Linking Bad Credentials to Safety Issues

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Kentucky Transportation Center
College of Engineering, University of Kentucky, Lexington, Kentucky

in cooperation with
Kentucky Transportation Cabinet
Commonwealth of Kentucky

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Kentucky Transportation Center • University of Kentucky
176 Raymond Building • Lexington, KY 40506 • 859.257.6898 • www.ktc.uky.edu

Research Report
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Linking Bad Credentials to Safety Issues

Andrew Martin, Ph.D.
Research Scientist

Jeeyen Koo, MPP
Research Scientist

Valerie Keathley-Helil, Ph.D.
Research Associate

Mallory Brown, Ph.D.
Research Scientist

and

Jennifer Walton, P.E.
Program Manager

Kentucky Transportation Center
College of Engineering
University of Kentucky
Lexington, Kentucky

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16. Abstract

This study assesses (1) the effectiveness of the Kentucky Automated Truck Screening (KATS) system, (2) the relationship between credential and vehicle safety violations, (3) the relationship between credential and driver safety violations, and (4) the relationship between credential violations and crashes. The KATS system, which is installed at weigh stations throughout the Commonwealth of Kentucky, is highly effective at detecting KYU, IFTA, and UCR violations with sensitivities of 80.54, 87.56, and 88.28 percent, respectively. However, the system is less effective at detecting IRP violations (sensitivity = 20.83 percent). There is a statistically significant relationship between credentialing and vehicle safety violations, and the same is true for credentialing violations and driver safety violations. Carriers with at least one KYU, IFTA, UCR, or IRP violation were 111.16 percent more likely to receive a citation for a vehicle safety violation than motor carriers without credentialing violations. Compared to carriers without credentialing violations, carriers with at least one credentialing violation were 112.50 percent more likely to receive a citation related to driver safety. In terms of the relationship between Kentucky-based credentialing violations and nationwide crashes (major crashes only), carriers with at least one credentialing violation were 35.43 percent more likely to be involved in a serious crash than carriers without credentialing violations.

17. Key Words KYU, IFTA, UCR, IRP, Credentialing Violations, Safety Violations		**18. Distribution Statement** Unlimited with approval of the Kentucky Transportation Cabinet	
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Executive Summary

Kentucky commercial vehicle enforcement officers and administrators of motor carrier programs have long suspected a connection between safety violations and credentialing violations (i.e., violations of required credentials, permits, or taxes owed). Many officers, inspectors, and administrators have contended that violators breach safety and credentialing requirements due to the cost of compliance. Others have argued these violations are not meaningfully related. In this report, Kentucky Transportation Center (KTC) researchers evaluate the association between safety and credentialing violations and the statistical strength of their relationship.

KTC researchers examined how effectively the Kentucky Automated Truck Screening (KATS) system detects credentialing compliance issues and driver and vehicle safety violations using commercial vehicle (CMV) screening data collected at weigh stations. The study period covers January 2017 through August 2020. Based on license plate and USDOT numbers, KATS checks vehicles against Kentucky and national databases to determine whether there are KYU, IFTA, UCR, and IRP-related credentialing violations. The specificity rates (true negative) for all four violations exceeded 90 percent, a common benchmark used to evaluate screening tests. The sensitivity rates (true positive) for KYU, IFTA, and UCR violations were 80.54, 87.56, and 88.28 percent, respectively — all above the 80 percent benchmark used to evaluate screening tests. However, the sensitivity rate for IRP violations was 20.83 percent, which is significantly lower than that of other credentialing violations. As such, a comprehensive plan is needed to improve IRP data quality to improve the effectiveness of KATS, since having accurate and timely updated data is essential for catching violators who can threaten highway safety.

Researchers also looked at the relationship between credentialing and vehicle safety violations at the motor carrier level (as opposed to individual inspections). On average, motor carriers without KYU violations in 2019 received fewer than one citation for vehicle safety violations (0.524). Motor carriers with at least one KYU violation received an average of 0.979 citations for violating vehicle safety. These entities received 86.83 percent more citations for vehicle safety violations than motor carriers without KYU violation records. A similar pattern was found for IFTA, UCR, and IRP. Motor carriers with at least one KYU, IFTA, UCR, or IRP violation were 111.16 percent more likely to receive a citation for a vehicle safety violation than those without credentialing violations.

Examining the relationship between credentialing and driver safety violations revealed that motor carriers with at least one KYU violation were 24.21 percent more likely receive a citation for driver safety violations than operations that had no KYU violations. Motor carriers with at least one IFTA violation were 149.45 percent more likely to be cited for a driver safety violation than those without an IFTA violation. Comparing motor carriers with any kind of credentialing violation to those without any indicated that motor carriers with at least one credentialing violation were 112.50 percent more likely to receive a citation related to driver safety.

Using the number of CMV crashes nationwide recorded in the FMCSA Analysis & Information Portal, the relationship between credentialing violations and crashes was investigated (crashes resulting in minor incidents were excluded). Motor carriers with at least one KYU compliance issue were 29.67 percent more likely to be involved in a crash than those with no KYU compliance issues. Motor carriers with at least one credentialing violation averaged 0.237 crash records for each power unit they operated over the 15-month study period, while motor carriers without credentialing violations had 0.175 crash records per power unit they operated.

The final chapter presents best practices for Kentucky's Innovative Technology Deployment (ITD) team can use to more effectively capture credentialing and safety violators and improve highway safety. These are:

- Continue data quality improvement efforts
- Address IRP data sensitivity issues
- Increase scrutiny of IRP violations
- Continue analysis of KATS, PrePass, DriveWyze, and RIMS Observation data
- Enhance KATS, PrePass, DriveWyze, and RIMS Observation data
- Revisit automated enforcement and screening
- Improve KATS data verification
- Improve KATS LPR/USDOT number capture rate
- Capture roadside screening data

Chapter 1 Introduction

Kentucky commercial vehicle enforcement officers and administrators of motor carrier programs have long suspected a connection between safety violations and credentialing violations (i.e., violations related to required credentials, permits, or taxes owed). Many officers, inspectors, and administrators contend that multiple violators breach safety and credentialing requirements for the same reason – the cost of compliance. However, others have suggested the two may bear little to no meaningful relationship, which means states must balance competing enforcement goals to ensure safety and compliance with credentialing, permitting, and tax requirements. The primary objective of this project is to determine if carriers that violate credentialing requirements are more likely to commit safety violations than carriers which abide by credentialing requirements. If so, how much more likely?

Kentucky Transportation Center (KTC) researchers began the project with a comprehensive review of laws and regulations related to the safety and credential requirements underpinning enforcement activities at Kentucky weigh station facilities. Chapter 2 traces the evolution of motor carrier regulations from the Motor Carrier Act of 1935 through the most recent Motor Carrier Safety Improvement Act of 1999. Safety inspections are a crucial tool for enforcing the motor carrier acts, and this chapter discusses the North American Standard Inspection Program. Commercial vehicle enforcement personnel use the eight-level inspection system to maintain highway safety in Kentucky, although they most commonly adopt Levels I through III in their daily activities; Levels I – III are the most important variables for this project. Chapter 2 also provides background on the Kentucky Automated Truck Screening (KATS) system, one of the automated systems used to screen for safety and credentials at weigh station facilities. Data for this project were derived from KATS. Finally, Chapter 2 discusses the four credentials that comprise the dataset used in our analysis — the Kentucky Weight Distance Tax (KYU), International Registration Program (IRP), International Fuel Tax Agreement (IFTA), and United Carrier Registration (UCR).

Chapter 3 discusses the data analysis undertaken to determine if a link between safety violations and credential violations exists. We collected commercial vehicle screening data for January 2017 – August 2020 via the KYTC BusinessObjects database. During the study period, Kentucky screened approximately 30 million vehicles according to observations recorded in KATS, PrePass, Drivewyze, and through inspections by mobile enforcement patrols. After data collection, we linked screening data with the corresponding inspection data. Since KATS is the only automated system that retains screening data, analysis relied solely on KATS data. Analysis of this dataset revealed that as the number of credentialing violations detected by KATS increases, the percentage of inspections resulting in no vehicle safety violations decreases. Also, the percentage of inspections resulting in more than five vehicle safety violations increases as the number of credentialing violations detected by KATS increases. The result shows the positive relationship between the number of credentialing violations and vehicle safety violations. Analysis also found that motor carriers with at least one credentialing violation are more likely to have vehicle safety violations (111.16 percent), driver safety violations (112.50 percent), Hazmat permit violations (24.24 percent), and OWOD permit violations (60.00 percent) than motor carriers without credentialing violations.

After demonstrating a statistically significant relationship between safety violations and credentialing violations, we developed a strategies report for commercial vehicle enforcement officers and inspectors to maximize the utility of these findings to increase the number of FOOS, VOOS, DOOD, and HOOS detected at Kentucky's weigh station facilities.

Chapter 4 contains a strategies report. We initially planned to conduct an enforcement detail to present the strategies report and demonstrate its effectiveness. However, the CVOID-19 pandemic prevented us from conducting the enforcement detail because weigh station buildings were closed to everyone except personnel.

