other reasons.

Furthermore, the results indicate that the rate of violation issuance across the top violations in each BASIC relative to the national rate varied. For example, carriers operating in California may be more likely to receive certain violations that are issued at a rate greater than the national average; this includes "inoperative/defective brakes" (+663.3%) in which California ranked first in the nation for most violations per MVMT. The converse appears to be true that carriers operating in California may be less likely to receive certain violations (fewer issued than

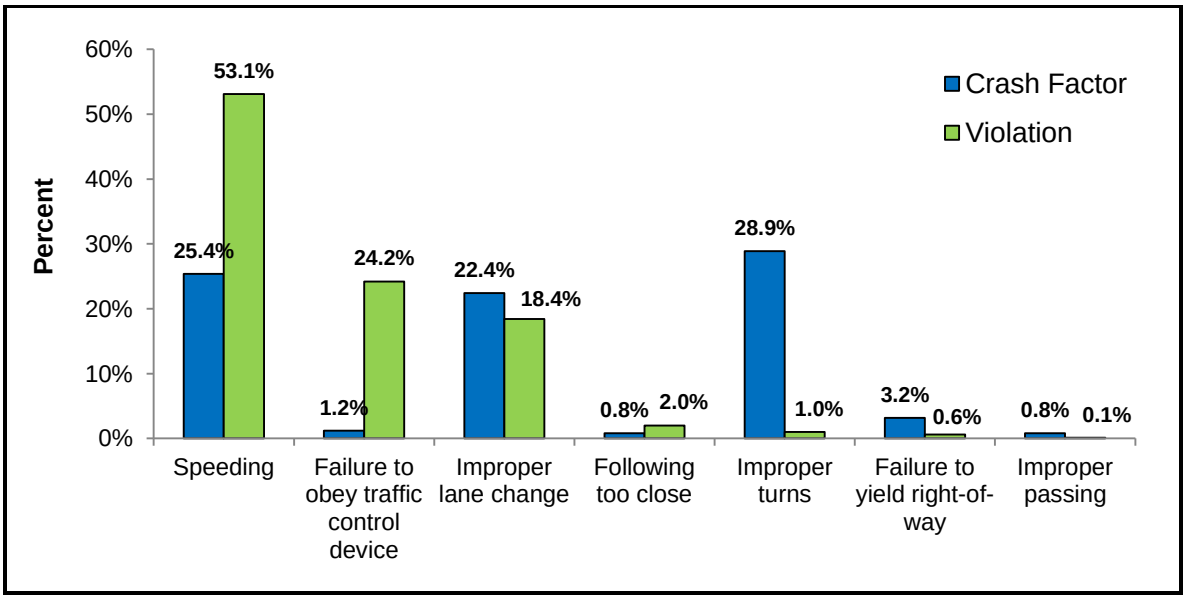
[61] California—Motor Carrier Safety Assistance Program Commercial Vehicle Safety Plan—FY 2011. Federal Motor Carrier Safety Administration.
[62] Carrier Safety Measurement System Methodology Version 3.0.1 (2013). Federal Motor Carrier Safety Administration. Available Online: http://csa.fmcsa.dot.gov/documents/smsmethodology.pdf

the national average), such as “driver failing to retain previous seven days’ logs” (-33.1%) in which California ranked 26th in the nation for most violations per MVMT.

Relating CVSP Strategies to Safety Outcomes

Figure 11 demonstrates California’s specific focus on certain violations during TEs compared to the percentage of truck crash factors for those same violations, which implies that California CMV enforcement personnel were effective in targeting certain behaviors (Figure 11). [63,64]

Figure 11. Comparing Moving Violations and Truck Crash Factors in California, 2011



For example, failure to obey traffic control device violations accounted for 24.2 percent of moving violations issued, but accounted for only 1.2 percent of truck crash factors. This may indicate that California enforcement efforts have been successful in mitigating the number of truck crash factors due to failing to obey traffic control devices. But it also proposes that enforcement personnel could realign the enforcement strategies to focus on other behaviors identified as being the top primary causal crash factors.

Likewise, in 2011 improper lane change was among the top three moving violations issued and the top three truck crash factors, suggesting that California CMV enforcement personnel are appropriately focusing on this behavior and should continue to address this behavior. Moreover, speeding accounted for the top moving violation issued and was among the top three truck crash factors, indicating enforcement personnel should continue to target drivers who exceed the speed limit.

[63] SWITRS Raw Data. California Highway Patrol. Available Online: http://iswitrs.chp.ca.gov/Reports/jsp/RawData.jsp
[64] The crash figures reported represent data coded as: at-fault, Truck or Tractor with Trailer and violations that were coded with terms similar to the moving violations.

Addressing other findings, improper turns accounted for 28.9 percent of truck crash factors, but only accounted for 1.0 percent of moving violations issued during TEs. Furthermore, previous research by ATRI found that future crash likelihood for a driver convicted of an improper turn increased by 84.0 percent.[65] California CMV enforcement personnel may benefit by realigning several violations that more closely relate to crash risk and California-identified crash factors.

California CMV enforcement personnel could address improper turns through educational outreach, campaigns and even partnerships with carriers or the California Trucking Association. For example, focus groups among enforcement personnel, carriers and drivers could be held to identify what environmental and human factors contribute to the occurrence of improper turns so that future behaviors or factors can be targeted to reduce the number of crashes due to improper turns.

Indiana CVSP Case Study Findings

Relating CVSP Strategies to Violations

Within their 2011 CVSP Indiana highlighted a number of strategies to increase CMV traffic safety. Among the listed strategies was increased TE in "high crash" areas of the following corridors: Interstates 64, 65, 69, 80, 70, 465 and U.S. Highways 20, 30 and 31. In addition, it was noted that in 2009, improper lane change, following too close, speeding too fast for weather conditions and unsafe speed accounted for 50.0 percent of all crashes among the aforementioned high crash locations. Therefore, in 2011 Indiana CMV enforcement personnel placed increased TE emphasis on these violations. In addition, Indiana CMV enforcement personnel set goals to exceed the number of RIs completed in 2010, increase the number of Level III RIs and increase seat belt compliance.[66]

The results of the Indiana case study analysis demonstrate that certain violation rates are related to specific strategies outlined in a state's CVSP. For example, in 2011 Indiana CMV enforcement specifically focused on speeding, following too close and seat belt violations. In 2011, these violations were among the top five Unsafe Driving violations issued per MVMT by Indiana CMV enforcement personnel (see Appendix P for the top violations across each BASIC). It is interesting to note that several of the top five violations across the BASICs had severity weights of less than five. Echoing previous conclusions, these findings may be due to lower severity weighted violations being more common than violations with stronger crash risk weightings.

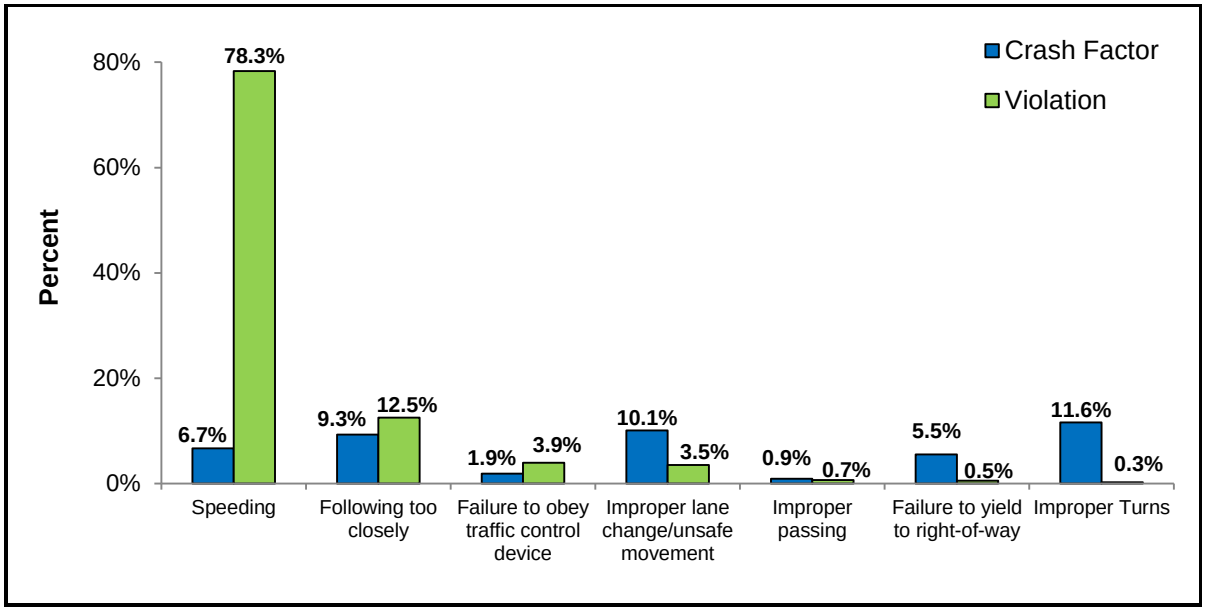
Furthermore, the results indicate that if carriers are operating in Indiana they may be more likely to receive certain violations such as "lane restriction" (+528.7% higher than the national average) in which Indiana ranked second in the nation for most violations issued per MVMT. The opposite is true for certain violations such as "operating a CMV without periodic inspection" (-21.0%) in which Indiana ranked 20th for most violations issued per MVMT.

[65] Lueck, M.D., & Murray, D.C. (2011). Predicting Truck Crash Involvement: A 2011 Update. Arlington, VA: American Transportation Research Institute.
[66] Indiana Motor Carrier Safety Assistance Program Commercial Vehicle Safety Plan FY 2011. Federal Motor Carrier Safety Administration.

Relating CVSP Strategies to Safety Outcomes

Relative to Indiana's specific focus of certain violations during TEs, the percentage of truck crash factors for the same violations conveys that Indiana CMV enforcement personnel were effective in targeting certain behaviors (Figure 12). [67,68]

Figure 12. Comparing Moving Violations and Truck Crash Factors in Indiana, 2011



For example, as noted within Indiana's CVSP, following too closely was recognized "as one of the most common CMV-related contributing crash factors in 2009," therefore continued emphasis would be placed on this violation. As displayed in Figure 12, following too closely was among the top three moving violations and truck crash factors in 2011, implying continued focus was appropriate. Furthermore, failure to obey traffic control device accounted for a greater percentage of violations relative to its truck crash factor indicating that Indiana was appropriately targeting this behavior.

Addressing other findings Indiana CMV enforcement personnel should consider redistributing emphasis from speeding violations to other behaviors that exhibit disproportionate relationships between the percentages of moving violations issued relative to the truck crash factors. For example, improper turns accounted for 11.6 percent of truck crash factors, but only 0.3 percent of moving violations. As previously noted, Lueck and Murray (2011) determined that a driver convicted of an improper turn is 84.0 percent more likely to be involved in a future crash.

[67] ATRI requested and obtained truck crash data from the Indiana University Public Policy Institute (IUPPI). Available Online: http://policyinstitute.iu.edu/contact-us/startaproject

[68] The crash figures reported represent data coded as: Tractor/one semi-trailer, Tractor/double trailer, Tractor/triple trailer; violations that were coded with terms similar to the moving violations; and when the contributing circumstance matched the primary crash factor which determined that the crash factor was attributable to the vehicle.

In addition, Indiana CMV enforcement personnel noted in their CVSP that improper or unsafe lane movements[69] were among the top performance target objectives during TEs. However, in 2011 improper lane change accounted for 3.5 percent of moving violations issued, but 10.1 percent of truck crash factors were due to unsafe lane movements. Again, previous research suggests that a driver who receives an improper lane change violation is 41.0 percent more likely to be involved in a future crash.

Likewise, Indiana's CVSP highlighted failure to yield to right-of-way among the top performance target objectives during TEs. However, in 2011 failure to yield to right-of-way accounted for 5.5 percent of truck crash factors and only 0.5 percent of moving violations issued.

Massachusetts CVSP Case Study Findings

Relating CVSP Strategies to Violations

In the 2011 CVSP, Massachusetts CMV enforcement personnel identified a number of strategies to increase highway traffic safety. Among them was an increased emphasis on CMV driver seat belt compliance. Massachusetts enforcement personnel received additional training on seat belt compliance, statutory materials and materials related to the "Be Ready, Be Buckled" campaign. In addition, Massachusetts CMV enforcement personnel received distracted driving training and were encouraged to target CMV drivers exhibiting unsafe driving behaviors. Likewise, Massachusetts increased TE presence at identified high crash corridors and work zones.[70]

The results of the Massachusetts case study analysis determined that many of the state's CVSP objectives mapped well to violation issuance. For example, in 2011 Massachusetts enforcement personnel noted a goal to increase seat belt use among CMV drivers. Not only were seat belt violations the top Unsafe Driving violation issued in Massachusetts, the state also ranked first nationally for most seat belt violations issued per MVMT (see Appendix Q for the top violations across each BASIC). Reiterating previous findings, several of the top five violations across the BASICs had severity weights of less than five which may mean that these violations are more likely to be identified during RIs and that more serious violations are less common.

However, the results also identified violation issuance variability to national rates. If carriers are operating in Massachusetts they may be more likely to receive "false report of driver's record of duty status" (+38.9% higher than national average) in which Massachusetts ranked ninth in the nation for most violations per MVMT. Alternatively, carriers operating in Massachusetts may be less likely to receive a "driver lacking physical qualifications" violation (-15.8% lower than national average) in which Massachusetts ranked 19th nationally for most violations per MVMT.

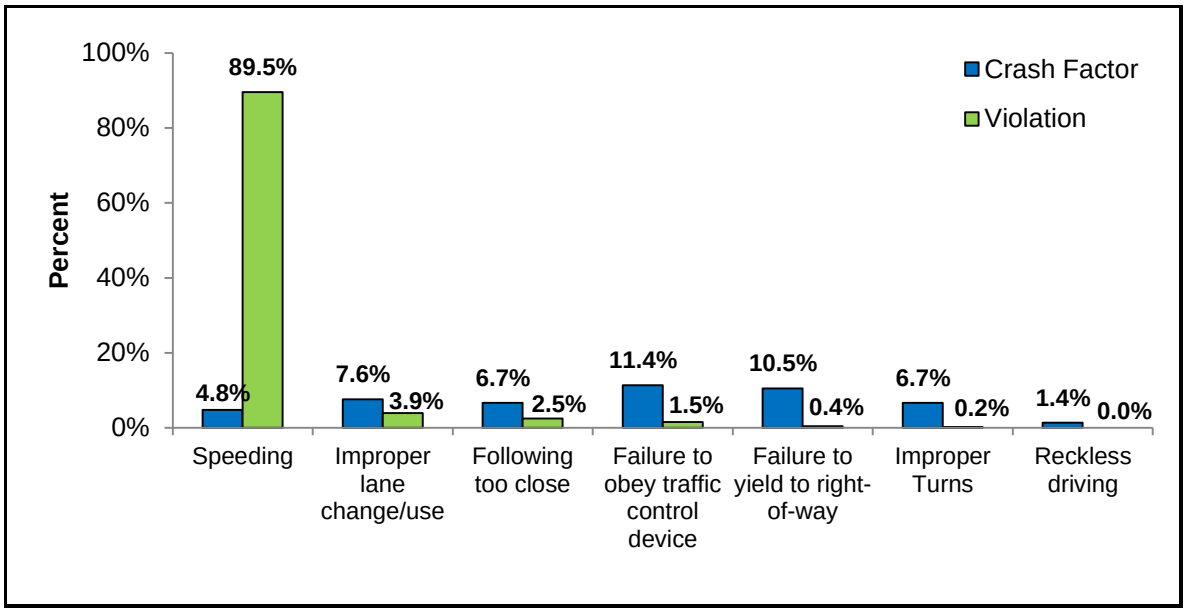
[69] ATRI contacted IUPPI to clarify whether the crash factor "unsafe lane movement" encompassed improper lane change, as improper lane change was not a specific crash factor in the data. Staff at IUPPI informed ATRI that "unsafe lane movement" is the crash factor option provided on the Automated Reporting Information Exchange System (ARIES) crash forms used by Indiana enforcement personnel and while improper lane changes are likely included under this heading, the staff at IUPPI cannot definitively state that improper lane change is included. Email correspondence with Sam Nunn, IUPPI. July 28, 2014.

[70] Massachusetts Motor Carrier Safety Assistance Program Commercial Vehicle Safety Plan FY 2011. Federal Motor Carrier Safety Administration.

Relating CVSP Strategies to Safety Outcomes

The comparison of the moving violation percentages relative to the truck crash factor percentages suggests that Massachusetts' enforcement personnel should realign their enforcement efforts to target multiple unsafe driving behaviors relative to the predominant focus on speeding violations (Figure 13).[71,72]

Figure 13. Comparing Moving Violations and Truck Crash Factors in Massachusetts, 2011



Of particular note is that in 2011 zero reckless driving violations were issued to truck drivers, however reckless driving accounted for 1.4 percent of the truck crash factors. It may be that a TE officer issued a written citation for reckless driving, but not a federal violation (which counts under CSA). However, this is an issue given that future crash involvement of a driver convicted of reckless driving increases by 64.0 percent (Lueck & Murray, 2011). Enforcement personnel may need to refocus their efforts to better target and issue violations to drivers who behave in a reckless manner.

Addressing other findings, Massachusetts enforcement personnel should consider increasing emphasis on drivers who exhibit aggressive driving behaviors other than speeding, such as failure to yield to right-of-way, improper lane change,[73] or failure to obey traffic control device as these collectively accounted for 29.5 percent of truck crash factors but only 5.8 percent

[71] Crash Records. Ad Hoc Query Tool. Massachusetts Department of Transportation. Available Online: http://services.massdot.state.ma.us/crashportal/MainIntro.aspx
[72] The crash figures reported represent data coded as: Tractor/semi-trailer, Tractor/doubles, & Tractor/triples, and violations that were coded with terms similar to the moving violations.
[73] Massachusetts' crash data did not include a specific behavior coded as "improper lane change" as a contributing crash factor. To determine the percentage of crash factors attributable to improper lane changes, ATRI researchers selected crash records with the pre-crash vehicle behavior coded as entering, exiting, or changing lanes.

(collectively) of issued moving violations. The likelihood of a future crash increases by 68.0 percent for drivers convicted of failure to obey traffic sign and by 80.0 percent for drivers convicted of an improper lane change (Lueck & Murray, 2011).

In general, the above findings illustrate that Massachusetts CMV enforcement personnel efficiently target unsafe truck drivers who speed, however less attention is devoted to other violations that accounted for a greater percentage of truck crash factors in 2011. Massachusetts enforcement personnel participate in the "Road Respect" traffic safety campaign which targets aggressive driving and provides a "Top 10 Safety Tips" list for roadway safety.[74] Future promotions of the program could involve a combination of education and enforcement activities that target specific tips, such as "never run yellow lights and come to a full stop at red lights and stop signs," in order to raise awareness and increase compliance.