Our team reviewed background literature to determine why a positive correlation between tax evasion and poor safety records exists. The most obvious reason is that a company or person evades taxes to preserve as much of their money as they can. Motor carriers are historically resistant to additional taxation for obvious reasons — it means a potential loss of profits. A 1956 discussion of New York's development of the highway-use tax, similar to the Kentucky Weight Distance Tax (KYU), described the trucking industry as "possessing a natural aversion to taxes" (Long, 1956; page 416). Research by Denison and Eger (2002) found that smaller companies have much smaller profit margins and thus are more likely to evade taxes. Research on tax evasion examines other factors that influence the decision to evade taxes. Molero and Pujol (2012) found that a sense of grievance over taxation can motivate tax evasion; someone may be more likely to cheat on taxes if they believe taxes are too high. Survey research by KTC found that motor carrier respondents perceive that KYU is an unfair tax on the industry (Martin et al., 2020). In addition, companies are more likely to cheat on their taxes if enforcement is lax (Denison et al., 2000; Yusuf and O'Connell, 2012). Company management potentially weighs the fiscal benefit of not paying taxes against the risk of an audit and penalties. Scholars recommend that states improve tax enforcement efforts to raise revenue before increasing taxation (Denison et al., 2000; Denison and Eger, 2002). There are also less apparent motivations for compliance or noncompliance — namely concern over public image and stakeholders (Denison et al., 2000; Denison and Eger, 2002). Denison and Eger (2002) noted that a large company is more likely than smaller companies to pay its taxes because it faces more scrutiny from the government, public, and stakeholders.

The literature on safety in the trucking industry shows a similar cost-benefit analysis for complying with safety regulations. Larger carriers are more compliant with safety regulations (i.e., lower crash rates, citations, and hours of service violations) than smaller firms (Monaco and Williams, 2000; Miller, 2020; Swartz and Douglas, 2009). There are various explanations for this finding. First, larger carriers have the resources to invest to maintain compliance (Miller, 2020). Large carriers can afford to implement more safety technologies in their vehicles, maintain their vehicles, and hire safety managers (Cantor et al., 2016). These companies do not operate on thin profit margins, so there is less motivation to push a driver to violate regulations to deliver more loads in a shorter amount of time (Schwartz and Douglas, 2009). Larger carriers also face regulatory pressure from the Federal Motor Carrier Safety Administration (FMCSA) since they have more vehicles on the highway and are thus more likely to be subject to a roadside safety inspection (Miller, 2020). Larger companies also want to protect their brand and face additional pressure from stakeholders, shippers, brokers, and insurance companies (Miller, 2017).

We conclude that companies which violate tax laws are more likely to receive citations for safety violations because the decision to comply with taxes and safety regulations features a cost-benefit analysis of the same factors. A company must determine whether it has the money to pay taxes and whether the penalties for evasion outweigh the benefits. A carrier must also determine if it has the money to invest in safety measures and vehicle maintenance and weigh those factors against the cost of non-compliance and the probability of a Level 1, 2, or 3 inspection. A motor carrier lacking the capital for vehicle maintenance and operating on a tight profit margin that prioritizes deliveries over hours-of-service limits is less likely to have the money to meet its tax obligations.

Chapter 2 Safety Regulations

2.1 History of Safety Regulations for Commercial Vehicles

The evolution of governance over safety standards for commercial vehicles (CMVs) has resulted in a complex tangle of regulations. Stakeholders must be vigilant about complying with these standards. CMV manufacturers, commercial drivers, and fleet owners of truck/trailer combinations that weigh 10,001 pounds or more must all adhere to the Federal Motor Carrier Safety Regulations (FMSCRs) set forth by FMCSA. Regulations evolved gradually from the Motor Carrier Act of 1935 (1936) through the Motor Carrier Safety Improvement Act of 1999 (Nebraska Department of Motor Vehicles, 2017). Each act has provided additional guidance and streamlined the process of creating and disseminating safety regulations for CMVs and their drivers. Each law is outlined below as it relates to the development of the most current safety regulations for CMVs.

2.1.1 Motor Carrier Act of 1935

Due to the development of a more sophisticated roadway system in the United States, transportation methods began to change. According to George (1936), the mileage traveled by passengers via steam railroad decreased by 40 percent from 1930 to 1934, but mileage traveled via bus increased 10% in the same timeframe. Not only did this shift result in declining revenue for other modes of transportation but also highlighted many other insufficiencies that required attention. George (1936) outlined the full scope of the problem and need for action at the federal level: "Thus the last decade has witnessed a combination of forces leading to Congressional action. Those forces include the magnitude of interstate motor transportation, inability of the states to control it adequately, the resulting injurious effects of unregulated interstate motor activity on regulated intrastate operation, on railroads, their employees, and shippers, on highway taxpayer-users, and on the increasing urgency of problems of public safety on the highways". The Motor Carrier Act of 1935's passage provided the Interstate Commerce Commission, or ICC, with full authority over bus and truck companies (i.e., motor carriers). Additionally, this act created a distinction among motor carriers. Common carriers were those that served the general public and contract carriers were those with a limited number of customers. The act also inhibited competition between motor carriers and railroads as well as between common carriers and contract carriers. It required potential new carriers to submit their rates for service 30 days in advance to allow for protest by companies already in business. Last, the act provided exemptions for several groups of individuals, including those using their own vehicles for business, motor vehicles driven by farmers, school buses, and taxis (George, 1936).

2.1.2 Department of Transportation Act of 1966

President Lyndon B. Johnson and the 89th Congress created the U.S. Department of Transportation (USDOT). Prior to the USDOT's establishment, all transportation matters were handled by the Secretary of Commerce for Transportation within the United States Department of Commerce. Alan S. Boyd held the position of Secretary of Commerce for Transportation before becoming the nation's first Secretary of Transportation. Due to many compromises made by both the House and Senate, the power of the secretary was vastly diminished by the act. While granted approval to develop initiatives and outline recommendations for the nation's transportation industry, the act specified that final congressional approval must be granted prior to action. However, the secretary was given full administrative authority over the federal airport aid program, Coast Guard (except for during war), highway beautification program, interstate highway program, and automobile and highway safety programs. In addition to these established parameters, the act created three divisions within the Department of Transportation: Federal Highway Administration (FHWA), Federal Aviation Administration (FAA), and the Federal Railway Administration (FRA). Each division would be controlled by their own administrators. Finally, the act required the creation of the National Transportation Safety Board, an independent entity responsible for accident investigation oversight (United States Department of Transportation, 2019)

2.1.3 The Hazardous Materials Transportation Act of 1975

The Hazardous Materials Transportation Act of 1975 gave the Secretary of Transportation authority to protect against potential risks to life and property posed by transporting hazardous materials. This authority was to be used to create and enforce regulations that ensured the utmost safety. Due to the convoluted nature of the act's language, the Hazardous Materials Transportation Uniform Safety Act (HMTA) of 1990 aimed to provide clarification. Seven provisions were included that related to radioactive materials: clarification of regulatory jurisdiction, highway routing standards, broadened industry registration, safety permits for motor carriers of high risk materials, expanded nuclear transportation requirements, new provisions for emergency response training and planning, and a public process for assessing the feasibility of a federally operated central reporting system and data center (United States Department of Labor, n.d.).

2.1.4 Surface Transportation Assistance Act of 1982

The Surface Transportation Assistance Act (STAA) of 1982 addressed concerns over improving or maintaining the integrity of highways and bridges. Title V of the act added five cents per gallon to the gas tax, which was the first increase since 1966. Four cents were allocated to improve highways and bridges while the remaining cent was directed toward public transit initiatives. Additionally, the STAA expanded the definition of CMV to all trucks weighing more than 10,000 pounds. The STAA also gave the Secretary of Transportation authority "to make grants to states for the development or implementation of programs for the enforcement of federal rules, regulations, standards, and orders applicable to CMV safety and compatible state rules, regulations, standards, and orders." This was the beginning of the Motor Carrier Safety Assistance Program (United States Department of Transportation, n.d.). Section 405 also went into effect in 1983 to protect CMV drivers who report noncompliance of safety regulations from retaliatory action. Under the STAA, drivers who believe they have suffered retaliatory action from their employer have the right to file a formal complaint with Occupational Safety and Health Administration (OSHA) within 180 days of the proposed offense. Should OSHA find evidence of an infraction, the adjudication process begins in a court of law (National Committees for Occupational Safety and Health Network, n.d.).

2.1.5 National Driver Register Act of 1982

Title I of the National Driver Register Act (NDRA) allocated funds to states that agreed to adopt and implement statewide programs to improve traffic safety issues related to driving under the influence of alcohol. Title II created the National Driver Register, a database comprised of individual motor vehicle driver records. Prior to the law's passage, individuals who had their driver's license revoked appeared on the Department of Commerce's registry. After the NDRA became law, the registry housed within the Department of Commerce dissolved and the National Driver Register was maintained by the Secretary of Transportation. Additionally, states that opted to participate in the register became responsible for reporting individuals for several reasons, including having a license canceled, revoked, or suspended as well as those individuals with a DUI conviction. The NDRA set the limit for these records appearing in the National Driver Register at seven years, after which they are removed (National Highway Traffic Safety Administration, 2020)

2.1.6 Motor Carrier Safety Act of 1984

The Motor Carrier Safety Act (MCSA) included provisions for drivers, owners, and operators of CMVs. The law had seven principal goals: require that CMVs are maintained, operated, equipped and loaded safely; ensure drivers could carry out their duties in a safe manner; confirm the physical condition of the drivers is appropriate for the responsibilities; and certify that driving CMVs does not detrimentally impact the physical condition of drivers. With this act, the Secretary of Transportation received authority to issue safety regulations related to the equipment, maintenance, operation, and physical condition of drivers as well as their work conditions. The act was amended in 1990 to include provisions for enforcing safety regulations. One such safety concern related to the visibility of trailers at night. Included in the MCSA of 1990 was the requirement that reflective strips outline trailers beginning in 1994 (U.S. Department of Transportation, n.d.).

2.1.7 Commercial Motor Vehicle Safety Act of 1986

The Commercial Motor Vehicle Safety Act (CMVSA) mandated that the Department of Transportation establish national standards for commercial driver's licenses (CDLs). The CMVSA determined that those operating a CMV could only hold one license at a time. The CMVSA also required drivers to report any traffic infractions to the state that issued their license, as well as their employer, within 30 days of the incident occurring. Those applying for a CDL must now provide a 10-year employment history. Once in possession of a CDL, drivers are also subject to harsher regulations regarding alcohol use and will lose their CDL if convicted of a DUI. Other reasons for being disqualified from driving a CMV include leaving the scene of an accident or using a CMV to commit a felonious act. The CMVSA of 1986 also created a national CDL program as well as the Commercial Driver's License Information System (CDLIS) (State of New Mexico, 2013).

2.1.8 Omnibus Transportation Employee Testing Act of 1991

As a result of a New York City subway train derailment, the Omnibus Transportation Employee Testing Act (OTETA) was passed. While the legislation only initially included alcohol testing for Department of Transportation employees, the list has since grown and encompasses a number of substances included on drug screenings. Those who must submit to testing include anyone who is in a position in which being impaired directly threatens public safety. People in the aviation, trucking, railroads, mass transit, and pipeline industries are all subject to multiple screenings. OTETA requires testing at several junctures, including pre-employment, if an accident occurs (post-accident, return to duty, and follow-up), and random screens predetermined by the USDOT. If an employee tests positive for a screened substance, OTETA requires that the employee be removed from their position immediately and referred to a substance abuse program. The USDOT did not establish uniform termination rules under OTETA but did establish that any employee wanting to return to work must commit to completing the process of returning to work set forth by their employer and substance abuse program (United States Department of Transportation, 2020).

2.1.9 Motor Carrier Safety Improvement Act of 1999

The Motor Carrier Safety Improvement Act (MCSIA) created the FMCSA as part of USDOT. Under the MCSIA, more strict regulations were put into place for disqualifying current commercial drivers. For instance, a driver will be disqualified from operating a CMV for at least one year if they drive a CMV without appropriate licensure or are convicted of causing a fatality due to negligence or criminal operation of a CMV. Further restrictions were also put in place for individuals wishing to obtain a CDL. MCSIA directed the Secretary of Transportation to require a federal medical qualification certificate before procuring a CDL (Nebraska Department of Motor Vehicles, 2017).

While this list of enacted laws is not exhaustive, it highlights the major changes that have taken place in the regulation of CMVs (United States Department of Labor, n.d.). The system is always changing, but there has been major economic deregulation of the trucking industry. At the same time, the federal government has expanded safety regulations to reduce highway fatalities. Currently there are 35,000-

40,000 fatalities each year with approximately 5,000 involving a CMV (United States Department of Transportation, 2020).

2.2 Current Standards and Regulations for Commercial Vehicles

2.2.1 Motor Carrier Safety Assistance Program

The Surface Transportation Assistance Act of 1982 created the Motor Carrier Safety Assistance Program (MCSAP). The program provides grants to states to help them work toward reducing the number of crashes and incidents involving commercial vehicles. The program supports more than 12,000 trained officers across the United States who enforce and uphold safety standards and guidelines related to commercial vehicle safety (United States Department of Transportation, 2020).

2.2.2 The Commercial Vehicle Safety Alliance

The Commercial Vehicle Safety Alliance (CVSA) has roots going back to 1980. While starting as an informal group of individuals representing various agencies in the United States and Canada responsible for commercial vehicle safety, early participants of the CVSA recognized a need to create uniform standards to reduce lost funds and redundancy of work. A Memorandum of Understanding (MOU) was drafted and created minimum inspections and out-of-service criteria. All agencies bound by the MOU agreed to adopt a uniform approach and recognize inspections completed by other jurisdictions just as they would their own inspections (Commercial Vehicle Safety Alliance, 2020).

Seven states and two Canadian provinces adopted the original MOU. It was later renamed the Western States CVSA. Nearly all agencies that opted into the Alliance saw a reduction in crashes and, in just two short years, bylaws were approved in October of 1982 which allowed CVSA to have international jurisdiction. Moreover, changes were made to allow for different types of memberships (Commercial Vehicle Safety Alliance, 2020). The U.S. Surface Transportation Assistance Act (1982) provided states with federal funds to engage in measures to reduce crashes and other CMV-related safety issues

By 1985, the Alliance had grown to a point of needing appointed leadership and administrative staff and an established home office. While CVSA once only encompassed the United States and Canada, Mexico was added in 1991. Currently, the main office of CVSA is located in Washington, D.C. The alliance is comprised of five geographical regions (Table 2.1) (Commercial Vehicle Safety Alliance, 2020).

Table 2.1 Geographical Regions of CVSA

Region	States
Region 1	Connecticut, Delaware, District of Columbia, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Puerto Rico, Rhode Island, US Virgin Islands and Vermont
Region 2	Alabama, American Samoa, Arkansas, Florida, Georgia, Kentucky, Louisiana, Mississippi, North Carolina, Oklahoma, South Carolina, Tennessee, Texas, Virginia and West Virginia
Region 3	Colorado, Illinois, Indiana, Iowa, Kansas, Michigan, Minnesota, Missouri, Nebraska, North Dakota, Northern Mariana Islands, Ohio, South Dakota and Wisconsin
Region 4	Alaska, Arizona, California, Guam, Hawaii, Idaho, Mexico, Montana, Nevada, New Mexico, Oregon, Utah, Washington and Wyoming
Region 5	Alberta, British Columbia, Manitoba, New Brunswick, Newfoundland and Labrador, Nova Scotia, Northwest Territories, Nunavut, Ontario, Prince Edward Island, Quebec, Saskatchewan and Yukon

CVSA is an international nonprofit organization whose mission is to "improve commercial vehicle safety and uniformity throughout Canada, Mexico, and the United States by providing guidance and education to enforcement, industry, and policy makers" (CVSA, 2020). Currently, the CVSA has four membership classes (Table 2.2).

Table 2.2 Membership Classes of CVSA

Class Level	Membership Type	Representatives
Class I	State/provincial	various departments of transportation, public utility and service commissions, state police, highway patrols, departments of motor vehicles and ministries of transport
Class II	Local	city or municipal police departments
Class III	Associate	companies, organizations, trade associations, trucking and bus companies, industry suppliers and vendors, training institutions, consultants, insurance companies, state or provincial trucking associations, and large and small fleet owners or owner operators
Class IV	Federal	federal government agency representatives

CVSA's commitment to commercial vehicle safety is evident by the inclusion of a broad range of entities involved in developing commercial vehicle inspections standards, including the trucking industry. Each membership level represents various interests and competing priorities. But having multiple perspectives has proven to be valuable to the organization's continued success at maintaining a high level of fidelity to safety inspection procedures for commercial vehicles.

2.2.3 North American Standard Inspection Program

One of CVSA's more notable accomplishments is the development of the North American Standard Inspection Program. The program created standardized practices across all jurisdictions for certified inspectors. The program provides clear guidelines for conducting proper inspections to identify safety issues that put drivers or their vehicles in danger (Commercial Vehicle Safety Alliance, n.d.). To ensure consistency among inspections, only certified law enforcement officers who completed a training program approved by CVSA are authorized to inspect CMVs. There are eight levels of inspections that can occur during a stop. A Level I inspection is the most thorough inspection. Level VIII is the least invasive and does not require the vehicle to stop. Although Level I, II, and III inspections are the most common, each is described in Table 2.3.

Table 2.3 Levels of North American Standard Inspections

Level	Areas of Focus
Level I	37-step inspection of both carrier and driver; includes verifying credentials, driving log, mechanical condition of vehicle and any hazardous or dangerous materials present
Level II	Inspection of driver and vehicle; walk-around of carrier; inspector checks every part of vehicle, minus the undercarriage
Level III	Driver-only inspection; driver's credentials and papers
Level IV	One-time inspection of a specific item; usually in compliance with study or research about trends
Level V	Vehicle-only inspection; can be performed without driver at any location
Level VI	Inspection of quantities of radioactive materials

Level VII	Inspection mandated by specific jurisdiction
Level VIII	Electronic/wireless inspection while vehicle drives past inspector

While some levels of inspection are relatively simple, all levels of inspections require attention to detail and consistency. To ensure inspectors do not overlook a critical part of their inspection, CVSA has inspection procedures for the Level I Inspection, Passenger Carrier Vehicle Inspection, Cargo Tank and Other Bulk Packagings, and Hazardous Materials/Dangerous Goods (Commercial Vehicle Safety Alliance, n.d.). A Level I Inspection has the most steps (Table 2.4).