Minnesota CVSP Case Study Findings

Relating CVSP Strategies to Violations

Within their 2011 CVSP Minnesota highlighted a number of strategies to increase CMV traffic safety with a predominant focus on driver conduct. One method to combat unsafe driving behaviors was the continued participation of Minnesota enforcement personnel in the Ticketing Aggressive Cars and Trucks (TACT) program. Following the theme of increased driver focus, Minnesota CMV enforcement personnel placed special attention on increasing the number of Level III RIs, seat belt violations, medical certificate violations, CDL status violations, HOS Compliance violations, and targeting ill or fatigued drivers.[75]

The results of the Minnesota case study analysis found that in 2011 Minnesota enforcement personnel specifically focused enforcement efforts on seatbelt violations, making this the state's top Unsafe Driving violation (see Appendix R for the top violations across each BASIC). Once again it is interesting to note that several of the top five violations across the BASICs had severity weights of less than five. Recapping previous conclusions, these findings may indicate that Minnesota CMV enforcement personnel are not necessarily targeting the violations that have a greater relationship to crash risk or these violations are more likely to be issued during TEs or RIs.

Furthermore, the results indicate that if carriers are operating in Minnesota they may be more likely to receive violations such as the "failure to obey traffic control device" (+153.5% higher than the national average) in which Minnesota ranked fourth in the nation for most violations per MVMT. The opposite may also be true; carriers operating in Minnesota may be less likely to receive "speeding 11-14 MPH over the speed limit" violations (-32.4% lower than the national average) in which Minnesota ranked 29th for most violations per MVMT.

Relating CVSP Strategies to Safety Outcomes

The comparison of the moving violation percentages relative to the truck crash factor percentages implies that Minnesota's CMV enforcement focus on failure to obey traffic control

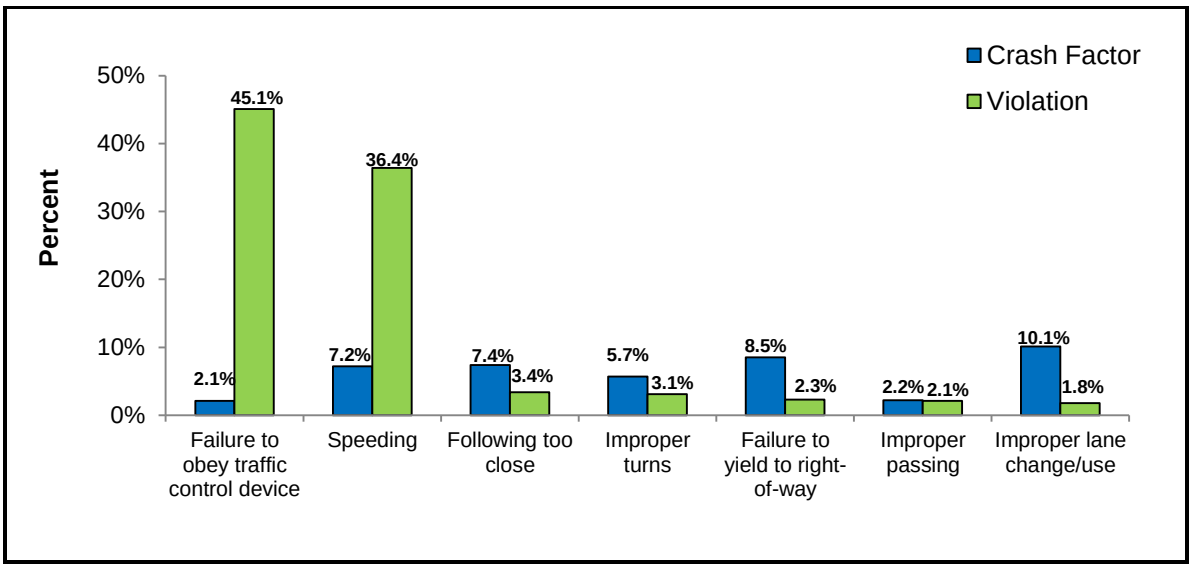
[74] Road Respect. (n.d.). Massachusetts Executive Office of Public Safety and Security. Available Online: http://www.mass.gov/eopss/crime-prev-personal-sfty/traffic-safety/road-respect.html

[75] Minnesota—Motor Carrier Safety Assistance Program Commercial Vehicle Safety Plan—FY 2011.Ibid. Federal Motor Carrier Safety Administration.

device violations has been effective as this accounted for 2.1 percent of truck crash factors in 2011 (Figure 14).[76, 77]

Furthermore, improper passing violations accounted for 2.1 percent of all moving violations issued and 2.2 percent of truck crash factors, which may indicate that enforcement personnel are dedicating an appropriate level of focus to improper passing violations. These findings may also indicate that CMV enforcement personnel could reallocate their focus to other types of moving violations where disparate relationships exist between the percentages of violations issued relative to the percentages of truck crash factors.

Figure 14. Comparing Moving Violations and Truck Crash Factors in Minnesota, 2011



For example, in 2011 improper or unsafe lane use[78] accounted for 10.1 percent of the truck crash factors, however only 1.8 percent of moving violations were due to improper lane change. Likewise, failure to yield to right-of-way, following too closely and improper turns accounted for greater percentages of truck crash factors relative to the percentages of moving violations issued, proposing that enforcement personnel should increase their attention to these behaviors.

One strategy could be printing research findings on violation/citation forms that indicate that the likelihood of a future crash increases by 41.0 percent for drivers who receive a following too close violation, by 41.0 percent for drivers who receive an improper lane change violation, by

[76] Minnesota Motor Vehicle Crash Facts—2011. (2012). Minnesota Department of Public Safety. Available Online: https://dps.mn.gov/divisions/ots/educational-materials/Documents/CRASH-FACTS-2011.pdf

[77] The crash figures reported represent data coded as: Two-axle, six tire-single unit truck or step van, three or more axle single unit truck, single unit truck with trailer, truck tractor with no trailer, truck tractor with semi-trailer, truck tractor with double trailers, truck tractor with triple trailers and heavy truck of other or unknown type.

[78] ATRI verified with the Minnesota Department of Public Safety that the crash factor coded as "improper or unsafe lane use" encompasses improper lane changes, however this finding should be interpreted with caution as it may include other behaviors related to unsafe lane use. Phone conversation with Lisa Elliott, Minnesota Department of Public Safety. July 28, 2014.

80.0 percent for drivers who are convicted of an improper lane change and by 84.0 percent for drivers who receive an improper turn conviction (Lueck & Murray, 2011).

Texas CVSP Case Study Findings

Relating CVSP Strategies to Violations

In 2011 Texas CMV enforcement personnel highlighted a number of activities to improve traffic safety. Among the key focus areas was the increased presence of CMV enforcement among the top 60 counties identified as "high crash" locations. Additionally, a specific focus was placed on aggregate haulers within the Dallas/Fort Worth Metroplex as their driver and vehicle OOS rates tend to be exceptionally high. Another tactic among Texas CMV enforcement personnel was the targeting of seat belt and radar detector violations. Likewise, Texas CMV enforcement personnel noted that speeding, following too close, improper lane change and sign/signal offenses were the top behaviors that would be targeted during TEs.[79]

The results of the 2011 Texas case study analysis demonstrate that Texas CMV enforcement personnel specifically targeted drivers who failed to wear seat belts, sped, engaged in improper lane changes, failed to obey traffic control devices, and equipped their trucks with radar detectors. These behaviors were among the top five Unsafe Driving violations issued in Texas in 2011 (see Appendix S for the top violations across each BASIC). Once again, several of the top five violations across the BASICs had severity weights of less than five. This may imply that these violations are more common than severe violations and are more likely to be identified during TE activities.

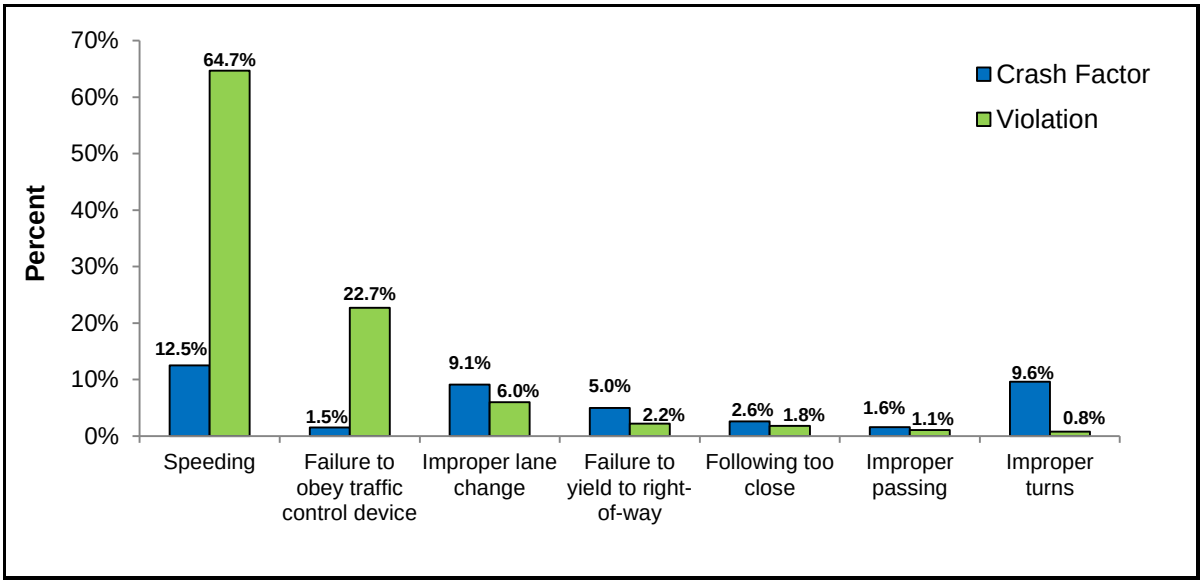
Furthermore, the results indicate that if carriers are operating in Texas they may be more likely to receive violations such as "oil and/or grease leak" (+383.6% higher than the national average) in which Texas ranked second for most violations per MVMT. In contrast, carriers operating in Texas may be less likely to receive violations such as "expired medical examiner's certificate" (-40.1% lower than the national average) in which Texas ranked 36th for most violations issued per MVMT.

Relating CVSP Strategies to Safety Outcomes

The comparison of the moving violation percentages relative to the truck crash factor percentages suggests that the enforcement focus on failure to obey traffic control device violations has been effective as this accounted for 22.7 percent of moving violations in Texas, but only 1.5 percent of truck crash factors in the state in 2011 (Figure 15). [80,81]

[79] Texas—Motor Carrier Safety Assistance Program Commercial Vehicle Safety Plan—FY 2011. Federal Motor Carrier Safety Administration.
[80] ATRI requested and obtained truck crash data from the Texas Department of Transportation. The data obtained represent crash records reported by Texas Peace Officer Crash Reports and are considered reportable when "any crash involving a motor vehicle in transport that occurs or originates on a traffic way, results in injury to or death of any person, or damage to the property of any one person to the apparent extent of $1,000." Available Online: http://www.txdot.gov/government/enforcement/crash-statistics.html
[81] The crash figures reported represent data coded as: Truck Tractor and violations that were coded with terms similar to the moving violations.

Figure 15. Comparing Moving Violations and Truck Crash Factors in Texas, 2011



Likewise, the percentage of truck crash factors and moving violations issued for improper passing are relatively similar suggesting that the Texas CMV TE focus is adequate for this violation. Furthermore, speeding violations accounted for 64.7 percent of all moving violations issued and 12.5 percent of truck crash factors. This finding may indicate that enforcement personnel are dedicating an appropriate focus to speeding violations, as this accounted for a greater percentage of truck crash factors. However, these findings may also indicate that Texas CMV enforcement personnel could reallocate their focus to other types of moving violations where disparate relationships exist between the percentages of violations issued relative to the percentages of truck crash factors.

For example, in 2011 improper turn violations accounted for 0.8 percent of the moving violations issued, but 9.6 percent of truck crash factors. This finding implies that Texas CMV enforcement personnel should devote more attention to drivers that engage in improper turns.

In addition, though the Texas CVSP noted that improper lane changes would be of specific focus during TE, the percentage of truck crash factors was greater than the percentage of violations issued for improper lane changes. A greater percentage of crash factors were attributable to failure to yield to right-of-way relative to the percentage moving violations issued.

Washington CVSP Case Study Findings

Relating CVSP Strategies to Violations

In 2011 Washington CMV enforcement personnel outlined a number of activities to improve traffic safety. Washington participated in several CVSA, FMCSA and state-sponsored safety events including Operation Safe Driver, Operation Air Brake, All American Buckle-Up Weeks, Road Check, TACT, Open Scales and Chain Enforcement. In addition, Washington CMV enforcement personnel targeted seat belt use, HOS violations, OOS orders, proper endorsements for hazardous materials and cellular phone use. Furthermore, strike force operations were set up in high risk corridors with specific emphases on logbook violations and load securement issues. In addition, TEs targeted drivers who exceeded unsafe speeds, were inattentive, followed too close and changed lanes improperly.[82]

The results of the 2011 Washington case study analysis demonstrate that in 2011 Washington CMV enforcement personnel specifically targeted drivers who failed to wear seat belts and sped. These behaviors were among the top Unsafe Driving violations issued in Washington in 2011 (see Appendix T for the top violations across each BASIC). Once again several of the top five violations across the BASICs had severity weights of less than five, insinuating that minor driver and vehicle violations are more likely to occur than more serious infractions.

Furthermore, the results indicate that if carriers are operating in Washington they may be more likely to receive violations such as "improper passing" (+510.2% higher than national average) in which Washington ranked first for most violations per MVMT. On the other hand, carriers operating in Washington may be less likely to receive violations such as "inspection or repair and maintenance parts and accessories" (-21.8% below national average) in which Washington ranked 21st for most violations issued per MVMT.

Relating CVSP Strategies to Safety Outcomes

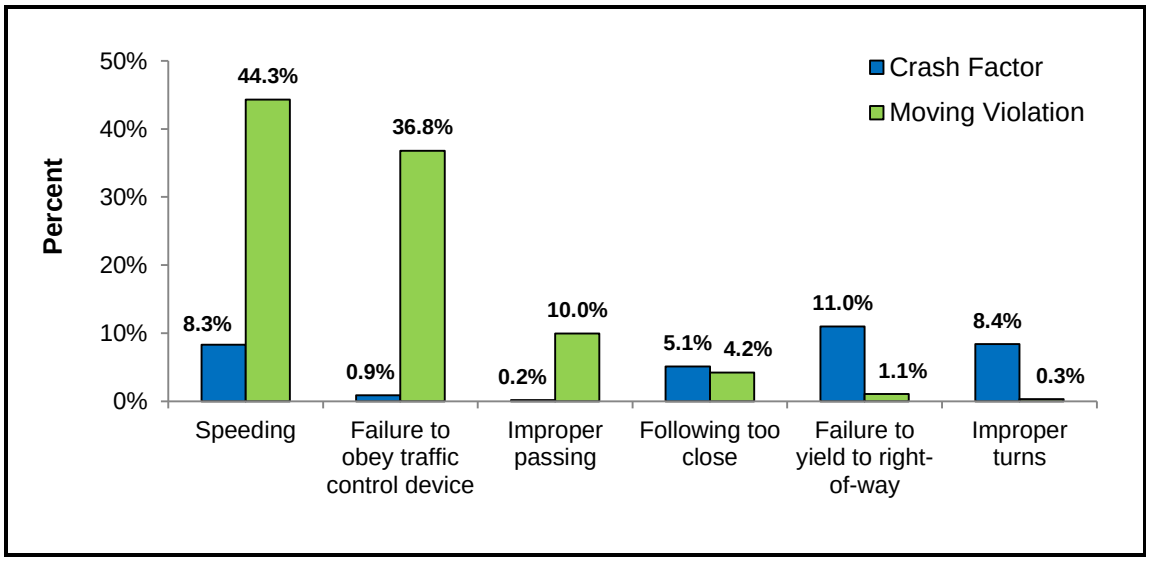
The comparison of the moving violation percentages relative to the truck crash factor percentages suggest that Washington's CMV enforcement focus on improper passing has been effective as this accounted for 10.0 percent of moving violations and 0.2 percent of truck crash factors (Figure 16).[83,84] In addition, failure to obey traffic control device accounted for 36.8 percent of the moving violations, but only 0.9 percent of truck crash factors. Furthermore, enforcement personnel focus on speeding violations (44.3%) may be appropriate given that these accounted for a greater percentage of truck crash factors (8.3%).

These findings may indicate that enforcement personnel are dedicating an appropriate focus to speeding, failure to obey traffic control device and improper passing violations. However, these findings may also indicate that Washington CMV enforcement personnel could reallocate their

[82] Washington—Motor Carrier Safety Assistance Program Commercial Vehicle Safety Plan—FY 2011. Federal Motor Carrier Safety Administration.
[83] ATRI requested and obtained truck crash data from the Washington State Department of Transportation. Available Online: http://www.wsdot.wa.gov/mapsdata/collision/collision_reports.htm
[84] The crash figures reported represent data coded as: Truck (Flatbed, van, etc.), Truck Tractor, Truck Tractor & Semi-Trailer, Truck-Double Trailer Combinations; vehicle and/or trailer with gross vehicle weight rating of 26,001+ pounds; and violations that were coded with terms similar to the moving violations.

focus to other types of moving violations where disparate relationships exist between the percentages of violations issued relative to the percentages of truck crash factors.

Figure 16. Comparing Moving Violations and Truck Crash Factors in Washington, 2011



For example, failure to yield to right-of-way accounted for 11.0 percent of truck crash factors, but only 1.1 percent of moving violations. In addition, Washington CMV enforcement personnel may want to focus on drivers that engage in improper turns as this accounted for 8.4 percent of truck crash factors, but only 0.3 percent of violations issued.

Finally it is worth noting that Washington's 2011 CVSP identified improper lane changes as an enforcement priority, however this was not recorded as a truck crash factor within the crash data. ATRI contacted the Washington State Department of Transportation about this finding and was informed that while improper lane changes may be a factor related to crashes it was not identified as a primary contributing circumstance in truck crashes.[85]

3.3 Conclusion: Understanding State Enforcement Objectives

The state case studies demonstrate that states share the same goal of increasing traffic safety through reduced CMV-related crashes and that specific enforcement emphases may or may not overlap between states. Furthermore, the results indicated a relationship between specific enforcement strategies and the top violations within a BASIC. For example, seat belt compliance was identified as a top priority across all case study states in which it was also among the top five Unsafe Driving violations issued across all case study states. However, the rate of seat belt violation issuance relative to the national average varied across the states with Massachusetts ranking first with 2.3 violations per MVMT and California ranking 46th with 0.03 violations per MVMT.

[85] Phone conversation with Mike Bernard, Washington State Department of Transportation. July 1, 2014.

In addition, it is interesting to note that across all six of the case studies several of the top five violations for each BASIC had severity weightings less than five, which may suggest that these violations are more likely to be issued than more serious violations. Moreover, these findings may suggest that drivers are less likely to commit more serious violations. Furthermore, the results illustrate that carrier scores across the BASICs are likely influenced by a combination of carrier safety performance and operating patterns as well as disparate violation issuance rates across the states. Finally, the relationships between the truck crash factors and state enforcement objectives illustrate that in some instances enforcement efforts are appropriately applied. However, in other instances resources may need to be reallocated to better target more prevalent crash causation behaviors.

TASK 4. Carrier Case Studies

The various analyses of this research have shown that differences exist in enforcement strategies and safety outcomes across states. Regardless of the merits of each state's strategy, these differences ostensibly generate disparate impacts on CSA scores that are presented and treated as a standardized safety monitoring system for all 50 states. Since different enforcement priorities and strategies target different violations, the result is that states issuing various violations at a much higher or lower rate than the national average have different impacts on carrier BASIC scores. The larger a carrier's VMT is in a particular state, the more likely that state's enforcement priorities will affect that carrier's score. As noted earlier, one might argue that enforcement disparities do not affect carrier BASIC scores as the measures are calculated using a ratio of violations to inspections (except Unsafe Driving and Crash Indicator). However, previous analyses demonstrated that states *do* issue violations at differing rates when normalized by relevant inspections, which supports the argument that enforcement disparities influence carrier BASIC scores.