Table 2.4 North American Standard Level I Inspection Procedure

Inspection Step
1. Choose inspection sight
2. Approach vehicle
3. Greet and prepare driver
4. Interview driver
5. Collect driver's documents
6. Check for presence of Hazardous Materials/Dangerous Goods
7. Identify the carrier
8. Examine driver's license
9. Check medical examiner's certificate and skill performance evaluation (if applicable)
10. Check record of duty status
11. Review driver's daily vehicle inspection report (if applicable)
12. Review periodic inspection report(s)
13. Prepare driver for vehicle inspection
14. Inspect front of tractor
15. Inspect Left front side of tractor
16. Inspect Left saddle tank area
17. Inspect trailer front
18. Inspect Left rear tractor area
19. Inspect Left side of trailer
20. Inspect Left rear trailer wheels
21. Inspect Rear of trailer
22. Inspect Double, Triple and Full Trailers
23. Inspect Right rear trailer wheels
24. Inspect Right side of trailer
25. Inspect Right rear tractor area
26. Inspect Right saddle tank area
27. Inspect Right front side of trailer
28. Inspect steering axle(s)
29. Inspect axle(s) 2 and/or 3
30. Inspect axle(s) 4 and/or 5
31. Prepare the vehicle and check brake adjustment
32. Inspect Tractor Protection System (tests both TPS and emergency brakes)
33. Inspect required brake system warning devices
34. Test air loss rate
35. Check steering wheel lash

Inspection Step
36. Check fifth wheel movement
37. Complete the inspection

Due to the extensive nature of a Level I Inspection, CVSA created a document that lists all components of the inspection. The document (*North American Standard Roadside Inspection Vehicle Cheat Sheet*) is provided in Figure 1 (CVSA, n.d.).

North American Standard Roadside Inspection Vehicle Cheat Sheet

BRAKES

Check for missing, non-functioning, loose, contaminated or cracked parts on the brake system. Check for S-cam flipover. Be alert for audible air leaks around brake components and lines. Check that slack adjusters are the same length (from center of S-cam to center of clevis pin) and the air chambers on each axle are the same size. Ensure the air system maintains air pressure between 90-100 psi (620-690 kPa). Inspect for non-manufactured holes (e.g., rust holes, holes created by rubbing or friction, etc.) and broken springs in the spring brake housing section of the parking brake. Measure pushrod travel. Inspect required brake system warning devices, such as ABS malfunction lamp(s) and low air pressure warning devices. Inspect tractor protection system, including the bleedback system on the trailer. Ensure the breakaway system is operable on the trailer.

COUPLING DEVICES

Safety Devices - Full Trailers/Converter Dolly(s): Check the safety devices (chains/wire rope) for sufficient strength, missing components, improper repairs and devices that are incapable of secure attachment. On the lower fifth wheel, check for unsecured mounting to the frame or any missing or damaged parts, or any visible space between the upper and lower fifth wheel plates. Verify that the locking jaws are around the shank and not the head of the kingpin and that the release lever is seated properly and the safety latch is engaged. Check the upper fifth wheel for any damage to the weight bearing plate (and its supports), such as cracks, loose or missing bolts on the trailer. On the sliding fifth wheel, check for proper engagement of locking mechanism (teeth fully engaged on rail); also check for worn or missing parts. Ensure the position does not allow the tractor frame rails to contact the landing gear during turns. Check for damaged or missing fore and aft stops.

FUEL AND EXHAUST SYSTEMS

Check your fuel tanks for the following conditions: loose mounting, leaks, or other conditions; loose or missing caps; and signs of leaking fuel below the tanks. For exhaust systems, check the following: unsecured mounting; leaks beneath the cab; exhaust system components in contact with electrical wiring or brake lines and hoses; and excessive carbon deposits around seams and clamps.

FRAME, VAN AND OPEN-TOP TRAILERS

Inspect for corrosion fatigue; cracked, loose or missing crossmembers; cracks in frame; missing or defective body parts. Look at the condition of the hoses and check the suspension of air hoses on vehicles with sliding tandems. On the frame and frame assembly, check for cracks, bends, sagging, loose fasteners or any defect that may lead to the collapse of the frame; corrosion; fatigue; cracked or missing crossmembers; cracks in frame; missing or defective body parts. Inspect all axle(s). For vans and open-top trailer bodies, look at the upper rail and check roof bows and side posts for buckling, cracks or ineffective fasteners. On the lower rail, check for breaks accompanied by sagging floor, rail or cross members; or broken with loose or missing fasteners at side post adjacent to the crack.

LIGHTING

Inspect all required lamps for proper color, operation, mounting and visibility.

SECUREMENT OF CARGO

Make sure you are carrying a safe load. Check tail board security. Verify end gates are secured in stake pockets. Check both sides of the trailer to ensure cargo is protected from shifting or falling. Verify that rear doors are securely closed. Where load is visible, check for proper blocking and bracing. It may be necessary to examine inside of trailer to ensure large objects are properly secured. Check cargo securement devices for proper number, size and condition. Check tiedown anchor points for deformation and cracking.

STEERING

Check the steering lash by first turning the steering wheel in one direction until the tires begin to pivot. Then, place a mark on the steering wheel at a fixed reference point and turn the wheel in the opposite direction until the tires again start to move. Mark the steering wheel at the same fixed reference point and measure the distance between the two marks. The amount of allowable lash varies with the diameter of the steering wheel.

SUSPENSION

Inspect the suspension for: indications of misaligned, shifted, cracked or missing springs; loose shackles; missing bolts; unsecured spring hangers; and cracked or loose U-bolts. Also, check any unsecured axle positioning parts and for signs of axle misalignment. On the front axle, check for cracks, welds and obvious misalignment.

TIRES, WHEELS, RIMS AND HUBS

Check tires for proper inflation, cuts and bulges, regrooved tires on steering axle, tread wear and major tread groove depth. Inspect sidewalls for improper repairs, exposed fabric or cord, contact with any part of the vehicle, and tire markings excluding it from use on a steering axle. Inspect wheels and rims for cracks, unseated locking rings, and broken or missing lugs, studs or clamps. Check for rims that are cracked or bent, have loose or damaged lug nuts and elongated stud holes, have cracks across spokes or in the web area, and have evidence of slippage in the clamp areas. Check the hubs for lubricant leaks, missing caps or plugs, misalignment and positioning, and damaged, worn or missing parts.

INTERNATIONAL ROADCHECK CVSA

Figure 2.1 North American Standard Roadside Vehicle Inspection Cheat Sheet

2.3 Safety Management System

The Safety Management System (SMS) is used by the FMCSA to estimate noncompliance with safety regulations and standards. The system receives information from four main sources: on-road performance, investigations, state-collected commercial vehicle crash data, and census data. On-road performance data are from roadside inspections and crash reports, while investigation data come from violations records collected over the previous 12 months. These data are used to prioritize interventions for noncompliance (Department of Transportation, 2019). State representatives are responsible for uploading commercial vehicle crash data into the Motor Carrier Management Information System (MCMIS). Census data are collected when an official USDOT number has been assigned. Both carriers and law enforcement contribute to census data. Census data are used by the SMS to enable correct identification of a carrier's information and normalize collected data. Information collected includes type of cargo carried, name of carrier, and USDOT number (Department of Transportation, 2019).

Within SMS lies the categorization of safety compliance offenses — Behavior Analysis and Safety Improvement Categories (BASIC). There are seven categories, whose definitions are outlined in Table 2.5 (Department of Transportation, 2019):

Table 2.5 Behavior Analysis and Safety Improvement Categories

BASIC	Definition	Example
Unsafe Driving	"Operation of commercial vehicles (CMVs) in a dangerous or careless manner"	Speeding, not wearing seatbelt
Crash Indicator	"Historical pattern of crash involvement, including frequency and severity"	
Hours-of-Service Compliance	"Operation of CMVs by drivers who are ill, fatigued, or in noncompliance with the HOS regulations"	Operating a motor carrier while sick
Vehicle Maintenance	"Failure to properly maintain a CMV and prevent shifting loads, spilled or dropped cargo, and overloading of a CMV"	Broken/inoperable brakes, lights
Controlled Substances/Alcohol	"Operation of CMVs by drivers who are impaired due to alcohol, illegal drugs, and misuse of prescription or over-the-counter medications"	Use or possession of drugs or alcohol
Hazardous Materials Compliance (HM)	"Unsafe handling of HM on a CMV"	Failing to get mandated inspection of cargo prior to trip
Driver Fitness	"Operation of CMVs by drivers who are unfit to operate a CMV due to lack of training, experience, or medical qualifications"	Invalid CDL

Motor carriers are graded on their performance in each category. This information is converted into a number. Motor carriers are initially grouped together in each BASIC based on number of infractions and then assigned a percentile ranging from 0-100. Higher percentiles represent poorer safety performance. In addition to BASIC, Acute and Critical Violations are used to identify carriers requiring intervention. If a CMV has one or more violations during an investigation, alerts are placed on BASICs not in compliance (Department of Transportation, 2019).

2.4 Commercial Vehicle Screening at Kentucky Weigh Station Facilities

Inspections at weigh station facilities play a vital role in promoting highway safety and ensuring motor carriers comply with credential and registration requirements. However, enforcement personnel cannot inspect every truck. Truck inspections are labor intensive. An inspection includes identifying a vehicle for inspection, stopping the vehicle, conducting the inspection, and completing associated paperwork. A 2013 study by Kissick et al. estimated an inspection lasts between 30 minutes and one hour (or more). The same study found that in 2011, only one percent of 4.5 million CMVs, were inspected at one of Kentucky's 14 fixed roadside weigh stations (Kissick et al., 2013). Kentucky State Police Commercial Vehicle Enforcement (KSP CVE) faces ongoing staffing shortages that make it challenging to keep weigh station facilities open for inspections. Throughout the U.S., budget constraints in state governments have resulted weigh station closures (Carter, 2012; Elliot, 2014). Also, weigh station facilities frequently lack adequate space to conduct inspections.

Automated screening systems, including transponder-based screening, license plate readers (LPR), USDOT readers (USDOTR), and geofencing, help address many of these problems by letting weigh station personnel monitor interstate truck traffic more efficiently. These technologies let weigh station staff focus on detecting motor carriers and drivers out of compliance with safety regulations and credentialing requirements while allowing compliant companies and drivers to bypass the station unimpeded (Benekohal et al., 1999; Crabtree & Walton, 2011; Ismail et al., 2010; Lane, 2008b; McCall et al., 1998). Researchers have found electronic screening successfully identifies more violators than manual selection (Brand et al., 2002; Ismail et al., 2010; Kissick et al., 2013; Walton et al., 2008). Automated systems also help prevent traffic congestion and reduce the number of trucks that bypass because weigh stations are at capacity (Rahim F. Benekohal et al., 1999; Gieseman & Maze, 2007; Lee & Chow, 2010, 2011; McCall et al., 1998).

FMCSA's Innovative Technology Deployment (ITD) Program objectives include improving highway safety through targeted enforcement, strengthening commercial vehicle data sharing among states, and enhancing electronic screening of CMVs (FMCSA, 2020). States can procure grants through the ITD program to develop and deploy electronic screening systems. KYTC has received multiple grants from FMCSA and used funding to develop award-winning truck safety and credential screening technology. In 2014, KATS was awarded the ITS Project of the Year Award by the Intelligent Transportation Society of the Midwest (ITS Midwest, 2014). It also garnered the American Association of State Highway and Transportation Officials (AASHTO) 2015 President's Award for Research (Kentucky's Commercial Vehicle Screening System Receives National Honor, 2015). This study's safety and credentials data are derived from KATS, an electronic screening system that automatically identifies CMVs for inspection using LPRs and USDOTRs. Kentucky deployed KATS at 14 locations (Figure 2). Systems are located on five interstates (I-75, I-64, I-71, I-65, I-23), three U.S. highways (U.S. 23, U.S. 25, and U.S. 41), and three state routes (KY-9, KY-9002, KY-9003).

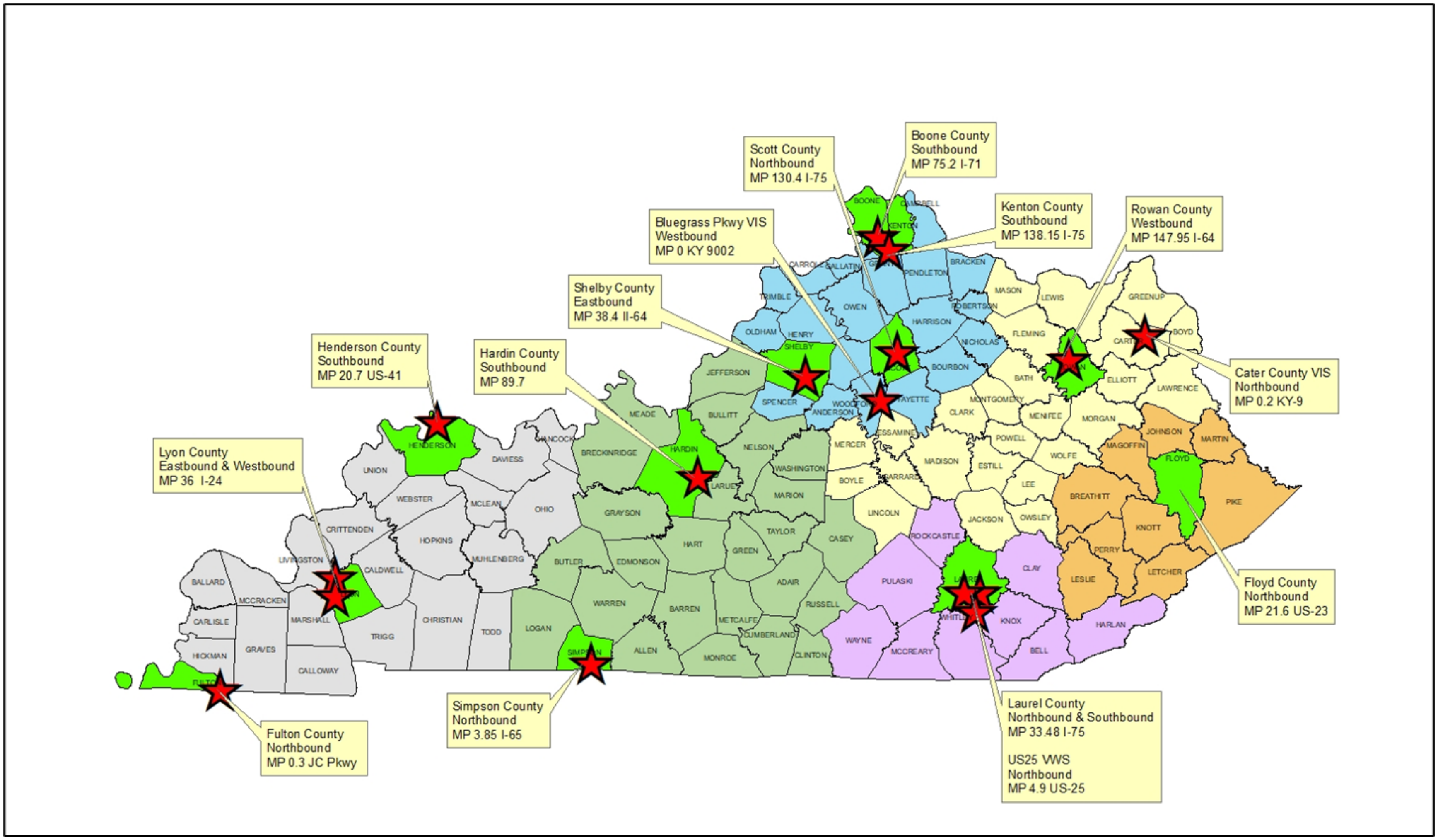

Figure 2.2 KATS Installations in Kentucky

KATS consists of USDOTRs and LPRs and uses optical character recognition (OCR) cameras to decode alphanumerical identifiers on CMVs, including the USDOT number and the vehicle registration plate string (Walton et al., 2020). KATS includes an additional scene camera to capture an overhead image of the vehicle for physical description purposes. As the truck enters the weigh station ramp, the LPR and a scene camera are triggered by loops embedded in the pavement (Kissick et al., 2013). The LPR captures images of the license plate and the registration string is decoded (Kissick et al., 2013). The scene image and the LPR images are sent to the screening computer inside the weigh station (Kissick et al., 2013). As the truck continues down the ramp, it crosses a second loop triggering the USDOT camera. The camera captures an image, and the USDOT number is decoded. The image and USDOT number are sent to the screening computer in the weigh station. Once the truck crosses the weigh-in-motion scale, the weight and vehicle axle information along with a tracking number is sent to the screening computer. All data are compiled into a single record (Kissick et al., 2013).

Once all data are compiled, the USDOT number and license plate string are checked against the Commercial Vehicle Information Exchange Window (CVIEW) database (Walton et al, 2020). CVIEW contains CMV credentialing and tax system information for interstate carriers and vehicles as well as an extensive carrier safety history and performance metrics. Data are exchanged between roadside inspection sites and the Safety and Fitness Electronic Records System (SAFER) database as well as other state databases for tax information (e.g. Kentucky's weight-distance tax (KYU) database (FMCSA, 2014). SAFER contains carrier information derived from federal and state motor carrier safety and credentialing data (FMCSA, 2020). CVIEW data screening also uses the Performance and Registration Information Systems Management (PRISM) target file. The PRISM target file identifies carriers that have been issued a Federal Out-of-Service Order (FOOS) and are therefore required to discontinue operations. Carriers targeted for an increased number of inspections due to poor safety records are also flagged (FMCSA, 2015). KATS screens for 16 elements contained in these databases, including credentials, registration, and safety-based factors (see list at the end of this section). When the KATS test of CVIEW data detects a compliance issue involving one of the elements, screening results are listed as a color-coded pass-warning-fault-screening result.

- Pass (Green) — No violations were detected during screening.
- Warn (Blue) — All screening tests were passed but there were missing data. Usually this is due to a jurisdiction not sending data for that screening element.
- Fault (Yellow) — The system detected a fail, but the violation is not set for a pull-in for inspection.
- Fail (Red) — The screening system detected a violation and the sorting system will direct the vehicle to park for inspections.

If a staff member is available, they use the park sign to direct the driver to park the vehicle and enter the facility for further instructions. If a staff member identifies a misread USDOT number or plate string, they can manually read the numbers using the camera images and the image magnification tool, reenter the USDOT number or license plate string, and rescreen the identifiers against CVIEW data.

- KATS Screening Elements
    - BASIC: Crash Indicator
    - BASIC: Driver Fitness
    - BASIC: Drugs/Alcohol
    - BASIC: Hazmat Compliance
    - BASIC: HOS Compliance
    - BASIC: Unsafe Driving

- BASIC: Vehicle Maintenance
- Database
- Driver OOS Percentage
- Expired Registration (IRP)
- Federal OOS
- Hazmat OOS Percentage
- IFTA
- ISS Insufficient Data
- ISS Safety
- KIT
- KY HIRE
- KY Prorate
- KYU
- Liability Insurance
- Registered Weight (IRP)
- UCR
- USDOT Status
- Vehicle OOS Percentage

2.5 Credentials

2.5.1 IFTA

Before 1986, each jurisdiction maintained separate fuel tax licensing and reporting systems, requiring a fuel tax license for every motor carrier that operated within its borders ("The History of IFTA and IRP", 2009). Motor carriers were required to submit tax reports to as many as 58 jurisdictions (Snelson, 2015; "The History of IFTA and IRP", 2009). ITFA began in the early 1980s and expanded incrementally over the next 20 years.