Hypothetically, if Carrier X has all of their miles in a state with a violation rate three-times the national average, while Carrier Y only has five percent of their VMT in that same state, Carrier X will see a much larger negative impact on their BASIC scores than Carrier Y. Conversely, this same effect can also produce lower scores for carriers that have a higher share of VMT in states with violation rates below the national average. Both examples create a challenge in interpreting and broadly applying CSA at a carrier-level, relative to its peers. While this simplified example conceptually highlights the potential bias in BASIC scores due to state enforcement disparities, a review of motor carrier data empirically validates that enforcement disparities are likely impacting carrier BASIC scores.

For example, one carrier in the case studies had slightly less than 7 percent of its annual VMT in a particular state, yet over 32 percent of that carrier's Unsafe Driving violation points were issued by that same state. If state enforcement disparities were non-existent, a carrier's share of VMT in a state would be equitable to the carrier's share of violations in that state, all things being equal. The subsequent carrier case studies demonstrate the impact of disparities on carrier BASIC scores and model the theoretical changes in BASIC scores that would result from more uniform enforcement.

4.1 Methodology

Carrier Case Study Selection

ATRI selected seven carriers to model the impact of enforcement disparities using empirical safety data. As Table 14 shows, ATRI chose primarily large carriers for this exercise to ensure access to adequate, detailed data and to ensure that BASIC scores would be available from the carriers in nearly all the public BASICs. Carrier G was the lone small carrier included in the case study analysis and did not have sufficient data to generate a Driver Fitness BASIC score. Therefore this carrier was excluded from the Driver Fitness analysis. Carriers provided ATRI with a signed informed consent form and their International Fuel Tax Agreement (IFTA) fuel tax miles.[86] ATRI also obtained carrier safety performance data for the five public BASICs from

[86] IFTA 101. (n.d.). *International Fuel Tax Association, Incorporated.* Available Online: http://www.iftach.org/

FMCSA's SMS website.[87,88] The SMS data from FMCSA was merged with the operational data provided by the carrier. Due the availability of data inputs from the carriers and FMCSA's SMS the analyses in this section were completed using data for the time period of 2012-2014.

Table 14. Profile of Case Study Carriers

		Safety Event Group				
Carrier	**# of Power Units**	**Unsafe Driving**	**HOS Compliance**	**Driver Fitness**	**Controlled Substances/ Alcohol**	**Vehicle Maintenance**
A	1,000-2,000	150+ Combination	501+	501+	2	501+
B	1,000-2,000	58-149 Combination	501+	501+	1	501+
C	1,000-2,000	58-149 Combination	501+	501+	1	501+
D	<1,000	150+ Combination	501+	501+	N/A	501+
E	>2,000	150+ Combination	501+	501+	4	501+
F	1,000-2,000	150+ Combination	501+	501+	1	501+
G	<100	9-21 Combination	101-500	101-500	1	21-100

BASIC Score Revision Model

A key assumption of the carrier case study research is that a particular carrier's safety culture, training programs, vehicle types and driver history do not vary from state to state; in other words, if a driver crosses from State A into State B, it is unlikely that noticeable safety differences would ensue. Therefore the research uses carrier data and metrics as a stable baseline, supported by the statistically defensible use of VMT metrics (i.e. a particular carrier's VMT in a state is strongly correlated to the number of violations that carrier would receive in that state). In other words, from a VMT perspective, there should be minimal variability in any one carrier's violation rate per mile from state to state. The fundamental approach of these carrier case studies is to model the impact that uniform enforcement would have on existing SMS scores. Simply put, how would a carrier's BASIC score change if every state issued violations at the same rate for that carrier?

While safety culture for a particular carrier should not vary from state to state, safety can vary significantly between different carriers (hence the importance of CSA). As such, ATRI determined the actual violation rate for each carrier in the case study and used it to model a recalibrated violation rate based on each carrier's exposure to state enforcement disparities.

[87] Analysis and Information Online. (n.d.). Safety Measurement System. Federal Motor Carrier Safety Administration. Available Online: http://ai.fmcsa.dot.gov/SMS/Default.aspx

[88] While carrier inspection and violation data are available for the HazMat Compliance BASIC, a carrier's SMS score for this BASIC is restricted.

There were three key steps in this modeling activity[89]:

1. **Generate state disparity factor:** Document a delta between each state's violation rate to national norms for each BASIC to determine if the state is issuing more or fewer violations than average.

2. **Calculate carrier disparity exposure:** Using each carrier's VMT by state, calculate whether the carrier's operational patterns expose it to higher- or lower-than-average violation rates.

3. **Compute revised safety score:** Based on the carrier's disparity exposure, adjust the number of actual violation points to compute a revised number of violation points. From this, a corrected SMS measure and percentile can be generated that equalizes the enforcement disparities between states, yet still accounts for the differences in safety between carriers.

It is important to note that these carrier case studies only provide a theoretical estimate of the revised percentile scores and are not intended to reflect what ATRI believes should be the actual percentile scores for these carriers. National percentile score data is not readily available from FMCSA's Analysis and Information (A&I) website and the method used by ATRI may not be as precise as if percentile data for each peer group were available. More importantly, these are percentile scores, which are based on the SMS measures of other carriers in that peer group. While a relatively accurate estimate can be given if one carrier's score changes and the rest remain constant, it is impossible to predict how percentile scores would change if all carrier SMS measures changed. The purpose of investigating the percentile score changes is to highlight the large changes in scores that enforcement disparities can cause, which can distort the actual safety record of a carrier relative to its peers.

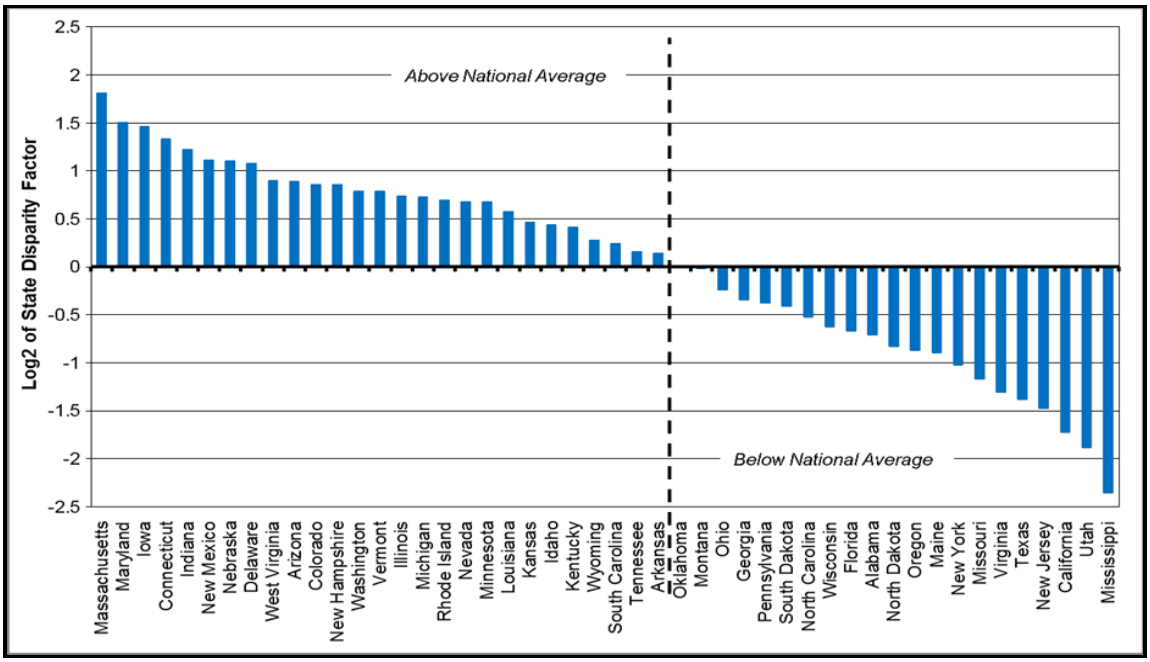
4.2 Results by BASIC

Unsafe Driving BASIC

As described in the methodology, ATRI analyzed the number of Unsafe Driving violations in each state relative to total truck VMT and compared that rate to the national average. Of the 48 states analyzed, 27 had Unsafe Driving violation rates greater than the national average of 2.6 Unsafe Driving violations per MVMT, while the remaining 21 states were below the national average.[90] Figure 17 sorts the corresponding State Disparity Factors in descending order. Note that the disparity factors were log transformed in Figure 17 for ease of understanding. Disparity factors greater than zero indicated violation rates above the national average, while factors less than zero indicated a violation rate below the national average. Massachusetts had the highest Unsafe Driving violation rate per MVMT, while Mississippi had the lowest rate.

[89] ATRI developed a series of inputs, formulas and algorithms that generated the outputs for the BASIC Score Revision Model. For additional information on the model, related assumptions and detailed outputs, contact ATRI.
[90] ATRI used mean averages in this modeling activity to illustrate that states with extremely high or low violation rates (outliers) can skew the data inputs for the SMS. An alternative to a mean average would be the use of a median average, which would not be susceptible to the effects of extreme outliers. The median average for Unsafe Driving violations per MVMT was 3.1.

Figure 17. State Disparity Factor for Unsafe Driving BASIC

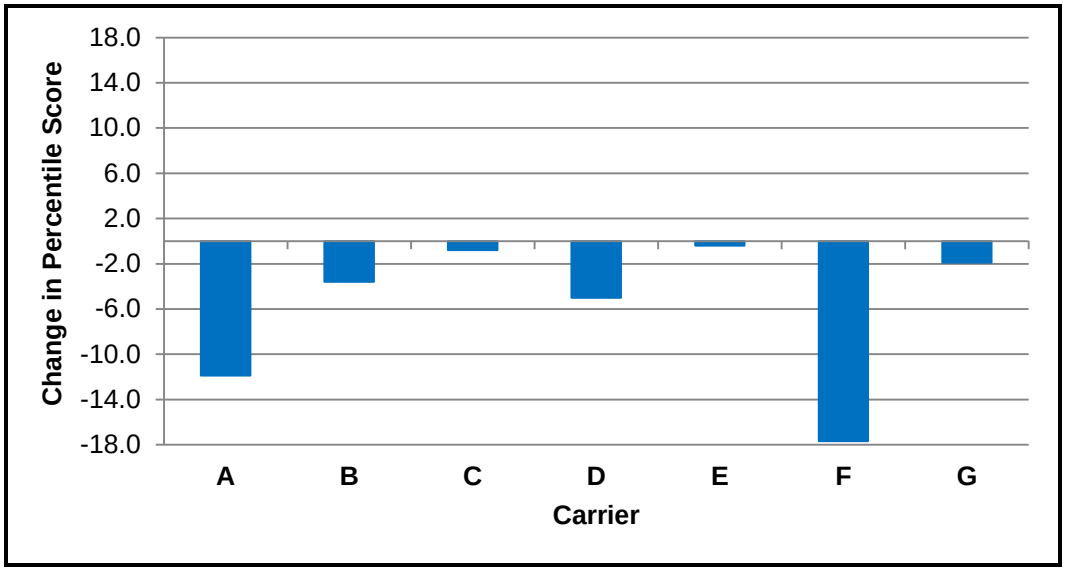


Given that motor carriers operate across a variety of geographic footprints, some carriers may be subjected to higher or lower rates of Unsafe Driving violations simply due to their VMT footprint in the states in which they operate. Using national averages, ATRI can project the impact that a carrier's exposure to enforcement disparities can have on violation rates. Hypothetically, if 100 percent of a carrier's VMT occurred in Massachusetts (the state with the highest violation rate) and that carrier had a total of 100 Unsafe Driving violation points, the carrier would have received only 29 violation points after adjusting the carrier's score if Massachusetts issued Unsafe Driving violations at the same rate as the national average.

Conversely, if a carrier had 100 percent of their VMT in Mississippi (the state with the lowest violation rate) and that carrier had a total of 100 Unsafe Driving violation points, the carrier would have received 513 Unsafe Driving violation points after adjusting the carrier's score if Mississippi issued Unsafe Driving violations at the same rate as the national average. After adjusting for enforcement disparities, two carriers that appeared equally safe (both with 100 violation points) are actually revealed to have quite different safety records.

In practice, the impacts of enforcement disparities across states may not be as dramatic. Using the data for the seven case study carriers, ATRI revised the Unsafe Driving BASIC percentile scores to account for enforcement disparities. As Figure 18 illustrates, all seven carriers saw a decline in Unsafe Driving percentile scores after adjusting scores to account for enforcement disparities. Carrier F saw the largest decline (17.7 points) while Carrier E had a much smaller decline (0.4 points).

Figure 18. Theoretical Change in Unsafe Driving Percentile Score



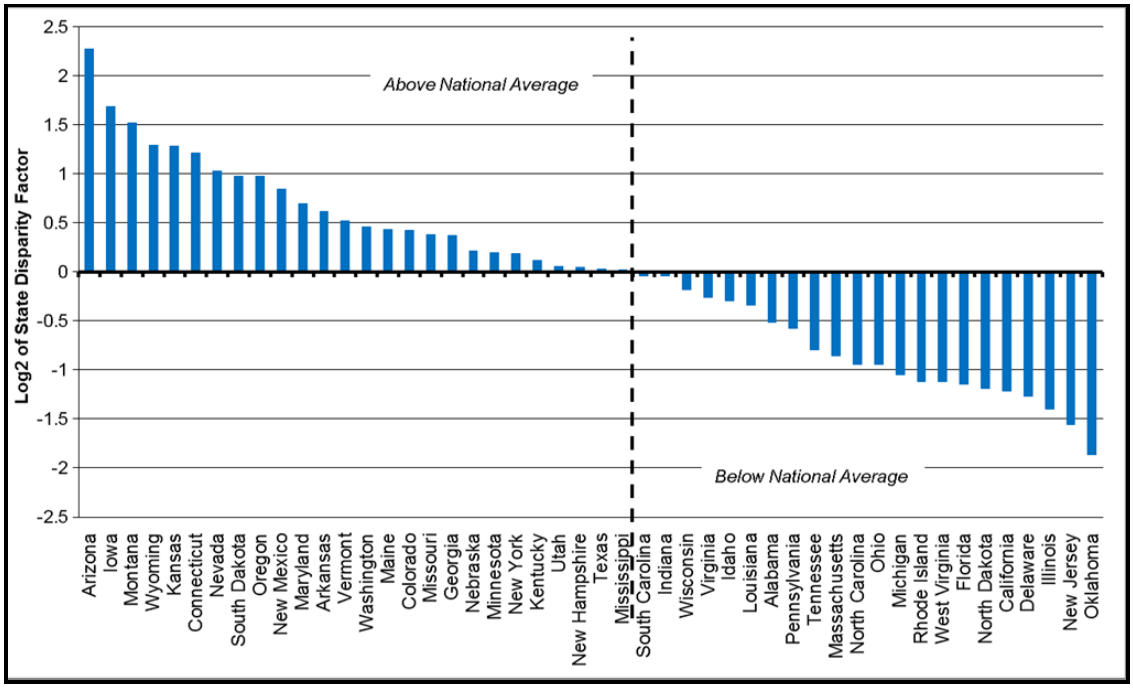
HOS Compliance BASIC

Next, ATRI studied the HOS Compliance BASIC. Of the 48 states analyzed, 26 had HOS Compliance violation rates greater than the national average of 4.9 HOS Compliance violations per MVMT, while 22 states were below the national average.[91] As Figure 19 illustrates, Arizona had the greatest HOS Compliance disparity factor, while Oklahoma had the smallest disparity factor. Hypothetically, if 100 percent of a carrier's VMT occurred in Arizona and that carrier had a total of 100 HOS Compliance violation points, the carrier would have received 21 HOS Compliance violation points after adjusting the carrier's score if Arizona issued HOS Compliance violations at the same rate as the national average.

On the other hand, if a carrier had 100 percent of their VMT in Oklahoma and had a total of 100 HOS Compliance violation points, the carrier would have received 365 HOS Compliance violation points after adjusting the carrier's score if Oklahoma issued HOS Compliance violations at the same rate as the national average.

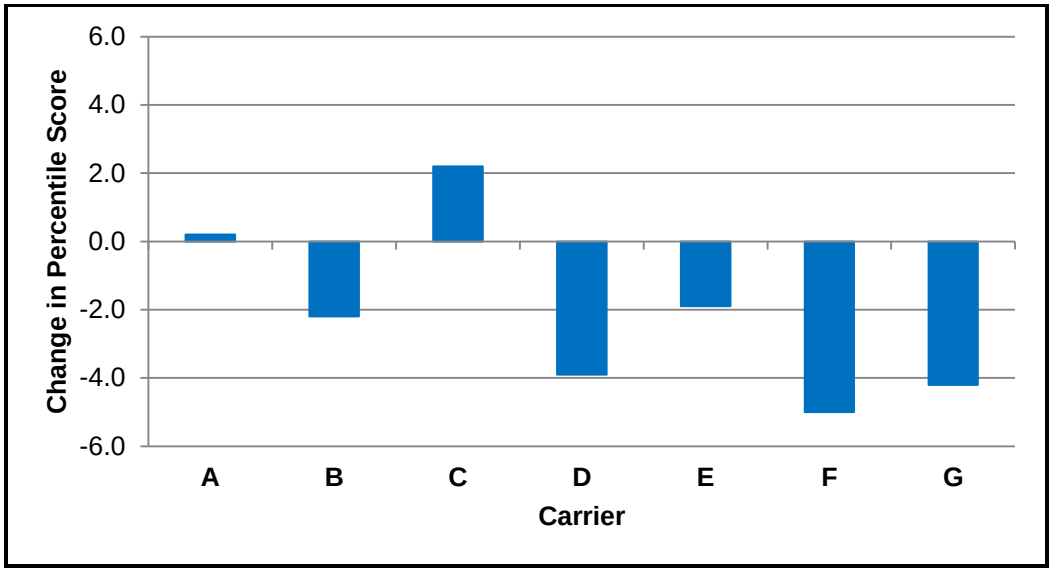
[91] The median average for HOS Compliance violations per MVMT was 5.0.

Figure 19. State Disparity Factor for HOS Compliance BASIC



ATRI applied the enforcement disparities adjustment methodology to the carrier case study data to determine the impact of HOS Compliance violation disparities on carrier scores. Figure 20 presents a somewhat more mixed and muted picture for carriers on the HOS Compliance BASIC. Carriers A and C experienced increases in their scores (0.2 & 2.2 points, respectively), while Carrier F had the greatest decline in HOS Compliance BASIC score (5.0 point decline).

Figure 20. Theoretical Change in HOS Compliance Percentile Score



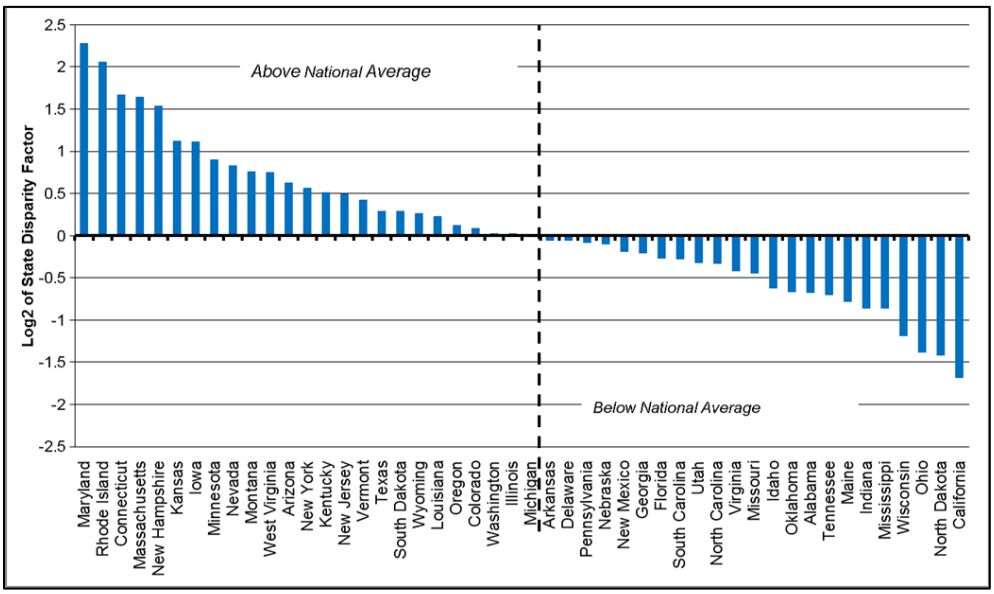
Driver Fitness BASIC

Twenty-five states had Driver Fitness violation rates greater than the national average of 1.9 Driver Fitness violations per MVMT, while 23 were below the national average.[92] As Figure 21 illustrates, Maryland had the greatest Driver Fitness disparity factor, while California had the smallest disparity factor. Hypothetically, if 100 percent of a carrier's VMT occurred in Maryland and that carrier had a total of 100 Driver Fitness violation points, the carrier would have received 21 Driver Fitness violation points after adjusting the carrier's score if Maryland issued Driver Fitness violations at the same rate as the national average.

Conversely, if a carrier had 100 percent of their VMT in California and had a total of 100 Driver Fitness violation points, the carrier would have received 321 Driver Fitness violation points after adjusting the carrier's score if California issued Driver Fitness violations at the same rate as the national average.

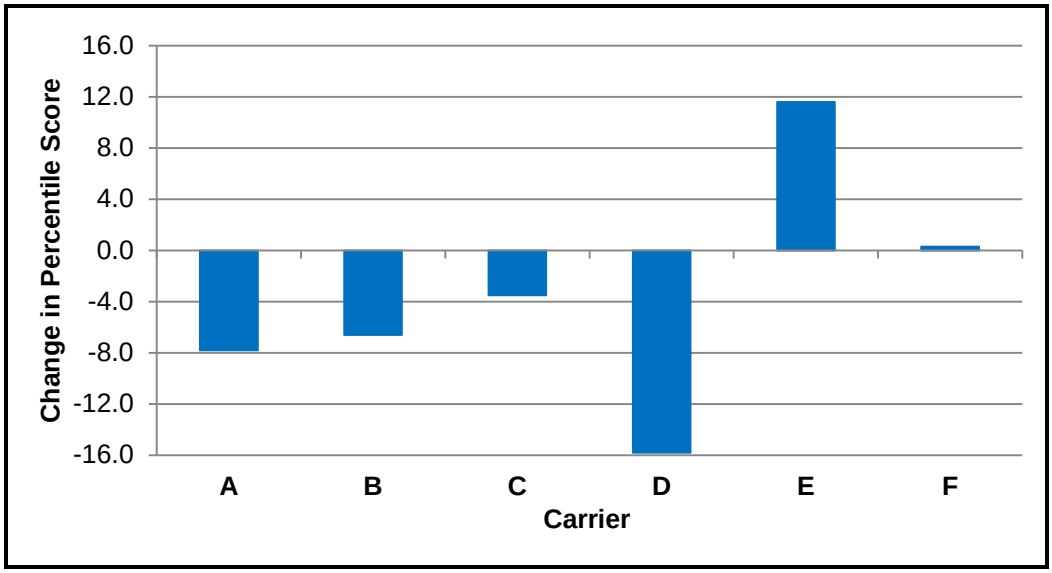
[92] The median average for Driver Fitness violations per MVMT was 1.9.

Figure 21. State Disparity Factor for Driver Fitness BASIC



To test the impact of Driver Fitness violation disparities on carrier BASIC scores, ATRI revised the carrier case study data to adjust for enforcement disparities. Interestingly, despite the smaller variance in the hypothetical scenario, the actual carrier data shows a wider range of differences among the six carriers (Figure 22). Carriers E and F were the only carriers to see increases in Driver Fitness score (11.6 & 0.3 points, respectively) while Carrier D had the largest decline in score (15.8 point decline). The results of this analysis reveal that even within a BASIC that exhibits slightly more uniformity on a national scale, a carrier's operational pattern is the true determinant of enforcement disparity impact. In this example, Carrier E had nearly one-fifth of its VMT in California, which had the lowest Driver Fitness violation rate among all states and therefore contributed to the large increase in violations when disparities were corrected.

Figure 22. Theoretical Change in Driver Fitness Percentile Score



Controlled Substances/Alcohol BASIC

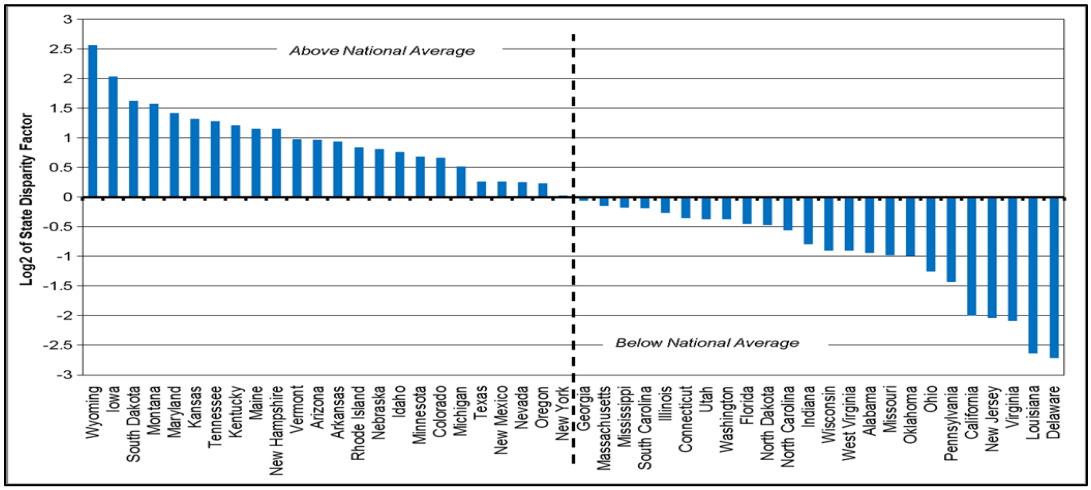
Of the five public BASICS, the Controlled Substances/Alcohol BASIC exhibited some of the greatest disparities on a national scale. While there were equal numbers of states above and below the national average of 0.04 Controlled Substances/Alcohol violations per MVMT, there was much more variation between extremes.[93] As Figure 23 illustrates, Wyoming had the greatest Controlled Substances/Alcohol disparity factor, while Delaware had the smallest disparity factor. Hypothetically, if 100 percent of a carrier's VMT occurred in Wyoming and that carrier had a total of 100 Controlled Substances/Alcohol violation points, the carrier would have received 17 Controlled Substances/Alcohol violation points after adjusting the carrier's score if Wyoming issued Controlled Substances/Alcohol violations at the same rate as the national average.

Conversely, if a carrier had 100 percent of their VMT in Delaware and had a total of 100 Controlled Substances/Alcohol violation points, the carrier would have received 654 violation points after adjusting the carrier's score if Delaware issued Controlled Substances/Alcohol violations at the same rate as the national average. Of the five BASICs analyzed, the Controlled Substances/Alcohol BASIC had the largest hypothetical change in score, indicating a wide divergence between state practices.

Due to the relatively rare occurrence of Controlled Substances/Alcohol violations, the strong safety record of the case study carriers in this BASIC, and the way in which the FMCSA A&I website presents data[94], it was not possible for ATRI to adjust the Controlled Substances/Alcohol BASIC scores of the carriers in the case study.

[93] The median average for Controlled Substances/Alcohol violations per MVMT was 0.04.
[94] FMCSA only reports SMS values to the hundredths decimal value on its website. Due to the very low numbers generated by the Controlled Substances/Alcohol BASIC calculations, a carrier with a percentile score of 20 is reported to have the same SMS score as a carrier with a percentile score of 0 (both reported as 0.00).

Figure 23. State Disparity Factor for Controlled Substances/Alcohol BASIC



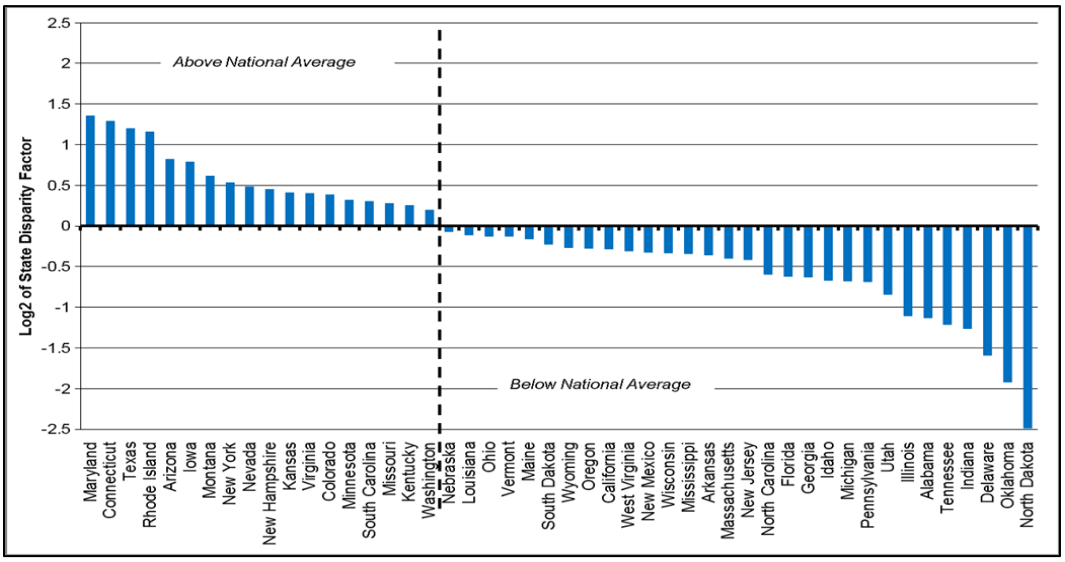
Vehicle Maintenance BASIC

The Vehicle Maintenance BASIC is the last BASIC that ATRI analyzed. In this BASIC, only 18 states had a violation rate above the national average of 32.3 Vehicle Maintenance violations per MVMT, while 30 states were below the national average.[95] Maryland had the greatest Vehicle Maintenance disparity factor, while North Dakota had the smallest disparity factor (Figure 24). Hypothetically, if 100 percent of a carrier's VMT occurred in Maryland and that carrier had a total of 100 Vehicle Maintenance violation points, the carrier would have received 39 Vehicle Maintenance violation points after adjusting the carrier's score if Maryland issued Vehicle Maintenance violations at the same rate as the national average.

Conversely, if a carrier had 100 percent of their VMT in North Dakota and had a total of 100 Vehicle Maintenance violation points, the carrier would have received 560 Vehicle Maintenance violation points after adjusting the carrier's score if North Dakota issued Vehicle Maintenance violations at the same rate as the national average.

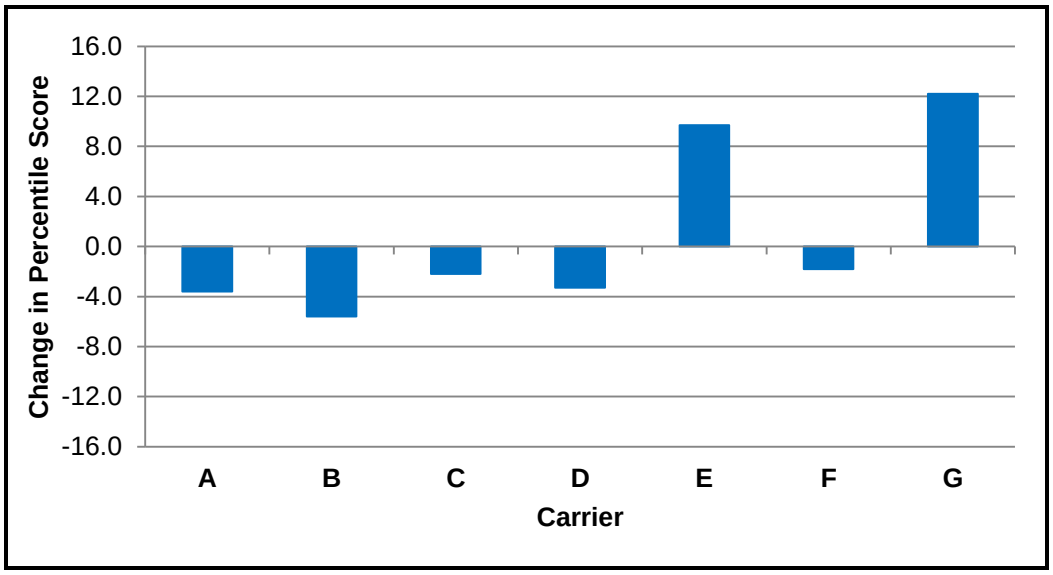
[95] The median average for Vehicle Maintenance violations per MVMT was 27.2.

Figure 24. State Disparity Factor for Vehicle Maintenance BASIC



Using actual carrier data, ATRI estimated the change in Vehicle Maintenance percentile scores for the seven carriers in the case study analysis. The results of that analysis are presented in Figure 25. Carriers E and G were the only carriers to see increases in their Vehicle Maintenance score (9.7 & 12.2 points, respectively) while Carrier B had the steepest decline in score (5.6 point decline). Carrier E was once again affected by its high share of VMT in California, which had a relatively low Vehicle Maintenance violation rate.

Figure 25. Theoretical Change in Vehicle Maintenance Percentile Score



4.3 Conclusion: Carrier Case Studies

A review of actual motor carrier safety and operational data demonstrates that state enforcement disparities can have a noticeable impact on carrier CSA safety measures. ATRI modeled the impact of normalizing state enforcement activities for seven carriers using violation data from four BASICs. Among those carriers, ATRI found that the range between theoretical scores and actual scores deviated between a 12.2 point increase and a 17.7 point decrease. The impact of these disparities is highly dependent on the operational pattern of each carrier; carriers with a strong presence in states with rates significantly above or below the national average tended to see the largest impact in scores. It is also important to note that the majority of the carriers in the case study, by design, tended to be larger carriers that operated in numerous states. The impact on smaller carriers may differ especially if these carriers operate in substantially fewer states. While safety culture within a particular carrier should not vary simply by crossing state lines, this analysis nevertheless has shown that enforcement disparities among states can lead to both inflated and deflated safety measures, obscuring the true safety record of carriers relative to their peers.

CONCLUSIONS AND KEY FINDINGS

As noted in Table 15, ATRI has definitively found that enforcement variability exists between states, echoing the findings of multiple previous studies. In many cases, these disparities are directly influenced by the enforcement strategies presented in state CVSPs, as evidenced by ATRI's review of six state CVSPs. While some flexibility is needed by the states to target unique enforcement experiences, ATRI found that many states are below the national average when it comes to issuing violations that have a demonstrated relationship to crash risk; in other words, enforcement strategies are not aligned with issuing violations that curb risky behavior. Regardless of the safety merits of each state's strategy, the resulting enforcement disparities are impacting motor carrier BASIC scores. ATRI's review of empirical carrier safety and operational data demonstrates that enforcement disparities may have the effect of obscuring a carrier's true safety performance relative to its peers. This could potentially lead to carriers being identified as unsafe, and more troubling, could also lead to unsafe carriers being overlooked.

Table 15. Enforcement Disparities Key Findings

TASK	KEY FINDINGS
State Data Metrics Evaluation	State violation rates per MVMT ranged from a high of 52.2 (Connecticut) to a low of 5.8 (North Dakota), with the national average at 22.8.
	Regional enforcement differences existed in which northeastern states collectively issued the most violations per MVMT, while southern states collectively issued the fewest violations per MVMT.
	States that lacked probable cause requirements for conducting RIs had moving violation rates equal to the states that required probable cause.
	States that contributed less to their CMV enforcement budget (relative to federal funds) could significantly increase the number of RIs and TEs if they contributed an amount commensurate to the national median ratio of state contributions.
	Violation rates per 100 relevant RIs do differ between states and across the BASICs, supporting the argument that carriers are affected by state enforcement disparities.
Relating Violations to Crash Risk	Certain violations may not have as strong relationships to crash risk than others, suggesting a need for potential revision of CMV enforcement priorities.
Understanding State Enforcement Objectives	Typically, CVSP enforcement strategies corresponded with top violations issued in that state and effectively addressed certain unsafe driving behaviors.
	In certain instances enforcement strategies focused less attention on the unsafe driving behaviors that contributed to a larger percentage of crash factors, suggesting a potential need for revising state enforcement priorities.
Carrier Case Studies	If enforcement activities were standardized across states, ATRI calculated that BASIC scores among the case study carriers would decrease by as much as 17.7 points and increase by as much as 12.2 points from the actual scores reported by the SMS.
	Carriers with mileage concentrated in fewer states are more susceptible to the impacts of enforcement disparities.

While CSA is a national initiative, it relies on data from state enforcement activities to calculate safety scores. With wide latitude given to states to set their own CMV enforcement agenda, this has resulted in disparities in enforcement activities across the states. Arguably, some latitude and discretion is appropriate for states to employ countermeasures in order to mitigate crash trends in their jurisdictions. However, simply by crossing state lines motor carriers are, in effect, suddenly exposed to changing enforcement priorities and potentially to changes in safety performance.

These differences in state enforcement priorities are leading to inequities in motor carrier BASIC scores. The impact of these disparities is highly dependent on carrier operational patterns. Carriers with a strong presence in states with violation rates significantly above or below the national average tended to see the largest impact on BASIC scores. While safety culture within a particular carrier should not vary simply by crossing state lines, this analysis nevertheless has shown that enforcement disparities among states can lead to both inflated and deflated safety measures, obscuring the true safety record of carriers relative to their peers.

Appendix A. BASIC Measure Calculation Methodology

BASIC Measure

The measures for the HOS Compliance, Driver Fitness, Vehicle Maintenance and Hazardous Materials (HazMat) Compliance BASICs are calculated by computing a ratio of violations (numerator) by relevant inspections (denominator). The measures for the Unsafe Driving and Crash Indicator BASICs are calculated by computing a ratio of violations or crashes (numerator) by a carrier's average power units (APU) multiplied by a utilization factor (UF) (denominator).