In 1983, Arizona, Iowa, and Washington formed IFTA based on the idea of one license, one jurisdiction (Snelson, 2015). In the following year, Congress approved a working group to investigate methods of collecting fuel taxes from motor carriers (Davidson and Davis, 2014). Based on the efforts of that working group, the National Governors Association approved a new fuel tax agreement that included Arizona, Idaho, Iowa, Minnesota, Oklahoma, and Washington (Davidson and Davis, 201). By 1990, 16 states joined this agreement. The Intermodal Surface Transportation Efficiency Act (ISTEA) formally codified the fuel tax agreement into federal law in 1991. ISTEA mandated official implementation of IFTA by September 30, 1996. The initial implementation of IFTA did not include Maine, New Hampshire, and Vermont because they were bound by a regional fuel tax agreement (Davidson and Davis, 2014). When the implementation date arrived, 10 Canadian provinces had joined the agreement and the group had established Articles of Agreement, a procedures manual, a compliance review process, and an auding manual (Davidson and David, 2014).

IFTA is a multijurisdictional pact among 48 states and 10 Canadian provinces (i.e., base jurisdictions) created to ensure motor fuels taxes benefit the highway system in the most efficient way possible ("The History of IFTA and IRP", 2009). A base jurisdiction is determined by the jurisdiction where a fleet's vehicles are registered and where the motor carrier maintains records for qualified vehicles. Under IFTA licensed carriers file fuel use tax reports through its base jurisdiction every quarter. The base jurisdiction is solely responsible for administering all fuel taxes related to that license and distributes taxes proportionally to all jurisdictions in which the licensee traveled based on the reported miles traveled in those jurisdictions (O'Connell et al., 2007). Carriers also report fuel purchases, which can be used as credits toward their tax assessment in jurisdictions where they purchase fuel. While states have considerable authority over IFTA, the agreement provides jurisdictions with a uniform tax report form format, tax calculations, interest calculations, auditing system, and determines due dates for tax filings (O'Connell et al., 2007). A board of trustees comprised of fuel tax administrators from member jurisdictions oversees IFTA, Inc. (O'Connell et al., 2007).

According to the Kentucky Transportation Cabinet's IFTA Compliance Manual (2018), three types of vehicles qualify for an IFTA fuel license:

- A vehicle having two axles and a gross vehicle weight or a registered gross vehicle weight exceeding 26,000 pounds or 11,797 kilograms
- A vehicle with three or more axles, regardless of weight
- A vehicle used in combination if the weight exceeds 26,000 pounds or 11,797 kilograms gross vehicle weight or registered gross vehicle weight

Five types of vehicles are exempted from IFTA — recreational vehicles, government vehicles, farm vehicles, interstate charter busses, vehicles operating in a non-commercial capacity, and unlicensed equipment such as self-propelled vehicles or cranes (Kentucky CVIEW Help Document, 2020).

When a motor carrier applies for an IFTA license in their base jurisdiction, it agrees to submit operational records for audit. The jurisdiction has the discretion to approve or reject that application. States enforce IFTA license terms such as non-payment or failure to file taxes through license suspension and revocation (IFTA Articles of Agreement, 2020). Jurisdictions cannot issue fuel tax licenses to motor carriers if they have revoked or suspended licenses in another state or province. Motor carriers have a choice of whether to obtain an IFTA license. If a motor carrier does not register as a licensee in a base jurisdiction, it must buy a permit to travel in each jurisdiction they enter. That permit is vehicle specific and only applies to a specific time period and routes (Kentucky CVIEW Help Document, 2020). Base jurisdictions must report all new licensee information to member jurisdictions quarterly (IFTA Articles of Agreement, 2020). All jurisdictions must be notified within 10 days of a license being revoked, suspended, or canceled (IFTA Articles of Agreement, 2020).

When an applicant is approved, the base jurisdiction supplies the new licensee with instructions on displaying decals or filing the license number/proof of license. Carriers receive two decals for each vehicle (power unit). Decals are visibly affixed to both sides of the vehicle. While the license number and decals are not vehicle specific, they are specific to the calendar year in which they are issued. Motor carriers pay IFTA taxes quarterly. An IFTA license is renewed annually and expires on December 31. Motor carriers receive new decals each year upon renewal.

IFTA carrier information is collected in the IFTA Clearinghouse, a repository of account information that verifies a motor carrier's license status, including active, suspended, closed, canceled, or revoked licenses (IFTA Articles of Agreement, 2020). This repository interfaces with CVIEW and SAFER. When a motor carrier is detained at a weigh station or inspection facility, a law enforcement officer or inspector examines the IFTA account status and required documentation to ensure the motor carrier has an active IFTA license. The enforcement officer begins by examining the IFTA decals and the IFTA license, paying careful attention to signs of fraudulent credentials (IFTA Law Enforcement Committee, 2019). They then confirm the license is in good standing by checking CVIEW, the IFTA Clearinghouse, or contacting the base jurisdiction (IFTA Law Enforcement Committee, 2019). In lieu of these documents, the enforcement officer may ask for a trip permit (IFTA Law Enforcement Committee, 2019). If the officer finds the IFTA license has been revoked (or suspended in the case of some states), the truck may be detained until the motor carrier brings the account into compliance with the base jurisdiction (Kentucky CVIEW Help Document, 2020).

Each jurisdiction must have reciprocal statutes that codify its participation in IFTA. Kentucky's statutory authority for IFTA participation is found in Kentucky Revised Statutes (KRS) 138.665 ("License for Use of Public Highways"). This statute requires each motor carrier to (1) have a fuel tax license to use Kentucky highways or (2) purchase a trip permit. The motor carrier must keep the IFTA license number in each vehicle in manual or electronic form at all times. KRS 138.720 is the statute for prohibited acts, which states that it is unlawful not to pay required fuel taxes, submit fuel tax returns, operate without a license, or allow another entity to use a motor carrier's fuel tax license. KRS 138.990 (15) enumerates the penalties for not obtaining a license, permit, or paying required fuel taxes. If CVIEW indicates a motor carrier is operating in Kentucky on a suspended or revoked IFTA license, law enforcement have the authority to impound the vehicle until the account is brought into compliance with the base jurisdiction (Kentucky CVIEW Help Document, 2020).

2.5.2 IRP

The International Registration Plan (IRP) is a registration reciprocity agreement among the lower 48 states, Washington, D.C., and Canadian provinces. Before 1968, states formed multiple reciprocity agreements to permit interstate commercial vehicle operations. In 1968, the American Association of Motor Vehicle Administrators (AAMVA) spearheaded an effort to consolidate reciprocity agreements in the U.S. and potentially incorporate Canadian provinces into an agreement (The History of IFTA and IRP, 2009; Adams, 2009). AAMVA created a subcommittee to develop a reciprocity agreement that would receive support from the motor carrier industry (Adams, 2009). Simultaneously, the agreement would ensure that an adequate amount of revenue would be forwarded to jurisdictions for highway construction and maintenance (Adams, 2009). By 1972 the subcommittee agreed upon a proportional distribution of registration fees, and the initial IRP was developed (Carey and Halstead, 2019; Adams, 2009). Nine U.S. jurisdictions, including Kentucky, were the first to join the IRP agreement in 1973, and Alberta was the first Canadian jurisdiction to join in 1974 (Adams, 2009). IRP currently consists of 59 jurisdictions (IRP, Inc., 2020). In 1995, the Federal Highway Administration and IRP, Inc. agreed to create a Clearinghouse project that lets jurisdictions exchange information on registrations and fees in an electronic format (Adams, 2009).

Any motor carrier that regularly operates in two or more IRP member jurisdictions must pay the IRP registration fee. IRP uses the same base jurisdiction organizing concept as IFTA. IRP is similar to IFTA in that it is primarily developed and administered without federal involvement. With IRP, motor carriers pay apportioned license fees to their base jurisdictions, and the base jurisdiction forwards those fees to the applicable jurisdictions. Under apportioned registration, the registrant pays registration fees based on the percentage of distance travelled in each jurisdiction. Motor carriers report mileage annually. States verify a motor carrier's fleet mileage using individual vehicle mileage records (IVMR), including trip sheets, electronic logs, dispatch logs, and bills of lading (KYTC, 2017). Table 2.6 elaborates on the apportionment concept. Suppose a motor carrier travels a total distance of 100,000 miles which is documented by IVMR. If 75,000 miles were travelled in Kentucky and 25,000 miles in Tennessee, 75 percent of the miles were traveled in Kentucky and 25 percent in Tennessee. When the motor carrier pays registration fees for each vehicle, it pays 75 percent of the $2,500 registration fee required in Kentucky ($1,875) and 25 percent of Tennessee's $2,100 registration fee ($525) which totals $2,400 in registration fees.

Table 2.6 Registration Fee Example

	Kentucky	Tennessee	Total Miles Traveled
Total distance travelled by all apportioned vehicles	75,000	25,000	100,000
Jurisdiction proportion of distance traveled	75%	25%	100%
Full registration cost for jurisdiction	$2,500	$2,100	
Apportioned fee for each vehicle in each jurisdiction	$1,875	$525	$2,400

* Source: Royer and Jarboe (2016)

Carriers are routinely audited to verify the accuracy of mileage reports. Base jurisdictions distribute fees to member jurisdictions within 30 days (Adams, 2009). Apportionable vehicles include those with:

- Two axles and a gross vehicle weight or registered gross vehicle weight greater than 26,000 pounds
- Three or more axles or
- Is used in combination, when the gross vehicle weight of such combination exceeds 26,000 pounds

Recreational vehicles, vehicles with restricted plates, and vehicles with government plates are exempt from IRP requirements (IRP Plan, 2019).