Numerator

To account for differences in a violation's relationship to crash risk, FMCSA developed time and severity weighting schemes for all violations or crashes within each BASIC (Table 16). A violation's severity weight is based on a scale from 1 (least crash risk) to 10 (greatest crash risk) relative to all other violations within the BASIC. A crash severity weight is based on a scale from 1 (tow-away, no injuries or fatalities) to 2 (involves injuries or fatalities), with the possibility of an additional point if HazMat are released.[96]

Violation and crash time weights are dependent on the date a violation is issued or crash occurred and based on a scale from 3 (most recent) to 1 (least recent) in which the time weight decreases at six month intervals. An additional two points are added to a violation severity weight if the driver or vehicle is placed OOS (except for Unsafe Driving and Controlled Substances/Alcohol). The numerator of the BASIC measure is the product of multiplying the time and severity weightings for each violation or crash in the previous 24 months.[97]

Table 16. Time and Severity Weighting Schemes

	Weight	
Incident	**Time**	**Severity**
Violation	3 (0-6 Months) 2 (>6-12 Months) 1 (>12-24 Months)	1 (least risk) -10 (greatest risk)
Crash	3 (0-6 Months) 2 (>6-12 Months) 1 (>12-24 Months)	1 (tow-away, no injury or fatality) 2 (injury or fatality) +1 (if Hazmat are released)

Denominator

For the Unsafe Driving and Crash Indicator BASICs the ratio denominator is calculated by multiplying the APU factor by the UF. The APU factor is calculated by averaging the number of power units (PU) in a carrier's fleet currently, six months previously and 18 months previously.[98] The UF for each carrier is dependent upon a carrier's operating status in which a carrier is categorized as "straight truck" if more than 30 percent of its PU's are single unit vehicles or as

[96] Carrier Safety Measurement System (CSMS) Methodology Version 3.0.1. (2013). Federal Motor Carrier Safety Administration. Available Online: http://csa.fmcsa.dot.gov/Documents/SMSMethodology.pdf
[97] Ibid.
[98] Ibid.

"combination truck" if 70 percent or more of its fleet is comprised of combination vehicles. The UF is determined by computing the average VMT per APU and adjusts for exposure differences in carrier VMT (as reported on the MCS-150).[99] Table 17 displays the UF applied for both straight and combination fleets.

Table 17. Utilization Factors for Straight and Combination Fleets

Utilization Factors			
Straight Fleets		**Combination Fleets**	
VMT per APU	**UF**	**VMT per APU**	**UF**
< 20,000	1	< 80,000	1
20,000 – 60,000	VMT per PU / 20,000	80,000 – 160,000	1 + 0.6*(VMT per PU – 80,000) / 80,000
60,000 – 200,000	3	160,000 – 200,000	1.6
> 200,000	1	> 200,000	1
No recent VMT data	1	No recent VMT data	1

BASIC Measure Formulas

Table 18 displays the formulas to calculate each of the seven BASIC measures.[100] The BASIC measures use the inputs described in the previous sections discussing the ratio numerators and denominators. After calculating the BASIC measure it is necessary to place a carrier into a specific safety event group so that carriers are compared to peers with similar safety performance and operational patterns.

Table 18. BASIC Measure Formulas

BASIC	Formula
Crash Indicator	$\frac{\text{Total of time and severity weighted applicable crashes}}{\text{APUs x UF}}$
Unsafe Driving	$\frac{\text{Total of time and severity weighted applicable violations}}{\text{APUs x UF}}$
HOS Compliance, Driver Fitness, HazMat Compliance, Vehicle Maintenance, Controlled Substances/Alcohol	$\frac{\text{Total of time and severity weighted applicable violations}}{\text{Total time weight of relevant inspections}}$

[99] Compliance, Safety, Accountability (CSA) How It Works. (2013). Arlington, VA: American Trucking Associations.
[100] Carrier Safety Measurement System (CSMS) Methodology Version 3.0.1. (2013). Federal Motor Carrier Safety Administration. Available Online: http://csa.fmcsa.dot.gov/Documents/SMSMethodology.pdf

Safety Event Groups

Carriers are placed in safety event groups based on the number of safety events (e.g., inspections, crashes) in which they have been involved. This tiered approach accounts for the inherent greater variability in rates based on small samples or limited levels of exposure and the stronger level of confidence in measures based on higher exposure. Figure 26 displays the safety event groups for each of the BASICs.[101]

Figure 26. Safety Event Groups by BASIC

Unsafe Driving		
Safety Event Group	Number of Inspections	
	Combination Truck Segment	Straight Truck Segment
1	3-8	3-4
2	9-21	5-8
3	22-57	9-18
4	58-149	19-49
5	150+	50+

Crash Indicator		
Safety Event Group	Number of Crashes	
	Combination Truck Segment	Straight Truck Segment
1	2-3	2
2	4-6	3-4
3	7-16	5-8
4	17-45	9-26
5	46+	27+

HazMat Compliance	
Safety Event Group	Number of Relevant Inspections
1	5-10
2	11-15
3	16-40
4	41-100
5	101+

HOS Compliance	
Safety Event Group	Number of Relevant Inspections
1	3-10
2	11-20
3	21-100
4	101-500
5	501+

Vehicle Maintenance & Driver Fitness	
Safety Event Group	Number of Relevant Inspections
1	5-10
2	11-20
3	21-100
4	101-500
5	501+

Controlled Substances/Alcohol	
Safety Event Group	Number of Relevant Inspections
1	1
2	2
3	3
4	4+

BASIC Percentile

After a carrier's BASIC measure has been calculated and safety event group determined, the carrier's BASIC measure is compared against all other peer carriers within the safety event group. Carriers are assigned a score between 1 and 100 which reflects their percentile rank relative to other carriers, with higher percentile rankings indicating worse safety performance.[102]

[101] Carrier Safety Measurement System (CSMS) Methodology Version 3.0.1. (2013). Federal Motor Carrier Safety Administration. Available Online: http://csa.fmcsa.dot.gov/Documents/SMSMethodology.pdf
[102] Compliance, Safety, Accountability (CSA) How It Works. (2013). Arlington, VA: American Trucking Associations.

Appendix B. Review of Enforcement Disparity Factors

Personnel Resources

At the state-level several individuals with differing capabilities may be involved in the enforcement of CMV regulations. For example, in a survey among 69 CVSA members enforcement personnel authority varied from "fully-sworn" police officers with full authority (67%), civilians with limited authority (17%) to the need for probable cause before vehicle inspection (35%).[103] Furthermore, research suggests that an enforcement officer's level of experience will dictate the selection of CMVs and methods for inspections, with an approximation of six to 10 CMVs thoroughly inspected per shift.[104]

In addition to operating authority, experience levels, training and the availability of CMV inspectors is critical to the proper enforcement of safety and compliance regulations. A 2012 analysis of CMV enforcement personnel revealed that there were 878 qualified FMCSA and state-level employees available to conduct compliance reviews for the 765,221 registered carriers.[105] Among qualified federal and state-level vehicle inspectors, there were 10,273 for the 4,830,972 registered CMVs.[106] This imbalance between the number of available enforcement personnel to inspect CMVs and carriers suggests that regulatory agencies cannot efficiently carry out the goals of carrier safety and compliance.

Safety Grants

As noted earlier, state budgets influence CMV enforcement programs, with research suggesting reductions in recent years.[107,108] Despite this downward trend in state operating budgets, states can apply for financial support for CMV enforcement activities through FMCSA's MCSAP. The MCSAP provides financial assistance to state enforcement agencies in order to achieve the national goal of reducing the number of CMV-related HazMat incidents, crashes, injuries and fatalities through the application of stable and uniform CMV safety programs.[109]

A state agency can apply for MCSAP funding by submitting a yearly CVSP to their respective FMCSA division administrator.[110] Each CVSP must contain 18 specific elements to be considered as a completed submission.[111,112] Among these elements a CVSP must include a

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[103] Commercial Truck and Bus Safety Synthesis 10: Alternative Truck and Bus Inspection Strategies. (2006). Federal Motor Carrier Safety Administration. Available Online: http://onlinepubs.trb.org/onlinepubs/ctbssp/ctbssp_syn_10.pdf
[104] Bordley, L., Cherry, C., Stephens, D., Zimmer, R., & Petrolino, J. (2012). Commercial Motor Vehicle Wireless Roadside Inspection Pilot Test Part B: Stakeholder Perceptions. Transportation Research Board Annual Meeting. Available Online: http://trid.trb.org/view.aspx?id=1129184
[105] Braver, E.R., Dodd, R.S., Cheung, I., & Long, L.O. (2012). Safety Challenges and Oversight in the Motorcoach Industry: Attitudes and Perceptions of Drivers, Roadside Inspectors, and Federal Investigators. *Annals of Advances in Automotive Medicine, 56,* 57-67. Available Online: http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3503431/
[106] Ibid.
[107] Commercial Truck and Bus Safety Synthesis 10: Alternative Truck and Bus Inspection Strategies. (2006). Federal Motor Carrier Safety Administration. Available Online: http://onlinepubs.trb.org/onlinepubs/ctbssp/ctbssp_syn_10.pdf
[108] Transportation Research Board. (2011). Achieving Traffic Safety Goals in the United States: Lessons from Other Nations. *Special Report, 300.* Available Online: http://onlinepubs.trb.org/onlinepubs/sr/sr300.pdf
[109] §350.101: What is the Motor Carrier Safety Assistance Program (MCSAP)? (n.d.). Federal Motor Carrier Safety Administration. Available Online: http://www.fmcsa.dot.gov/regulations/title49/section/350.101
[110] §350.205: How and When Does a State Apply for MCSAP Funding? (n.d.).Federal Motor Carrier Safety Administration. Available Online: http://www.fmcsa.dot.gov/regulations/title49/section/350.205
[111] §350.213: What Must a State CVSP Include? (n.d.). Federal Motor Carrier Safety Administration. Available Online: http://www.fmcsa.dot.gov/regulations/title49/section/350.213

general overview stating the enforcement agency's mission or goal. In addition it must include a summary of the previous year's activities and level of effectiveness at reducing the number of CMV-involved crashes, fatalities and injuries and the level of motor carrier and driver safety improvement.[113]

Furthermore, the CVSP must include a narrative detailing how the state will address the following five national program elements: driver/vehicle inspections, TE, compliance reviews, public education and awareness, and data collection. Moreover, the CVSP must include data-supported problem statements, quantifiable performance objectives and measures, strategies aimed at achieving performance objectives and the specific activities that will be employed to achieve intended strategies and objectives.[114] The CVSP must also include the method for monitoring ongoing progress of the stated objectives, strategies and activities as well as an objective evaluation of its performance and problem areas.[115]

Finally, the CVSP must address the enforcement agency's budget and describe the nature of the expenditures (e.g., salary, training, equipment) relative to the plan's objectives. Moreover, the plan must include results of the annual review to determine compatibility of state laws and regulations with FMCSRs and HazMat regulations, any new state CMV enforcement laws or regulations since the previous year's CVSP, a list of MCSAP contacts, the annual certification of compatibility and the executed state certification.[116]

After the FMCSA division administrator receives the completed CVSP he/she will review it for completeness and compatibility with national CMV enforcement and safety goals.[117] Once these factors are determined a state will receive notice of whether their CVSP was accepted or rejected.[118] If a state agency's CVSP is rejected the agency has 30 days from the date of notice to revise and resubmit their plan for MCSAP funding.[119]

Among the available MCSAP funds are four grants which include Basic, Incentive, New Entrant, and High Priority (Table 19). In order to receive funding under each of the MCSAP grants a state must demonstrate adequate performance or completion of requirements specific to each grant type. On average between 2010 and 2013, approximately $166 million in Basic and Incentive grants, $29 million in New Entrant grants and $10 million in High Priority grants[120] have been awarded to the 50 states, D.C. and the U.S. territories of American Samoa, Guam, Northern Marianas, Puerto Rico and the Virgin Islands.[121,122,123]

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[112] The required 18 CVSP elements are described briefly within this section. For a more detailed description of each element visit FMCSA's site at http://www.fmcsa.dot.gov/regulations/title49/section/350.213
[113] §350.213: What Must a State CVSP Include? (n.d.). Federal Motor Carrier Safety Administration. Available Online: http://www.fmcsa.dot.gov/regulations/title49/section/350.213
[114] Ibid.
[115] Ibid.
[116] Ibid.
[117] §350.207: What Response Does a State Receive to its CVSP Submission? (n.d.). Federal Motor Carrier Safety Administration. Available Online: http://www.fmcsa.dot.gov/regulations/title49/section/350.207
[118] Ibid.
[119] Ibid.
[120] This figure does not include High Priority grants awarded to local jurisdictions or other entities.
[121] Motor Carrier Safety Assistance Program Basic and Incentive Grant Fiscal Year Awards Archive. (n.d.). Federal Motor Carrier Safety Administration. Available Online: http://www.fmcsa.dot.gov/mcsap-basic-incentive-grant/motor-carrier-safety-assistance-program-basic-and-incentive-grant-fiscal
[122] New Entrant Safety Assurance Grant Awards by Fiscal Year Archive. (n.d.). Federal Motor Carrier Safety Administration. Available Online: http://www.fmcsa.dot.gov/new-entrant-safety-assurance-program-grant/new-entrant-safety-assurance-grant-awards-fiscal-year

Table 19. MCSAP Grant Descriptions

MCSAP Grant	Description
Basic	Basic grants are distributed to states based on the 1997 FMCSA defined road miles, VMT, population, and fuel consumption specific to each state.[124]
Incentive	Incentive grants are awarded if a state demonstrates improvement in one, a combination, or all of the following criteria: reductions in CMV fatal accidents and fatality rates, uploading of CMV accident reports and inspection data, and CDL verification during RIs.[125]
New Entrant	New Entrant grants are awarded to states to assist in funding new entrant carrier safety audit activities. The funds can be used for safety auditor salaries, training and other related expenses.[126]
High Priority	High Priority grants are available at the state and local levels, as well as government agency organizations. Specific grant eligibility criteria exist for each enforcement entity level. Recipients of this grant must demonstrate they have safety projects with a national focus, effort to increase public education and awareness, deployment of new technology and the reduction in CMV accident numbers and rates.[127]

Inherent to MCSAP is the differential award allocation to the states based on the Basic, Incentive, New Entrant and High Priority fund criteria. This is a factor that would likely influence enforcement disparities even though the CVSPs share a common goal. For example, the 2011 fiscal year MCSAP budget had approximately $200 million in available funds for the 50 states and the District of Columbia.[128,129,130,131] Of the available funds, California received approximately $10.9 million, while Maine received approximately $454,000. Though the state characteristics (e.g. VMT, road miles), CVSP and grant applications impact fund amounts, California enforcement personnel have greater flexibility in deciding how to apply the MCSAP funds, such as purchasing more advanced RI technology, vehicles, or increasing the number of roadside inspectors, whereas Maine would be limited in comparison.

[123] Motor Carrier Safety Assistance Program High Priority Grant Fiscal Year 2013 Awards. (n.d.). Federal Motor Carrier Safety Administration. Available Online: http://www.fmcsa.dot.gov/mcsap-high-priority-grant/motor-carrier-safety-assistance-program-high-priority-grant-fiscal-year
[124] MCSAP Basic and Incentive Grants—Criteria. (n.d.). Federal Motor Carrier Safety Administration. Available Online: http://www.fmcsa.dot.gov/grants/mcsap-basic-incentive-grant/motor-carrier-safety-assistance-program-mcsap-basic-and-incentive
[125] Ibid.
[126] New Entrant Safety Assurance Program—Overview. (n.d.). Federal Motor Carrier Safety Administration. Available Online: http://www.fmcsa.dot.gov/new-entrant-safety-audit-grant
[127] MCSAP High Priority Grants—Overview. (n.d.). Federal Motor Carrier Safety Administration. Available Online: http://www.fmcsa.dot.gov/motor-carrier-safety-assistance-program-mcsap-high-priority-grant
[128] MCSAP Basic and Incentive Grant Awards by Fiscal Year (n.d.). Federal Motor Carrier Safety Administration. Available Online: http://www.fmcsa.dot.gov/about/grants/MCSAP-Basic-Incentive/funding-archives.aspx
[129] MCSAP New Entrant Grant Awards by Fiscal Year. (n.d.). Federal Motor Carrier Safety Administration. Available Online: http://www.fmcsa.dot.gov/about/grants/New-Entrant/funding-archives.aspx
[130] MCSAP High Priority Grant Awards by Fiscal Year. (n.d.). Federal Motor Carrier Safety Administration. Available Online: http://www.fmcsa.dot.gov/about/grants/MCSAP-High-Priority/funding-archives.aspx
[131] Additional MCSAP funds are available to U.S. territories including American Samoa, Guam, Northern Marianas, Puerto Rico, and the Virgin Islands.

State-Specific Regulations

Though the Federal Highway Administration (FHWA) regulates CMV weight, length (overall & trailer) and width on the national interstate system, states have the authority to place additional regulations on the roadways within their borders.[132] One study examined regulatory disparities between CMV height, weight, width, length and permit procedures across Iowa, Minnesota, Nebraska, North Dakota and South Dakota.[133] Among the findings were that CMV maximum overall length regulations ranged from no limit in Iowa, 65' in Nebraska, 75' in Minnesota, 81.5' in South Dakota, to 110' in North Dakota. In addition, across these states the maximum CMV gross vehicle weight regulations ranged from 80,000 pounds (lbs) in Iowa and Minnesota, 95,000 lbs in Nebraska, 105,500 lbs in North Dakota and 129,000 lbs in South Dakota. The authors suggested that while these states share similar geographical features, the enforcement of CMV regulations are specific to each state.[134]

In another study, the Upper Great Plains Transportation Institute analyzed state differences in CMV enforcement activities across Montana, North Dakota, South Dakota and Wyoming.[135] The researchers identified that across the states differences in fine amounts exist for the same violations. For example, the fine for an overweight CMV in excess of 20,001 lbs is $750 in Wyoming, $1,000 in Montana, and $4,200 in North Dakota.

Additional findings indicate that in 2011:

- South Dakota had the fewest number of CMV safety audits (70);
- Wyoming had the most TE inspections (5,017);
- Montana had the most RIs (53,328); and
- North Dakota had the most CMV safety audits (319), but the fewest RIs (22,838) and TE inspections (2,069).[136]

Enforcement Technology

The deployment of CMV inspection technology is another variable which may influence state enforcement disparities. One study examining inspection technology deployment across 19 states revealed vast differences in utilization.[137] Among the findings:

- 11 of the states had infrared brake monitoring systems at their inspection sites;
- 14 states utilized electronic credential systems;
- 13 states utilized weigh bypass systems;
- Nine states used radiation detectors;
- One state deployed a global positioning system for CMV security tracking; and

[132] Freight Management and Operations. (2003). Federal Highway Administration. Available Online: http://ops.fhwa.dot.gov/freight/sw/overview/

[133] Garry, P.M., Spurlin, C., & DeWaelsche. (2006). The Challenges to Harmonization of Inter-Jurisdictional Trade Laws: A Study of Transportation Regulation Disparities Within the Northern Great Plains Region. *South Dakota Law Review, 51,* 256-295. Available Online: http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1133129

[134] Ibid.

[135] Brachman, J.M. (2013). Commercial Motor Vehicle Enforcement: Identifying Appropriate Levels. Upper Great Plains Transportation Institute, North Dakota State University. Available Online: http://www.ugpti.org/pubs/pdf/SP178.pdf

[136] Ibid.

[137] Conway, A.J., & Walton, C.M. (2010). State Commercial Vehicle Security Enforcement: Operations, Technologies, and Barriers. Southwest University Region Transportation Center, University of Texas at Austin. Available Online: http://texashistory.unt.edu/ark:/67531/metapth303516/m1/1/

- One state used an optical character recognition system for vehicle identification and permit verification.[138]

Furthermore, 18 states had weigh and inspection stations on secondary roads, 18 states conducted separate vehicle and cargo inspections, 16 states conducted separate cargo and HazMat inspections, three states operated separate agricultural inspection sites and four states conducted chemical or biological weapons inspections.[139]

Results from another study indicated that 48 states used the FMCSA-developed RI software ASPEN, which is an electronic data reporting system.[140] Furthermore, 36 states used electronic screening systems, which target "high risk" drivers, vehicles and carriers.[141] In addition, participants indicated that their most frequently utilized devices included weigh-in-motion screening tools (94.1%), automatic vehicle identification readers (41.2%), remote monitoring devices (23.5%), and automatic vehicle classification technologies (11.8%).[142] Despite the widespread use of enforcement technologies, 54 percent indicated that the devices are ineffective for CMV safety enforcement due to data quality issues such as data accuracy, integrity or timeliness in uploading.[143]

Summary of Findings

The aforementioned findings demonstrate that CMV enforcement disparities exist and are influenced by a multitude of factors. That the demographics of a CMV enforcement division can vary from fully-sworn officers to inspectors with limited enforcement authority influences the nature and type of enforcement activities for a unit. Further, that states have differing regulations or agendas may influence the number and types of violations issued to carriers. In addition, the availability and utilization of differing technology among jurisdictions may affect the methods used to screen, select and inspect vehicles. Finally, a state's ability to effectively carry out FMCSA's initiative is dependent on MCSAP funds which vary from state to state.

[138] Ibid.
[139] Ibid.
[140] Commercial Truck and Bus Safety Synthesis 10: Alternative Truck and Bus Inspection Strategies. (2006). Federal Motor Carrier Safety Administration. Available Online: http://onlinepubs.trb.org/onlinepubs/ctbssp/ctbssp_syn_10.pdf
[141] Ibid.
[142] Ibid.
[143] Ibid.

Appendix C. State Data Metrics Database Development

As with any database construction, refinement was necessary prior to data analysis. Detailed below are the steps ATRI undertook to ensure the accuracy and quality of their data inputs.

Truck VMT

Common to trucking research is the use of truck VMT to control for exposure and normalize data across states. While FHWA's Office of Highway Policy Information (OHPI) publishes annual statistics on vehicle travel across the U.S., 2011 truck travel percentages by state were not available at the time of this research.[144] Therefore, ATRI researchers developed 2011 large truck VMT by using 2010 data from Table VM-4 and 2011 data from Table VM-2 of OHPI's Highway Statistics Series.[145]

Table VM-2 provides the distribution of annual VMT within each state, while Table VM-4 provides the distribution of travel within each state by vehicle type. [146,147] The data in Table VM-2 are further defined by urban and rural travel across differing roadway systems including the interstate, freeways and expressways, principal and minor arterial roads, major and minor collector roads and local roads. The data in Table VM-4 are further defined by urban and rural roadway systems across the broad categories of the interstate system, other arterials and other. In order to calculate annual VMT for each state the researchers multiplied the distribution of combination truck percentages by annual VMT across all urban and rural roadway systems.[148]

Truck Crash Data

MCMIS is a central database that contains all state reported CMV crash records.[149] Crash records are comprised of approximately 80 data elements which provide details of the crash such as the date, location, crash environment, severity, and vehicle type.[150] Despite the comprehensiveness of MCMIS, data quality issues such as missing data or duplicate crash records exist. Therefore, ATRI removed any duplicate records, excluded records with substantial missing data and excluded crash records involving trucks with a gross vehicle weight rating of 26,000 lbs or less.

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[144] FHWA personnel informed ATRI researchers that due to data quality issues 2011 truck VMT data would not be published.
[145] For this study, ATRI defines a large truck as having a GVW of 26,001 LBS or greater.
[146] Highway Statistics 2011: Functional System Travel—2011—Annual Vehicle Miles. (2011). Office of Highway Policy Information, Federal Highway Administration. Available Online: http://www.fhwa.dot.gov/policyinformation/statistics/2011/vm2.cfm
[147] Highway Statistics 2010: Distribution of Annual Vehicle Distance Traveled—2010—Percentage by Vehicle Type. (2010). Office of Highway Policy Information, Federal Highway Administration. Available Online: http://www.fhwa.dot.gov/policyinformation/statistics/2010/vm4.cfm
[148] ATRI researchers verified with FHWA which roadway systems in Table VM-2 mapped to the broad categories in Tables VM-4 in order to calculate the VMT.
[149] MCMIS Catalog and Documentation: Crash File Documentation—Overview. (n.d.). Federal Motor Carrier Safety Administration. Available Online: http://mcmiscatalog.fmcsa.dot.gov/d_crash1.asp
[150] Ibid.

RIs, TEs, Violations and BASICs

FMCSA's A&I database contains data pertaining to state and federal RIs, TEs, violations, and carrier reviews.[151] ATRI examined RI data (driver and vehicle violations) as well as TEs data among the five publicly available BASICs. Within this database users can narrow the scope of their search by applying several filters including the domicile, time period, year, vehicle type, and report focus.

For ATRI's data analysis the following filters were selected

- Domicile – U.S.
- Time Period – Fiscal Year
- Year – 2011-2014
- Vehicle Type – All trucks
- Report Focus – National and individual state reports
- Data Level – State

While the A&I database contains the necessary information to compare carrier and enforcement personnel safety performance across states, the data is not organized according to the BASICs. Therefore, once ATRI selected the above filters for their datasets, each violation was manually mapped to its corresponding BASIC.

[151] Analysis and Information Online. (n.d.). Safety Programs and Program Effectiveness. Federal Motor Carrier Safety Administration. Available Online: http://ai.fmcsa.dot.gov/SafetyProgram/Home.aspx

Appendix D. State Data Metrics: CMV Enforcement Budget, RIs and TEs, 2012

State	State Funds Expended per Federal Funds	Total Cost per RI	Total Cost per TEs
AL	$0.25	$142.86	$1,201.68
AR	$0.52	$122.54	$688.13
AZ	$0.52	$193.92	$983.76
CA	$11.00	$327.54	$2,445.72
CO	$0.37	$181.48	$941.11
CT	$1.25	$224.57	$641.98
DE	$0.21	$172.14	$551.00
FL	$2.44	$286.76	$2,376.67
GA	$0.62	$148.39	$1,629.32
IA	$0.46	$86.59	$465.54
ID	$0.75	$349.92	$911.83
IL	$0.49	$229.46	$833.38
IN	$0.50	$117.17	$316.88
KS	$0.39	$96.40	$898.96
KY	$0.66	$63.38	$509.59
LA	$1.24	$137.27	$1,297.27
MA	$0.90	$354.46	$620.41
MD	$6.92	$190.01	$1,306.18
ME	$4.35	$336.84	$3,782.87
MI	$1.49	$347.94	$1,032.89
MN	$0.61	$222.01	$1,262.69
MO	$1.91	$146.51	$577.21
MS	$1.42	$102.98	$5,809.26
MT	$0.21	$93.21	$1,168.42
NC	$0.45	$98.52	$1,174.07
ND	$0.17	$230.92	$1,319.82
NE	$0.29	$129.62	$652.39
NH	$0.42	$135.07	$713.10
NJ	$1.64	$483.15	$2,281.41
NM	$0.18	$53.24	$209.01
NV	$1.96	$186.25	$967.20
NY	$1.95	$337.03	$2,467.33
OH	$1.26	$214.21	$1,188.06
OK	$0.63	$267.32	$808.32
OR	$1.59	$137.88	$1,600.66
PA	$1.36	$157.17	$927.61
RI	$0.23	$469.67	$1,488.37
SC	$1.23	$230.28	$1,247.94
SD	$1.16	$59.13	$528.69
TN	$1.30	$145.71	$1,146.34
TX	$0.57	$160.87	$3,318.64
UT	$0.74	$112.86	$774.84
VA	$1.15	$288.52	$1,962.36
VT	$0.20	$217.84	$865.31
WA	$2.53	$194.78	$963.97
WI	$0.26	$178.11	$1,079.96
WV	$0.89	$115.65	$720.85
WY	$0.33	$77.84	$397.19
MEDIAN	**$0.70**	**$175.13**	**$975.48**

Appendix E. State Data Metrics: RIs, TEs AND Violations, 2011

State	RIs per MVMT	Violations per MVMT	OOS Violations per MVMT	RIs per 10 Lane Miles	Violations per 10 Lanes Miles	TEs per MVMT	TEs Violations per MVMT
AL	5.9	9.6	1.5	30.1	48.7	0.74	0.38
AR	9.9	22.5	4.1	49.2	112.0	1.6	0.68
AZ	14.5	42.2	4.8	62.3	181.1	3.5	1.5
CA	23.9	25.7	4.7	168.8	181.5	3.5	0.24
CO	13.8	21.6	3.4	26.1	40.7	2.8	1.5
CT	12.8	52.2	8.8	47.9	196.2	4.5	0.6
DE	5.9	7.2	1.6	33.9	41.4	2.1	1.3
FL	8.9	14.0	2.4	58.8	92.2	1.2	0.38
GA	8.2	22.0	2.6	43.7	117.9	1.1	0.53
IA	16.6	37.9	4.8	50.2	114.6	3.1	2.3
ID	4.4	14.8	2.4	14.6	48.6	1.9	1.2
IL	7.1	11.3	2.1	31.2	50.1	1.9	1.1
IN	10.6	17.4	2.0	100.4	165.1	4.9	3.4
KS	17.6	31.2	4.3	44.2	78.5	2.1	0.92
KY	21.5	24.1	5.4	103.2	115.4	2.9	0.79
LA	8.2	18.5	3.1	55.0	124.3	1.7	0.25
MA	8.8	20.9	3.2	23.2	54.7	5.8	2.2
MD	27.9	47.5	9.7	148.0	251.5	4.6	1.4
ME	9.0	16.8	3.2	30.0	56.1	1.2	0.41
MI	7.2	18.3	2.4	27.1	68.5	2.9	1.5
MN	8.2	26.6	4.3	20.3	66.0	1.9	0.87
MO	10.6	25.0	4.7	57.1	135.2	3.2	0.22
MS	21.4	15.0	2.8	81.1	56.8	0.43	0.17
MT	24.7	29.3	6.4	27.9	33.0	1.7	0.89
NC	9.5	13.3	2.1	53.5	74.8	1.0	0.26
ND	6.9	5.8	0.8	16.0	13.4	0.92	0.36
NE	14.5	21.8	4.1	34.3	51.7	3.2	2.3
NH	14.4	29.0	4.9	46.1	92.8	2.8	0.58
NJ	8.0	18.0	2.4	36.9	83.3	1.7	0.17
NM	18.3	25.1	3.9	84.4	115.7	4.5	2.0
NV	20.4	34.0	3.8	49.6	82.7	4.7	1.7
NY	12.9	27.7	5.1	45.8	98.3	1.8	0.29
OH	7.2	17.5	2.9	41.3	101.0	1.3	0.82
OK	3.7	8.0	1.3	19.9	42.5	1.1	0.73
OR	12.4	18.5	5.2	46.9	70.2	1.3	0.44
PA	6.4	12.9	2.2	48.8	98.7	1.2	0.29
RI	13.8	45.9	5.1	39.6	131.8	6.1	1.2
SC	10.5	23.1	3.2	50.7	111.4	2.0	0.64
SD	21.8	26.4	3.8	32.6	39.6	2.2	0.54
TN	8.2	8.5	2.1	43.6	45.3	1.4	0.63
TX	10.9	36.8	4.1	52.6	177.1	0.59	0.49
UT	6.3	13.7	2.2	43.0	94.0	0.99	0.17
VA	8.7	23.4	3.3	27.6	74.3	1.5	0.39
VT	10.4	25.6	3.2	26.7	65.6	2.8	1.4
WA	18.8	28.1	4.4	88.0	131.5	4.5	1.5
WI	4.5	17.5	2.1	22.2	87.0	0.84	0.48
WV	17.7	21.3	2.8	52.8	63.5	3.5	2.8
WY	12.4	22.7	4.2	22.7	41.6	2.6	1.5
AVERAGE	**12.2**	**22.8**	**3.6**	**49.2**	**92.0**	**2.4**	**0.97**

Appendix F. State Data Metrics: RIs, Violations, and Weigh Stations, 2011[152]

State	Clean RIs per MVMT	RIs with Violations per MVMT	RIs with OOS Violations per MVMT	Violations per RI	OOS Violations per RI	RIs per Permanent Weigh Stations	Violations per Permanent Weigh Stations
AL	2.5	3.5	0.97	1.6	0.25	39,706.0	64,164.0
AR	3.2	6.7	2.2	2.3	0.41	5,407.3	12,311.6
AZ	2.7	11.8	3.2	2.9	0.33	3,405.0	9,903.7
CA	12.3	11.6	3.4	1.1	0.2	14,280.3	15,352.2
CO	5.9	8.0	2.0	1.6	0.25	3,038.5	4,739.8
CT	1.7	11.1	4.5	4.1	0.69	3,085.2	12,622.8
DE	2.1	3.7	1.2	1.2	0.27	2,294.0	2,804.5
FL	3.8	5.1	1.5	1.6	0.27	5,582.3	8,758.2
GA	2.4	5.8	1.6	2.7	0.32	6,148.3	16,603.2
IA	3.7	12.9	3.5	2.3	0.29	4,118.3	9,406.6
ID	0.55	3.9	1.3	3.3	0.54	810.8	2,693.6
IL	2.6	4.5	1.3	1.6	0.3	2,462.7	3,956.6
IN	2.4	8.2	1.3	1.6	0.19	11,908.0	19,586.7
KS	7.2	10.4	2.6	1.8	0.24	8,052.2	14,294.5
KY	12.5	9.0	3.2	1.1	0.25	7,983.4	8,925.4
LA	1.7	6.4	2.1	2.3	0.38	4,579.4	10,347.0
MA	1.2	7.6	1.8	2.4	0.36	-	-
MD	12.0	15.9	5.5	1.7	0.35	10,993.3	18,687.3
ME	3.3	5.7	2.0	1.9	0.36	670.3	1,251.1
MI	0.94	6.3	1.4	2.5	0.34	4,236.8	10,708.1
MN	1.7	6.5	2.2	3.3	0.52	3,760.1	12,236.1
MO	3.2	7.4	2.9	2.4	0.44	5,787.0	13,710.6
MS	15.1	6.3	2.0	0.70	0.13	4,439.1	3,108.1
MT	12.2	12.6	4.6	1.2	0.26	1,969.7	2,333.8
NC	4.5	5.1	1.4	1.4	0.22	10,547.4	14,740.6
ND	3.8	3.1	0.59	0.84	0.11	1,516.4	1,270.8
NE	6.2	8.2	2.3	1.5	0.29	3,680.6	5,545.6
NH	4.9	9.5	2.8	2.0	0.34	5,451.5	10,973.5
NJ	2.9	5.1	1.4	2.3	0.3	8,626.0	19,464.8
NM	7.8	10.5	2.5	1.4	0.21	7,298.6	10,008.2
NV	7.9	12.5	2.8	1.7	0.19	10,660.7	17,781.3
NY	4.8	8.1	2.9	2.1	0.39	-	-
OH	1.6	5.5	1.7	2.4	0.4	5,284.9	12,914.6
OK	1.0	2.7	0.75	2.1	0.34	3,954.5	8,427.0
OR	4.7	7.7	3.7	1.5	0.42	812.7	1,215.7
PA	2.4	3.9	1.3	2.0	0.35	93,052.0	188,263.0
RI	2.6	11.2	2.7	3.3	0.37	661.2	2,202.0
SC	2.7	7.8	1.9	2.2	0.3	5,478.6	12,043.9
SD	9.7	12.0	2.9	1.2	0.18	2,064.5	2,506.9
TN	4.3	3.9	1.2	1.0	0.25	11,775.2	12,250.0
TX	2.4	8.5	2.7	3.4	0.38	4,015.8	13,527.6
UT	2.6	3.6	1.3	2.2	0.36	3,687.8	8,066.6
VA	2.8	5.9	2.0	2.7	0.38	3,120.0	8,394.5
VT	2.4	8.0	1.9	2.5	0.3	5,733.0	14,076.0
WA	6.4	12.4	3.1	1.5	0.24	1,933.7	2,890.4
WI	0.65	3.8	1.2	3.9	0.46	2,346.9	9,208.9
WV	8.1	9.6	1.9	1.2	0.16	6,136.6	7,377.2
WY	4.2	8.1	2.6	1.8	0.34	785.2	1,441.0
AVERAGE	**4.5**	**7.7**	**2.2**	**2.0**	**0.32**	**7,361.3**	**13,814.5**

[152] It was reported in 2011 that both Massachusetts and New York had zero permanent weight stations. Deluxe Motor Carriers' Road Atlas. (2011). Rand McNally.