IRP is connected to the PRISM program. When a motor carrier attempts to register their vehicle and obtain their apportioned licensed plate, it indicates the USDOT number for motor carrier responsible for safety (MCRS) of the vehicle for that year. The MCRS is the motor carrier that is held accountable for compliance with FMCSRs (State of Michigan, 2020). A motor carrier deemed unfit under the PRISM program may be denied the ability to register vehicles and obtain apportioned registration plate (KYTC, 2017).

IRP fees consist of base jurisdiction fees and the fees for other member jurisdictions (KYTC, 2017). Fee schedules for each jurisdiction are available on IRP's website https://www.irponline.org/. The IRP credential is known as the cab card. The apportioned vehicle registration plate also serves as an IRP credential. The cab card shows the vehicle was proportionally registered in the base jurisdiction and lists other jurisdictions in which the vehicle was proportionally registered and the registered gross vehicle weight under which it was registered (IRP Plan, 2019). Drivers present this credential during roadside inspections. The cab card includes the owner/lessor name, motor carrier address, the USDOT of the MCRS, and vehicle information, including combined weight, number of axles, make, and model (IRP Plan, 2019). A cab card is truck-specific and non-transferrable (Kentucky CVIEW Help Document, 2020). Each jurisdiction maintains a unique cab card with security features, contact information for the jurisdiction, and formatting. The cab card must be in the vehicle in either paper or electronic form. The registration plate serves as verification of the IRP registration.

Jurisdictions are responsible for enforcing the IRP requirement, and this is achieved by issuing citations and penalties such as fines and court fees (Walton et al., 2020). When law enforcement inspects a driver's documents, they examine the IRP cab card to verify the IRP registration is active, indicating the motor carrier paid their registration fees. Enforcement also confirms that the motor carrier is registered to operate in that jurisdiction at the current gross vehicle weight based on the cab card. If enforcement discovers a motor carrier operating without proper registration, the motor carrier must purchase a temporary permit to continue the trip.

Jurisdictions can revoke and suspend motor carrier IRP registration for violations (e.g., operating a vehicle on an expired registration, failing to pay an audit or IRP bill, paying with a check written on an account with insufficient funds). In Kentucky, an officer or inspector can issue a citation if a motor carrier is operating on an expired or suspended license (Kentucky CVIEW Help Document, 2020). If an officer discovers that the USDOT number on the IRP cab card is linked to a FOOS due to a PRISM safety rating, they are authorized to put the vehicle out of service (Kentucky CVIEW Help Document, 2020). A motor carrier can never receive a FOOS order for an issue strictly related to the vehicle registration because IRP is a state-based credential. A FOOS order is only associated with IRP when it is related to a low PRISM safety score that is linked to the USDOT listed on the vehicle registration.

In the case of an expired IRP registration, some jurisdictions have grace periods between the period of time when IRP registration expires and a new credential is required. Law enforcement should be aware of jurisdictions with grace periods before writing citations for expired credentials. Only nine jurisdictions have grace periods for expired IRP registrations. However the length of grace periods varies significantly — 5 working days for vehicles registered in Texas to 91 days for registered vehicles in Wyoming (Table 2.7). The average grace period is 46.1 days, which is effectively the same as the median grace period of 46 days (North Carolina).

Table 2.6 IRP Grace Periods

Base Jurisdiction	Grace Period
Colorado	30 Days
Kansas	60 Days
Mississippi	15 Days
North Carolina	46 Days
Nebraska	31 Days
Oklahoma	62 Days
Oregon	75 Days
Texas	5 Working Days
Wyoming	91 days

2.5.3 KYU

Kentucky's weight distance tax (KYU) is assessed against any CMV with a combined weight more than 59,999 pounds. The combined licensed weight is defined by KRS 138.655 (14) and consists of the greater of (1) the declared combined maximum gross weight of the vehicle and any towed unit for registration purposes for the current registration period, or (2) the highest actual combined gross weight of the vehicle and any towed unit when operated on the public highways of the state during the current registration period. The KYU program requires motor carriers to file a quarterly tax return declaring mileage traveled in Kentucky during the previous quarter. The KYU tax rate is 2.85 cents per mile. The MCRS, owner, or lessor may obtain the license and pay KYU taxes. Three types of vehicles are exempt from the KYU license requirement: government-plated vehicles, farm-plated vehicles operating in a non-commercial capacity, and unlicensed equipment (e.g., self-propelled equipment or cranes) (CVIEW Help Document, 2020). Motor carriers must keep an inventory of each vehicle included under a KYU license number (CVIEW Help Document, 2020). A farm-plated vehicle is one which is only used on farm property and not in a commercial capacity. A KYU license number does not expire (CVIEW Help Document, 2020).

Four states — Kentucky, New York, Oregon, and New Mexico — levy a weight-distance tax on CMVs. Kentucky has a much higher minimum gross vehicle weight for its weight-distance tax than New York, Oregon, or New Mexico. New York's Highway Use Tax (HUT) assesses a tax on any vehicle with a gross vehicle weight over 18,000 pounds (New York Tax Bulletin, 2014). In New Mexico a vehicle with a gross vehicle weight above 26,000 pounds must obtain a weight distance tax permit (mvd.newmexico.gov, 2020). Commercial vehicles in Oregon with a registered weight above 26,000 pounds must also pay a weight-mile tax on their tax report (Oregon.gov, 2020).

Several states have eliminated weight-distance taxes and rely on state fuel taxes or increasing IFTA and IRP revenue (Martin et al., 2014). Weight-distance taxes are strongly contested as critics argue that they are expensive to administer and evasion rates are high (Martin et al., 2014). However, Martin et al. (2014) evaluated an alternative fee-based program and found that in Kentucky, a weight-distance tax creates more equity among carriers and provides a more reliable revenue stream for the state compared to a registration-fee-based alternative.

KYU is crucial to Kentucky's highway maintenance — 100 percent of the revenue from this tax goes directly to the Road Fund. Road Fund revenues finance 61 percent of Kentucky's transportation system, including road construction, maintenance, planning, and engineering (Kentucky Transportation Cabinet, 2021). Most of KYTC's administrative operations are funded through the state's Road Fund as well (Kentucky Long-Rand Statewide Transportation Plan, 2007).

The Kentucky statutory authority for KYU is found in KRS 138.660. Every vehicle weighing over 59,000 pounds must pay the KYU tax. KRS 138.664 (7) requires vehicles to display the KYU license number to enable manual or electronic recording of the number. In some cases, the USDOT number links directly to the motor carrier's KYU number and the carrier does not display the KYU number on the side of the vehicle. If the USDOT number does not link to the KYU license, the KYU number must be displayed on the door. Leased vehicles must display the KYU number on the door, and a copy of the license must be kept in the vehicle and be available for inspection by law enforcement officials.

Violations of the KYU statute can include three citable offenses:

- Failure to add a vehicle to the KYU inventory
- Failure to have a KYU license
- Operating on an inactive, canceled, or revoked weight-distance tax license

Law enforcement use KY CVIEW to verify the status of a KYU credential. If law enforcement personnel determine that a vehicle is operating without a KYU license or if the vehicle is not listed on the KYU vehicle inventory, the motor carrier has the option of purchasing a permit. If a more serious infraction is detected (e.g., operating on a suspended or revoked license) the inspector or officer can impound the vehicle until the violation is resolved with Kentucky's Division of Motor Carriers (DMC) (Kentucky CVIEW Help Document, 2020).

Motor carriers report KYU mileage via quarterly tax filings. Even if a motor carrier accumulates no KYU mileage during a quarter, company representatives must file a tax return if they have a KYU license. If a carrier does not meet this requirement, its KYU license is suspended. Motor carrier representatives have 45 days to bring their account up to date, or the license is revoked. If the vehicle is detained at a weigh station, law enforcement can impound the vehicle until credentialing issues are resolved.

Given the importance of KYU for Kentucky's highway system, KATS and the Observation System play an critical role in ensuring motor carriers pay their fair share of the weight-distance tax. DMC staff routinely review zero-mileage tax returns and compare them with records from the Observation System. If a motor carrier is observed traveling in Kentucky during the tax period, staff contact them to obtain payment for estimated miles, create a jeopardy assessment, or refer the company to the Division of Road Fund Audits. Forlines et al. (2019) demonstrated that using the Observation System as an automated enforcement tool could result in additional collections of up to $7 million annually.

2.5.4 UCR

The Unified Carrier Registration (UCR) Plan replaced the Single State Registration System (SSRS) in 2005 under the Unified Carrier Act. The Act ensures that each state receives an equal amount of registration revenue and that no state establishes additional regulatory fees (UCR Handbook, 2020). UCR is a state revenue program, but the fees are mandated by federal law (known as The UCR Act 49 USC 14504a) through the Secretary of Transportation with the UCR Board's guidance. The UCR Board consists of 15 representatives from USDOT, FMCSA, participating states, and the motor carrier industry. The Secretary of Transportation selects the UCR Board representatives (UCR Agreement, 2020). The UCR Program uses a similar base jurisdiction concept as IFTA and IRP, where the motor carrier pays fees through the state of their principal place of business and the state distributes fees to other participating states as required by the UCR agreement. Under the UCR plan, states are responsible for enforcing compliance by issuing citations that assess fines and penalties.