Appendix G. State Data Metrics: MCSAP Grants, RIs, TEs and CVSA Certified Inspectors, 2011

State	MCSAP Grants per MVMT	RIs per $1,000 MCSAP Grants	TEs per $1,000 MCSAP Grants	RIs per CVSA-Certified Inspector
AL	$708.65	8.3	1.0	169.0
AR	$717.51	13.7	2.2	322.8
AZ	$995.56	14.6	3.5	79.6
CA	$497.06	48.0	7.1	542.5
CO	$1,873.37	7.4	1.5	69.7
CT	$1,454.30	8.8	3.1	440.7
DE	$1,088.77	5.4	1.9	458.8
FL	$734.02	12.2	1.7	600.2
GA	$638.09	12.8	1.7	335.4
IA	$1,077.62	15.4	2.9	334.6
ID	$750.15	5.9	2.5	152.0
IL	$947.93	7.4	2.0	65.7
IN	$636.32	16.7	7.7	290.4
KS	$1,435.18	12.2	1.5	125.2
KY	$809.51	26.6	3.6	367.7
LA	$629.98	13.0	2.8	422.7
MA	$1,546.37	5.7	3.7	493.1
MD	$823.81	33.9	5.6	261.1
ME	$382.03	23.6	3.1	202.4
MI	$953.73	7.6	3.0	391.6
MN	$1,313.62	6.2	1.4	280.0
MO	$598.05	17.7	5.3	470.0
MS	$738.01	29.0	0.58	2,555.8
MT	$1,304.24	19.0	1.3	113.6
NC	$741.17	12.9	1.4	274.0
ND	$932.46	7.4	0.99	109.3
NE	$1,351.44	10.7	2.4	98.5
NH	$1,743.00	8.3	1.6	162.7
NJ	$1,339.17	6.0	1.3	201.8
NM	$466.97	39.2	9.6	486.6
NV	$1,467.24	13.9	3.2	179.7
NY	$1,360.78	9.5	1.4	350.3
OH	$673.10	10.6	1.9	503.3
OK	$654.04	5.7	1.7	194.5
OR	$666.17	18.6	1.9	84.2
PA	$517.34	12.3	2.4	125.9
RI	$3,319.07	4.1	1.8	220.4
SC	$766.29	13.7	2.6	456.5
SD	$639.05	34.1	3.4	149.1
TN	$691.32	11.8	2.0	75.7
TX	$430.93	25.3	1.4	215.6
UT	$394.24	15.9	2.5	420.1
VA	$1,221.44	7.1	1.2	343.7
VT	$1,636.89	6.4	1.7	191.1
WA	$809.68	23.2	5.5	364.4
WI	$673.76	6.6	1.2	232.9
WV	$1,044.56	17.0	3.4	426.2
WY	$727.50	17.0	3.6	78.9
AVERAGE	**$977.53**	**14.8**	**2.7**	**322.7**

Appendix H. State Data Metrics: Large Truck Crash Rates, 2011

State	Total Crashes per MVMT	Fatal Crashes per MVMT	Injury-Only Crashes per MVMT	PDO Crashes per MVMT
AL	0.25	0.008	0.10	0.15
AR	0.28	0.011	0.09	0.18
AZ	0.23	0.009	0.01	0.21
CA	0.23	0.006	0.07	0.15
CO	0.40	0.015	0.05	0.34
CT	0.30	0.006	0.06	0.22
DE	0.21	0.005	0.09	0.12
FL	0.12	0.005	0.07	0.04
GA	0.19	0.007	0.07	0.11
IA	0.32	0.012	0.12	0.18
ID	0.16	0.005	0.05	0.10
IL	0.25	0.006	0.10	0.14
IN	0.27	0.009	0.09	0.17
KS	0.41	0.015	0.11	0.29
KY	0.35	0.009	0.12	0.22
LA	0.26	0.006	0.14	0.11
MA	0.25	0.006	0.12	0.12
MD	0.22	0.005	0.10	0.11
ME	0.27	0.010	0.11	0.14
MI	0.31	0.007	0.10	0.20
MN	0.34	0.011	0.10	0.23
MO	0.23	0.005	0.07	0.15
MS	0.14	0.013	0.06	0.06
MT	0.37	0.017	0.07	0.29
NC	0.27	0.007	0.13	0.13
ND	0.23	0.014	0.11	0.11
NE	0.26	0.007	0.10	0.15
NH	0.24	0.008	0.06	0.17
NJ	0.48	0.007	0.20	0.27
NM	0.08	0.004	0.02	0.06
NV	0.22	0.010	0.08	0.13
NY	0.25	0.006	0.10	0.14
OH	0.31	0.007	0.11	0.18
OK	0.23	0.010	0.09	0.13
OR	0.18	0.009	0.05	0.12
PA	0.16	0.006	0.07	0.08
RI	0.24	0.003	0.08	0.16
SC	0.27	0.010	0.12	0.13
SD	0.19	0.005	0.02	0.17
TN	0.25	0.009	0.09	0.15
TX	0.23	0.008	0.08	0.14
UT	0.11	0.003	0.03	0.08
VA	0.39	0.010	0.14	0.24
VT	0.21	0.007	0.07	0.13
WA	0.20	0.004	0.02	0.18
WI	0.20	0.007	0.05	0.14
WV	0.27	0.010	0.10	0.16
WY	0.52	0.014	0.12	0.38
AVERAGE	**0.26**	**0.008**	**0.09**	**0.16**

Appendix I. State Data Metrics: Specific Violations per 100 Relevant RIs, 2011

State	Log violation (General/ Form and Manner)	Driver Not In Possession Of Medical Certificate	Windshield Wipers Inoperative/ Defective
AL	7.2	3.2	1.5
AR	10.5	4.3	6.3
AZ	35.6	3.2	11.1
CA	1.2	0.49	0.30
CO	2.9	2.0	3.0
CT	16.0	9.0	7.1
DE	0.62	4.8	0.30
FL	1.7	3.9	1.1
GA	13.9	7.7	1.6
IA	11.8	4.8	0.34
ID	12.3	5.3	2.7
IL	2.4	6.3	1.2
IN	6.7	2.9	2.0
KS	6.9	5.1	2.9
KY	1.8	3.3	0.33
LA	1.4	4.8	2.1
MA	2.8	20.1	1.8
MD	1.6	6.6	1.3
ME	10.0	1.7	0.60
MI	0.99	10.6	0.80
MN	7.7	9.1	4.6
MO	6.9	2.8	0.79
MS	3.0	1.3	0.76
MT	10.2	2.0	0.75
NC	2.7	3.1	0.63
ND	2.9	2.6	0.19
NE	3.5	2.5	0.52
NH	3.5	9.1	0.47
NJ	5.7	9.8	1.1
NM	13.8	2.0	1.0
NV	7.7	5.2	2.1
NY	8.8	3.4	2.3
OH	4.1	3.9	1.4
OK	2.1	8.5	0.90
OR	6.0	1.2	0.47
PA	6.1	5.9	1.5
RI	4.7	21.3	2.4
SC	3.1	7.1	0.81
SD	4.4	2.6	0.28
TN	1.4	2.6	0.26
TX	11.8	3.9	12.2
UT	15.2	6.1	6.2
VA	6.2	4.8	1.2
VT	14.4	6.4	0.58
WA	4.5	2.3	0.54
WI	15.5	3.4	2.3
WV	2.0	4.7	1.1
WY	12.4	3.4	0.45
AVERAGE	**7.1**	**5.2**	**2.0**

Appendix J. Speed Limit Analysis

ATRI maintains one of the largest databases in the world of freight truck probe data which is composed on both engine ECM data and global positioning system (GPS) data. ATRI captures and processes billions of unique probe points annually from approximately 500,000 freight trucks. ATRI's large database skews toward tractor-trailer combination trucks, medium- to large fleet trucks and dry van and flatbed trailers. These operating sectors and truck configurations represent more than 85 percent of all domestic tonnage moved by the trucking industry. Each moving truck probe generates a truck position read every 1 to 10 minutes. The position reads contain location, time and speed information. Additional ECM data for items such as spot-speed and fuel consumption is also obtained. Both spot-speeds and space-mean speeds can be compiled and averaged to determine operating conditions on a roadway.

Average speeds were calculated at four locations to test the hypothesis that:

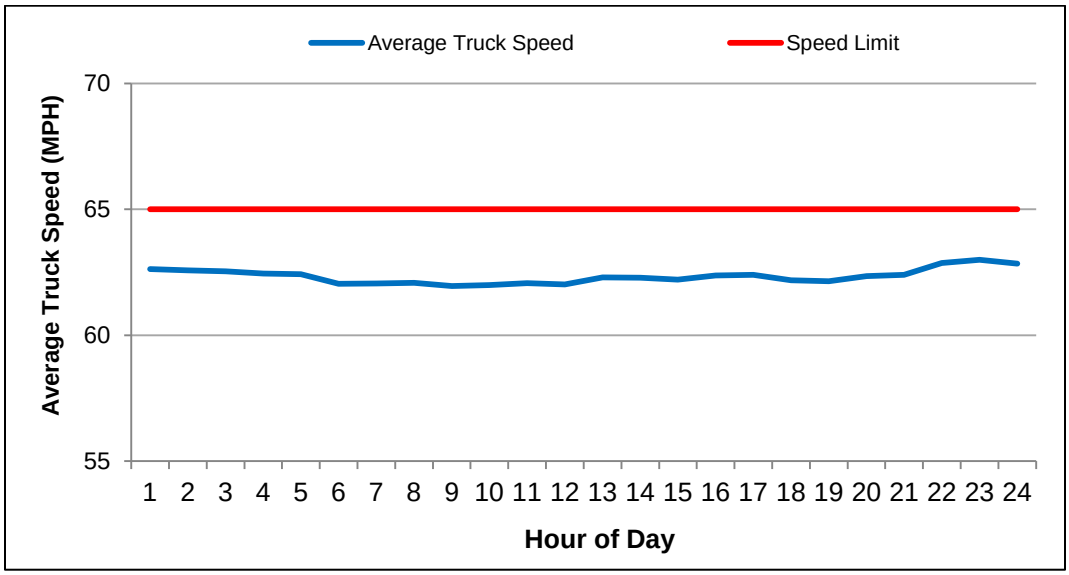
1. Interstate truck speed is consistent across the U.S.; and
2. That speed limits and not differences in truck operating behavior can be tied to speeding violations.

As is shown in the following analysis, highway truck speed is mostly consistent with the exception of Massachusetts.

Indiana

ATRI researchers first analyzed the average speed of trucks on a section of Interstate 70 near New Castle, Indiana. This particular segment is a rural, eight-mile, two-lane highway in relatively poor condition. The maximum posted speed limit for this segment is 65 MPH and as indicated in Figure 27, the average truck speed was consistently two to three MPH below the speed limit over a 24-hour period.

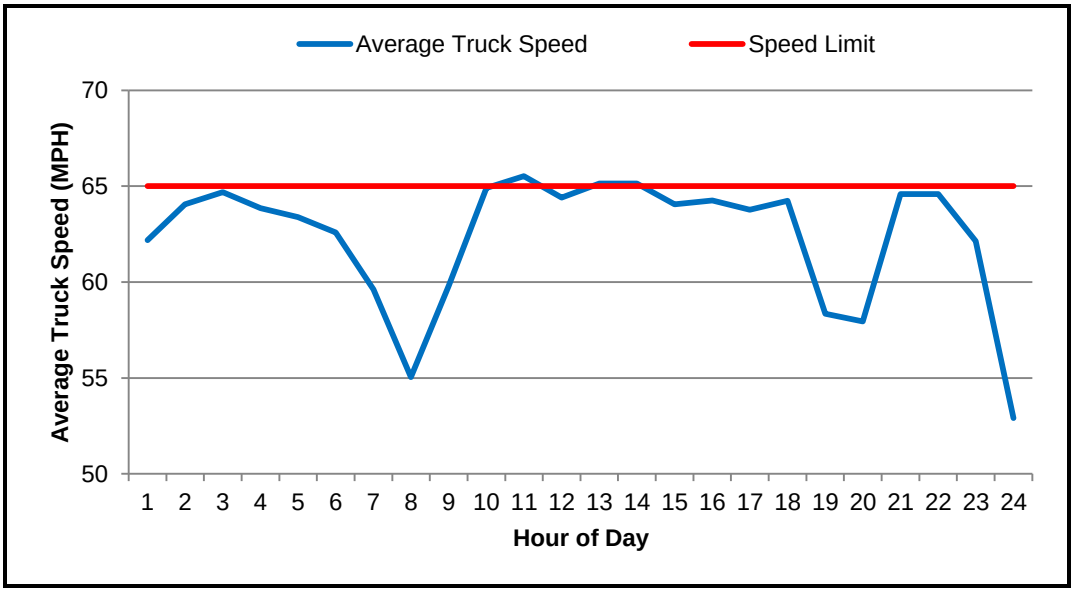
Figure 27. Average Truck Speed on Interstate 70 in Indiana



Massachusetts

ATRI researchers next analyzed the average speed of trucks on a section of Interstate 495 near Chelmsford, Massachusetts. This particular segment is a suburban 4.1 mile, three-lane highway in good condition. Trucks are prohibited from using the left lane. The maximum posted speed limit for this segment is 65 MPH and as indicated in Figure 28, the average truck speed was mostly below the speed limit over a 24-hour period. The lower speeds in the off-peak time period are likely related to traffic incidents, construction or maintenance. Lower speeds during morning and evening rush hours are also visible in the chart.

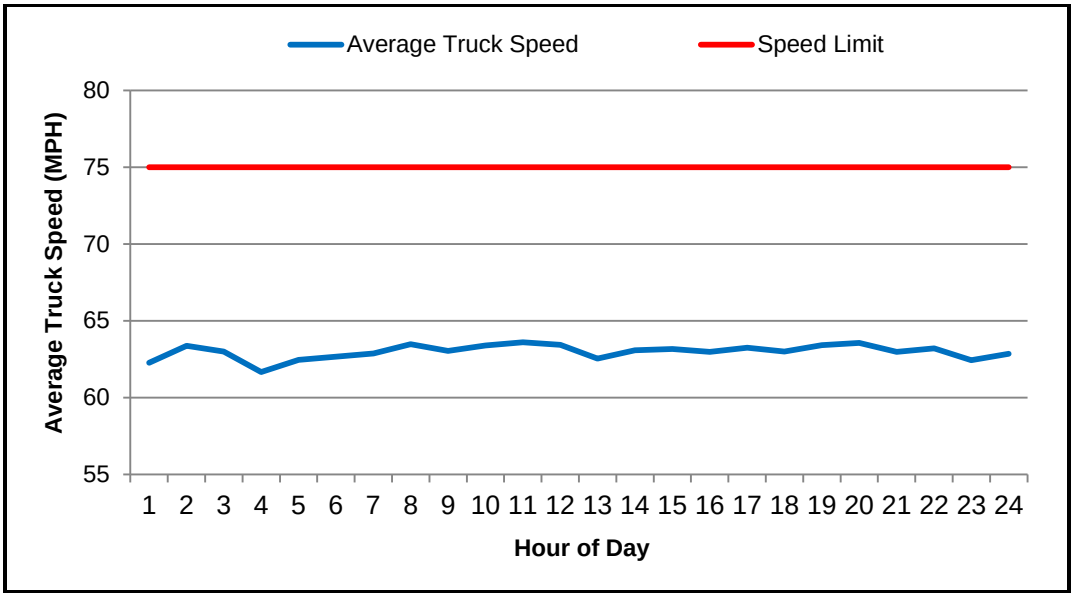
Figure 28. Average Truck Speed on Interstate 495 in Massachusetts



North Dakota

Next, the average speed of trucks on a section of Interstate 94 near Tappen, North Dakota was analyzed. This particular segment is a rural, 5.5 mile, two-lane highway in fair condition. The maximum posted speed limit for this segment is 75 MPH and as indicated in Figure 29, the average truck speed was consistently 11 MPH below the speed limit over a 24-hour period.

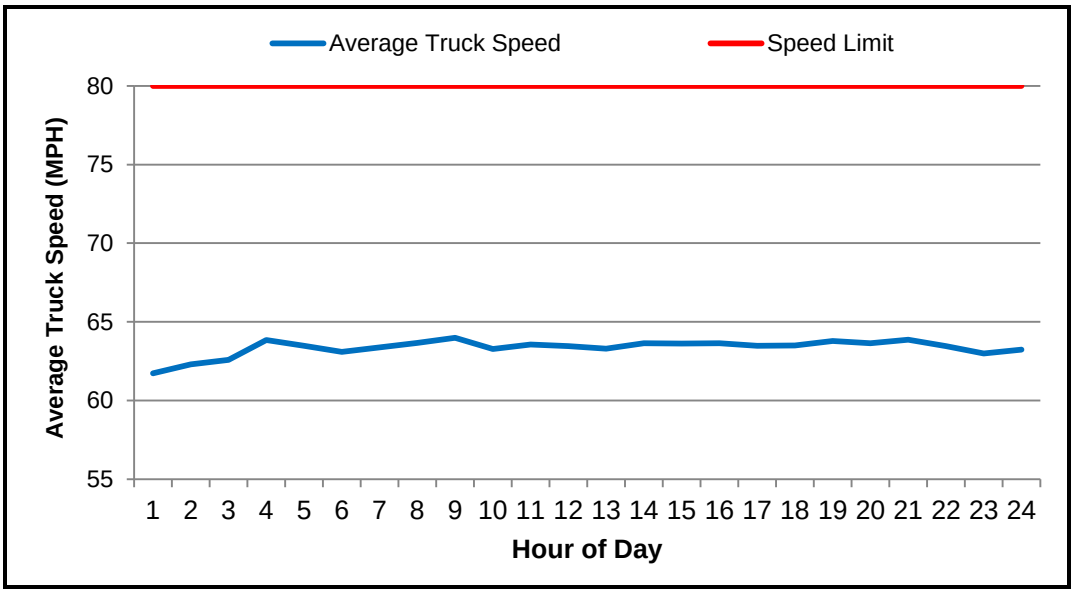
Figure 29. Average Truck Speed on Interstate 94 in North Dakota



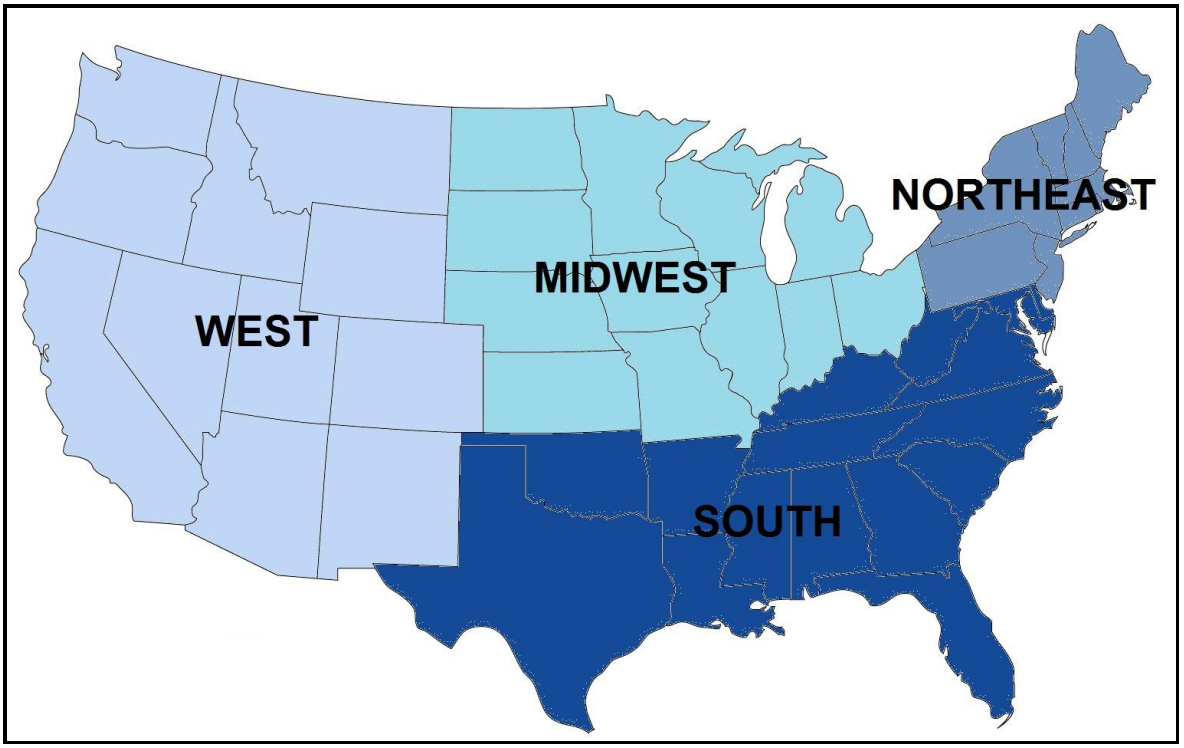
Texas

Finally the average speed of trucks on a section of Interstate 10 near Van Horn, Texas was analyzed. This particular segment is a rural, 6.7 mile, two- lane highway in good condition. The maximum posted speed limit for this segment is 80 MPH and as indicated in Figure 30, the average truck speed was consistently 16 MPH below the speed limit over a 24-hour period.

Figure 30. Average Truck Speed on Interstate 10 in Texas



Appendix K. U.S. Regions[153]



[153] Census Regions and Divisions of the United States. (n.d.). United States Census Bureau. Available Online: http://www.census.gov/geo/maps-data/maps/pdfs/reference/us_regdiv.pdf

Appendix L. Probable Cause Policies for RIs

Probable Cause RI Policies

In 2010, CVSA and ATA surveyed State Trucking Associations (STAs) and law enforcement offices on whether probable cause was necessary to conduct a roadside inspection and developed a table detailing which states require probable cause, which states do not and states that require special circumstances (Table 20).[154]

While ATRI used the findings from this survey to complete the probable cause analyses, caveats exist to its applicability. First, the findings are based on STA and law enforcement understanding and interpretation of state requirements, and are not based on a review of state statutes in all cases. Second, not all states require probable cause by statute, but rather by department policy which may not apply to all law enforcement agencies within the state. Third, the findings are from 2010 and should not be considered representative of current probable cause policies. ATRI determined the use of the 2010 probable cause policy findings appropriate as their analyses were based on 2011 data.

[154] States that Require Probable Cause (PC) to Conduct Truck Inspections—Chart. (2010). Greenbelt, MD: Commercial Vehicle Safety Alliance; Arlington VA: American Trucking Associations.

Table 20. Probable Cause Policies by State

State	Required?	Additional Information
AL	No	
AR	No	
AZ	*Other*	Probable cause is not required by statute, but Arizona Department of Public Safety policy requires probable cause to make a stop. Other agencies in the state select randomly or use Inspection Selection System (ISS) score criteria.
CA	*Other*	The California Highway Patrol can set up a truck inspection lane at any time and in such instances, does not need probable cause to stop CMVs for inspection. In other circumstances (e.g. observing a vehicle traveling on a freeway) probable cause is required.
CO	No	
CT	No	
DE	*Yes*	
FL	*Other*	Florida Department of Transportation Motor Carrier Compliance Officers are not required to have probable cause. With few exceptions, the Florida Highway Patrol (a non-MCSAP agency) must have probable cause.
GA	No	
IA	No	
ID	*Other*	CVSA certified officers may stop without probable cause, but all other enforcement officers must have probable cause.
IL	No	
IN	No	
KS	No	
KY	No	
LA	No	
MA	No	
MD	No	
ME	*Other*	CVSA Level 1 certified sworn troopers attached to Troop K may stop without probable cause. All other enforcement officers must have probable cause.
MI	*Yes*	
MN	*Other*	Minnesota statutes 169.771 allows spot checks to be conducted randomly, but not more than once in a 90-day period on any given vehicle unless probable cause is present.
MO	*Other*	Missouri statute 304.230 states that only authorized CMV enforcement officers may conduct random inspections. All others must have probable cause.
MS	No	
MT	No	
NC	No	
ND	*Other*	Probable cause is not required by state law to stop and inspect a CMV at an inspection site but North Dakota Highway Patrol policy requires probable cause in other circumstances.
NE	No	
NH	No	
NJ	No	
NM	*Yes*	
NV	No	
NY	*Yes*	
OH	No	
OK	No	
OR	*Yes*	
PA	*Other*	MCSAP certified Officers within Pennsylvania can stop and inspect a CMV without probable cause as long as they are engaged in a systematic inspection effort. All other Officers (non-MCSAP) must have probable cause.
RI	No	
SC	No	
SD	No	
TN	No	
TX	No	
UT	No	
VA	No	
VT	No	
WA	No	
WI	No	
WV	No	
WY	No	

Appendix M. State Ranking for Red Flag Violation Issuance

Most Violations Issued per MVMT	Ranking	State	Violations per MVMT
	1	MD	0.49
	2	IA	0.49
	3	OR	0.47
	4	CT	0.38
	5	TX	0.37
	6	MT	0.36
	7	NY	0.36
	8	AZ	0.33
	9	RI	0.33
	10	LA	0.32
	11	NJ	0.30
	12	CO	0.29
	13	KS	0.29
	14	NH	0.28
	15	MA	0.27
	16	ME	0.27
	17	WY	0.24
	18	VT	0.24
	19	NE	0.24
	20	NM	0.22
	21	NV	0.21
	22	IL	0.21
	23	VA	0.21
	24	SD	0.20
	25	KY	0.20
	26	SC	0.19
	27	MN	0.19
	28	WA	0.19
	29	GA	0.18
	30	MI	0.17
	31	FL	0.17
	32	AR	0.17
	33	MO	0.16
	34	ID	0.15
	35	NC	0.15
	36	WV	0.14
	37	CA	0.13
	38	MS	0.13
	39	UT	0.12
	40	DE	0.12
	41	OK	0.11
	42	IN	0.11
	43	TN	0.10
	44	WI	0.09
	45	AL	0.08
	46	PA	0.07
	47	OH	0.06
Least Violations Issued per MVMT	48	ND	0.06

Appendix N. State Ranking for Crash Predictor Violation Issuance

Most Violations Issued per MVMT	Ranking	State	Violations per MVMT
	1	MD	1.2
	2	NV	1.1
	3	WA	0.87
	4	MA	0.84
	5	DE	0.71
	6	NM	0.57
	7	IN	0.55
	8	GA	0.52
	9	MN	0.50
	10	AZ	0.49
	11	WY	0.45
	12	IL	0.44
	13	NE	0.44
	14	CO	0.43
	15	RI	0.39
	16	MI	0.38
	17	MT	0.36
	18	CT	0.35
	19	IA	0.34
	20	NH	0.33
	21	VT	0.30
	22	KS	0.27
	23	FL	0.27
	24	ID	0.26
	25	WV	0.24
	26	PA	0.24
	27	NY	0.24
	28	TN	0.23
	29	OR	0.23
	30	SC	0.22
	31	KY	0.21
	32	NJ	0.17
	33	ME	0.17
	34	AR	0.16
	35	NC	0.16
	36	TX	0.16
	37	OH	0.14
	38	UT	0.14
	39	ND	0.13
	40	SD	0.13
	41	AL	0.13
	42	WI	0.12
	43	OK	0.12
	44	CA	0.11
	45	VA	0.11
	46	LA	0.06
	47	MS	0.04
Least Violations Issued per MVMT	48	MO	0.03

Appendix O. Top Violations by BASIC in California, 2011

BASIC	FMCSR Code	Description	Severity Weight	Violations per MVMT	National Ranking	Percentage Difference to National Average
Driver Fitness	383.23A2	Operating a CMV without a CDL	8	0.09	10th	+38.6%
	383.23C2	Operating on learner's permit without valid driver's license	8	0.03	2nd	+1,597.0%
	383.51A	Driving a CMV (CDL) while disqualified	8	0.03	5th	+73.8%
	391.41A	Driver not in possession of medical certificate	1	0.11	48th	-81.2%
	391.45B	Expired medical examiner's certificate	1	0.01	48th	-96.3%
HOS Compliance	395.3A2	Requiring or permitting driver to drive after 14 hours on duty	7	0.14	38th	-60.4%
	395.8F1	Driver's record of duty status not current	5	0.20	48th	-64.8%
	395.8A	No driver's record of duty status	5	0.11	24th	-28.8%
	395.8K2	Driver failing to retain previous 7 days' logs	5	0.08	26th	-33.1%
	395.8	Log violation (general/form and manner)	1	0.27	38th	-67.5%
Unsafe Driving	392.16	Failing to use seat belt while operating CMV	7	0.03	46th	-89.9%
	392.2C	Failure to obey traffic control device	5	0.06	35th	-61.3%
	392.2LC	Improper lane change	5	0.05	10th	+24.9%
	392.2S	Speeding	1	0.13	22nd	-28.2%
	397.3	State/local laws ordinances regulations	1	0.01	4th	+231.9%
Vehicle Maintenance	393.75C	Tire—other tread depth less than 2/32 of inch	8	1.4	2nd	+135.4%
	393.48A	Inoperative/defective brakes	4	1.8	1st	+663.3%
	393.11	No/defective lighting devices/reflective devices/projected	3	1.2	5th	+129.4%
	396.3A1	Inspection/repair and maintenance parts and accessories	2	3.1	2nd	+355.8%
	393.9A	Inoperative required lamps	2	1.4	26th	-19.1%
Controlled Substances/Alcohol	392.4A	Driver uses or is in possession of drugs	10	0.0011	44th	-82.3%
	392.5C2	Violating OOS order pursuant To 392.5(A)/(B)	10	0.0002	31st	-62.7%
	392.5A	Possession/use/under influence alcohol-4hrs prior to duty	5	0.0025	45th	-81.8%

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Appendix P. Top Violations by BASIC in Indiana, 2011

BASIC	FMCSR Code	Description	Severity Weight	Violations per MVMT	National Ranking	Percentage Difference to National Average
Driver Fitness	383.23A2	Operating a CMV without a CDL	8	0.05	30th	-24.3%
	391.11B2	Non-English speaking driver	4	0.03	15th	+4.4%
	391.11B4	Driver lacking physical qualifications	2	0.03	12th	+8.8%
	391.41A	Driver not in possession of medical certificate	1	0.31	34th	-47.5%
	391.45B	Expired medical examiner's certificate	1	0.08	43rd	-60.0%
HOS Compliance	395.3A2	Requiring or permitting driver to drive after 14 hours on duty	7	0.30	21st	-13.5%
	395.8F1	Driver's record of duty status not current	5	0.98	8th	+70.2%
	395.8K2	Driver failing to retain previous 7 days' logs	5	0.19	9th	+47.0%
	395.8A	No driver's record of duty status	5	0.09	29th	-41.2%
	395.8	Log violation (general/form and manner)	1	0.71	20th	-15.0%
Unsafe Driving	392.16	Failing to use seat belt while operating CMV	7	0.50	11th	+50.3%
	392.2FC	Following too close	5	0.44	1st	+837.7%
	392.2-SLLS2	State/local laws - speeding 6-10 MPH over the speed limit	4	0.40	10th	+75.6%
	392.2LV	Lane restriction violation	3	0.21	2nd	+528.7%
	392.2S	Speeding	1	0.50	3rd	+172.6%
Vehicle Maintenance	393.75C	Tire—other tread depth less than a 2/32 of an inch	8	0.39	31st	-34.9%
	396.17C	Operating a CMV without periodic inspection	4	0.61	20th	-21.0%
	393.47E	Clamp or roto-chamber type brake(s) out of adjustment	4	0.51	26th	-13.4%
	393.9A	Inoperative required lamps	2	0.52	41st	-69.4%
	396.3A1	Inspection or repair and maintenance parts and accessories	2	0.38	31st	-44.8%
Controlled Substances/Alcohol	392.4A	Driver uses or is in possession of drugs	10	0.0024	35th	-61.3%
	392.5C2	Violating OOS order pursuant to 392.5(A)/(B)	10	0.0002	29th	-59.2%
	392.5A	Possession/use/under influence alcohol-4hrs prior to duty	5	0.0057	36th	-58.8%

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Appendix Q. Top Violations by BASIC in Massachusetts, 2011

BASIC	FMCSR Code	Description	Severity Weight	Violations per MVMT	National Ranking	Percentage Difference to National Average
Driver Fitness	383.23A2	Operating a CMV without a CDL	8	0.06	28th	-14.0%
	391.11B7	Driver disqualified from operating CMV	8	0.03	5th	+180.7%
	391.11B4	Driver lacking physical qualifications	2	0.02	19th	-15.8%
	391.41A	Driver not in possession of medical certificate	1	1.8	3rd	+204.7%
	391.45B	Expired medical examiner's certificate	1	0.35	5th	+87.5%
HOS Compliance	395.8E	False report of driver's record of duty status	7	0.32	9th	+38.9%
	395.3A2	Requiring or permitting driver to drive after 14 hours on duty	7	0.15	32nd	-56.7%
	395.8F1	Driver's record of duty status not current	5	0.39	30th	-32.7%
	395.8K2	Driver failing to retain previous 7 days' logs	5	0.08	30th	-38.1%
	395.8	Log violation (general/form and manner)	1	0.24	40th	-70.9%
Unsafe Driving	392.2-SLLS4	State/local laws - speeding 15 or more miles over the speed limit	10	0.51	2nd	+613.7%
	392.16	Failing to use seat belt while operating CMV	7	2.3	1st	+588.7%
	392.2-SLLS3	State/local laws - Speeding 11-14 MPH over the speed limit	7	0.46	1st	+386.9%
	392.2LV	Lane restriction violation	3	0.16	4th	+376.2%
	392.2S	Speeding	1	0.75	2nd	+311.7%
Vehicle Maintenance	393.9TS	Inoperative turn signal	6	0.41	29th	-15.9%
	393.25F	Stop lamp violations	6	0.32	26th	-15.6%
	393.9A	Inoperative required lamps	2	0.95	36th	-44.8%
	393.95A	No, discharged, or unsecured fire extinguisher	2	0.45	32nd	-34.3%
	396.3A1	Inspection/repair and maintenance parts and accessories	2	0.42	27th	-38.5%
Controlled Substances/Alcohol	392.4A	Driver uses or is in possession of drugs	10	0.0072	19th	+16.9%
	392.5C2	Violating OOS order pursuant to 392.5(A)/(B)	10	0.0005	18th	+5.8%
	392.5A	Possession/use/under influence alcohol-4hrs prior to duty	5	0.0123	20th	-11.7%

Appendix R. Top Violations by BASIC in Minnesota, 2011

BASIC	FMCSR Code	Description	Severity Weight	Violations per MVMT	National Ranking	Percentage Difference to National Average
Driver Fitness	383.23A2	Operating a CMV without a CDL	8	0.09	14th	+34.5%
	391.11B7	Driver disqualified from operating CMV	8	0.05	3rd	+273.6%
	391.11B4	Driver lacking physical qualifications	2	0.04	8th	+57.5%
	391.41A	Driver not in possession of medical certificate	1	0.75	12th	+28.6%
	391.45B	Expired medical examiner's certificate	1	0.20	14th	+6.7%
HOS Compliance	395.3A2	Requiring or permitting driver to drive after 14 hours on duty	7	0.25	23rd	-25.6%
	395.8E	False report of driver's record of duty status	7	0.18	17th	-21.5%
	395.8F1	Driver's record of duty status not current	5	0.48	23rd	-17.1%
	395.8A	No driver's record of duty status	5	0.20	11th	+31.8%
	395.8	Log violation (general/form and manner)	1	0.63	24th	-24.8%
Unsafe Driving	392.16	Failing to use seat belt while operating CMV	7	0.45	13th	+37.0%
	392.2-SLLS3	State/local laws - speeding 11-14 MPH over the speed limit	7	0.06	29th	-32.4%
	392.2C	Failure to obey traffic control device	5	0.40	4th	+153.5%
	392.2-SLLS2	State/local laws - speeding 6-10 MPH over the speed limit	4	0.15	22nd	-33.7%
	392.2S	Speeding	1	0.07	29th	-61.3%
Vehicle Maintenance	393.75C	Tire—other tread depth less than a 2/32 of an inch	8	0.62	24th	-31.0%
	393.47E	Clamp or roto-chamber type brake(s) out of adjustment	4	0.54	24th	-7.5%
	393.9A	Inoperative required lamps	2	2.3	12th	+32.9%
	393.95A	No, discharged, or unsecured fire extinguisher	2	0.90	16th	-4.0%
	396.3A1	Inspection or repair and maintenance parts and accessories	2	0.63	17th	-7.5%
Controlled Substances/Alcohol	392.4A	Driver uses or is in possession of drugs	10	0.0018	39th	-69.6%
	392.5C2	Violating OOS order pursuant to 392.5(A)/(B)	10	0	-	-
	392.5A	Possession/use/under influence alcohol-4hrs prior to duty	5	0.0174	12th	+24.8%

Appendix S. Top Violations by BASIC in Texas, 2011

BASIC	FMCSR Code	Description	Severity Weight	Violations per MVMT	National Ranking	Percentage Difference to National Average
Driver Fitness	391.11B5	Driver lacking valid license for type of vehicle being operated	8	0.33	1st	+766.7%
	391.11B2	Non-English speaking driver	4	0.03	17th	-2.7%
	391.11B4	Driver lacking physical qualifications	2	0.01	41st	-65.2%
	391.41A	Driver not in possession of medical certificate	1	0.43	22nd	-26.4%
	391.45B	Expired medical examiner's certificate	1	0.11	36th	-40.1%
HOS Compliance	395.3A2	Requiring or permitting driver to drive after 14 hours on duty	7	0.09	42nd	-73.6%
	395.8F1	Driver's record of duty status not current	5	0.62	18th	+7.9%
	395.8A	No driver's record of duty status	5	0.13	21st	-13.8%
	395.8K2	Driver failing to retain previous 7 days' logs	5	0.10	22nd	-22.5%
	395.8	Log Violation (general/form and manner)	1	1.3	9th	+54.2%
Unsafe Driving	392.16	Failing to use seat belt while operating CMV	7	0.08	39th	-75.3%
	392.2C	Failure to obey traffic control device	5	0.11	23rd	-28.7%
	392.2LC	Improper lane change	5	0.03	19th	-19.1%
	392.71A	Using or equipping a CMV with radar detector	5	0.03	7th	+63.6%
	392.2S	Speeding	1	0.21	10th	+15.8%
Vehicle Maintenance	393.75C	Tire—other tread depth less than 2/32 of inch	8	1.6	1st	+163.7%
	393.45B2	Failing to secure brake hose/tubing against mechanical damage	4	1.6	3rd	+254.2%
	393.11	No/defective lighting devices/reflective devices/projected	3	5.6	1st	+965.3%
	396.5B	Oil and/or grease leak	3	1.7	2nd	+383.6%
	393.9A	Inoperative required lamps	2	1.5	22nd	-14.8%
Controlled Substances/Alcohol	392.4A	Driver uses or is in possession of drugs	10	0.0028	30th	-53.8%
	392.5C2	Violating OOS order pursuant to 392.5(A)/(B)	10	0.0016	3rd	+236.4%
	392.5A	Possession/use/under influence alcohol-4hrs prior to duty	5	0.0135	17th	-3.3%

Appendix T. Top Violations by BASIC in Washington, 2011

BASIC	FMCSR Code	Description	Severity Weight	Violations per MVMT	National Ranking	Percentage Difference to National Average
Driver Fitness	383.23A2	Operating a CMV without a CDL	8	0.08	19th	+24.7%
	391.15A	Driving a CMV while disqualified	8	0.05	10th	+9.4%
	391.41A	Driver not in possession of medical certificate	1	0.42	25th	-28.3%
	391.45B	Expired medical examiner's certificate	1	0.21	13th	+13.4%
	391.43H	Improper medical examiner's certificate form	1	0.04	8th	+82.0%
HOS Compliance	395.8E	False report of driver's record of duty status	7	0.29	10th	+29.6%
	395.3A2	Requiring or permitting driver to drive after 14 hours on duty	7	0.17	28th	-50.5%
	395.3A1	Requiring or permitting driver to drive more than 11 hours	7	0.14	25th	-28.1%
	395.8F1	Driver's record of duty status not current	5	0.51	21st	-11.8%
	395.8	Log violation (general/form and manner)	1	0.82	17th	-2.3%
Unsafe Driving	392.16	Failing to use seat belt while operating CMV	7	0.32	17th	-3.4%
	392.2C	Failure to obey traffic control device	5	0.57	3rd	+257.8%
	392.2P	Improper passing	5	0.15	1st	+510.2%
	392.2-SLLS2	State/local laws - speeding 6-10 MPH over the speed limit	4	0.33	11th	+44.7%
	392.2S	Speeding	1	0.11	24th	-42.1%
Vehicle Maintenance	393.47E	Clamp or roto-chamber type brake(s) out of adjustment	4	0.55	22nd	-5.8%
	393.45B2	Failing to secure brake hose/tubing against mechanical damage	4	0.55	11th	+24.0%
	393.9A	Inoperative required lamps	2	1.6	19th	-7.4%
	393.95A	No, discharged, or unsecured fire extinguisher	2	0.74	20th	-20.3%
	396.3A1	Inspection or repair and maintenance parts and accessories	2	0.53	21st	-21.8%
Controlled Substances/Alcohol	392.4A	Driver uses or is in possession of drugs	10	0.0036	28th	-41.8%
	392.5C2	Violating OOS order pursuant to 392.5(A)/(B)	10	0.0008	10th	+63.8%
	392.5A	Possession/use/under influence alcohol-4hrs prior to duty	5	0.0125	19th	-10.3%

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