Mexican and Canadian motor carriers are required to participate in UCR if they operate in the U.S. and pay UCR fees through a designated state. Carriers usually choose to pay their UCR fees in the state where they travel most frequently. However, Mexico and Canada do not receive UCR funds.

Not all states participate in UCR. Figure 4 shows states that participate in UCR (shaded blue) and states that do not participate (shaded gray). The initial UCR Act, required states to officially indicate whether their state would join the agreement by August 10, 2008; after that date, they would not be permitted to participate (UCR Agreement, 2020). When a state declared its intent to join, it had to submit a state plan that identifies the agency granted legal authority to administer the agreement based on the rules of the UCR Board (UCR Agreement, 2020). States can withdraw from the agreement or amend their plan. However, a carrier must still register in a surrounding state if their domicile state does not participate in UCR. Also, Canadian and Mexican motor carriers must pay UCR fees if they operate in the U.S.

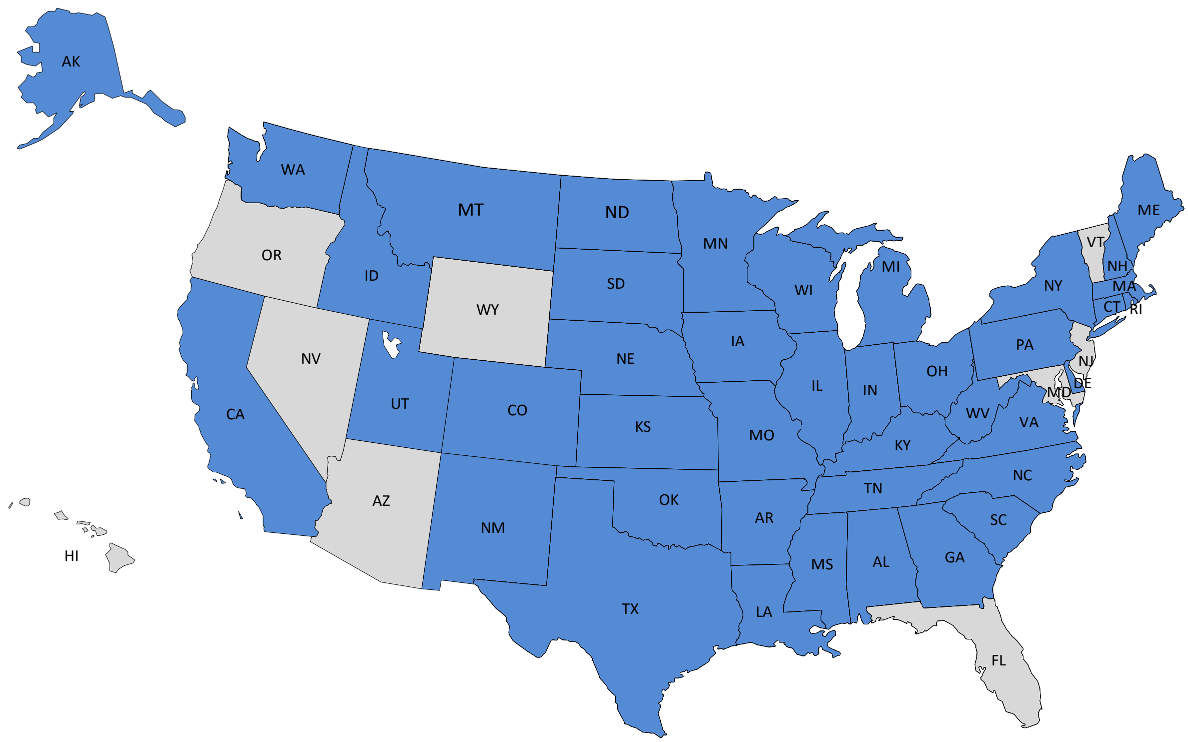

Figure 2.3 States Participating in UCR

Motor carriers must register for UCR when they obtain a USDOT number and pay fees annually. Motor carriers receive reminders each year and can visit www.ucr.in.gov to complete the process (UCR Handbook, 2020). Motor carriers do not receive a UCR credential to verify compliance, although the receipt may be carried in the truck (Commercial Vehicle Safety Alliance, 2020). UCR is an annual fee and a motor carrier must pay the full fee regardless of the time of year it initiates operations (UCR Handbook, 2020). Unlike other credentials discussed in this report, UCR does not offer a temporary permit.

Under the UCR Act, interstate motor carriers (private and for-hire), leasing companies, freight forwarders, and freight brokers pay the fee. UCR fees are based on the motor carrier's fleet size (Table 2.8). There are six brackets based on the number of vehicles in a fleet. A B1 bracket fleet consists of zero to two vehicles and must pay a $59 fee. A B4 bracket fleet has 21 to 100 vehicles and must pay $1,224 for the annual UCR fee. A B6 bracket fleet has over 1,000 vehicles in its fleet and is required to pay $56,977 for the annual UCR fee.

Freight brokers, freight forwarders, and leasing companies only pay a single fee of $59 because they do not maintain a fleet. A freight broker acts as an intermediary between shippers and motor carriers to arrange the transportation of goods. Freight brokers generally operate within one country. A freight forwarder arranges for the transportation of goods, while offering additional services such as handling, storing, or packaging. Freight forwarders usually facilitate international shipping. A leasing company pays for the services of a commercial vehicle but does not own the vehicle.

Table 2.7 UCR Registration Fees for 2020

Bracket	Number of vehicles owned or operated by exempt or non-exempt motor carrier, motor private carrier, or freight forwarder	Fee per entity for exempt or non-exempt motor carrier, motor private carrier, or freight forwarder	Fee per entity for freight forwarder, broker or leasing company
B1	0-2	$59	$59
B2	3-5	$176	
B3	6-20	$351	
B4	21-100	$1,224	
B5	101-1,000	$5,835	
B6	1,001 and above	$56,977	

* Source: UCR Handbook (2020)

The fee is not required of motor carriers that only operate intrastate unless they initiate interstate operations. Other entities exempt from UCR are states that have not adopted the agreement for intrastate carriers and private passenger carriers that operate interstate or internationally.

Enforcement of the UCR credential takes place primarily through commercial vehicle enforcement activities. Officers and inspectors may write citations for UCR violations, which generally carry fines and court costs. Enforcement verifies UCR compliance through CVIEW, SAFER, or contacting a state's UCR program directly. States must also perform desk audits to ensure motor carriers are paying UCR fees. In some cases, states tie IRP vehicle registration to UCR fees. If UCR fees are not paid, the motor vehicle agency administrator will not issue or renew the apportioned registration.

In Kentucky, the statutory authority for UCR is found in KRS 281.600. The statute permits the Department of Vehicle Regulation to conduct administrative functions that are related to acts administered by FMCSA and USDOT. Kentucky requires that motor carriers pay the current and previous year's UCR fees (provided the motor carrier operated during the previous year) (Kentucky CVIEW Help Document, 2020). When enforcing a previous year's UCR fee during a roadside inspection, enforcement personnel request that a driver provide documents that would demonstrate the motor carrier operated during the past year (e.g., entries from the electronic logging device, shipping papers, bills of lading, roadside inspection reports, toll receipts) (Commercial Vehicle Safety Enforcement Alliance, 2020). The UCR board announces the start date of the registration year, which is communicated annually to law enforcement through a CVSA Inspection Bulletin. When law enforcement detect a UCR violation, they can issue a citation.

Chapter 3 Analysis

3.1 Introduction

Kentucky CVE officers and administrators of motor carrier programs have long suspected a connection between safety violations and credentialing violations. Since the cost of compliance is regarded as the main reason for both safety and credentialing violations, there is good reason to think they are positively correlated. Some have argued there is little evidence to indicate a strong relationship between bad credentials and safety violations. If a strong positive relationship between credentialing and safety violations exists, subjecting vehicles with more credentialing violations to Level 1 inspections can improve highway safety and increase revenue. If it does not, enforcement officers need to develop additional criteria to determine when Level 1 inspections would be more efficient in identifying vehicles posing safety threats. Analysis in this chapter assesses the strength of the relationship between bad credentials and safety violations using screening and inspection data collected at weigh stations in Kentucky.

3.2 Data Description

3.2.1 Commercial Truck Screening Data

We obtained from KYTC's BusinessObjects database commercial vehicle screening data collected at weigh stations and roadside inspections from January 2017 to August 2020. Approximately 30 million vehicles were screened during this period, with between 73.95 percent and 81.28 percent of the data obtained by KATS installations. Another large portion of the screening data was collected by the PrePass system, with a small amount of data collected by KSP-CVE officers on the roadside (Table 3.1).[1] Drivewyze data were available for just four months of the 2019 calendar year. KATS data and PrePass/Drivewyze data can potentially overlap if vehicles using their prescreening services were pulled into the weigh station due to a compliance issue detected by the respective service or to satisfy random pull-in quotas.

Table 3.1 Observation Count by System

Year	KATS	PrePass	inSPECT	DriveWyze	Total
2017	6,358,449	1,929,550	18,694	0	8,306,693
	(76.55%)	(23.23%)	(0.23%)	(0.00%)	(100.00%)
2018	6,598,150	1,504,388	15,728	0	8,118,266
	(81.28%)	(18.53%)	(0.19%)	(0.00%)	(100.00%)
2019	6,305,078	1,696,995	0	523,619	8,525,692
	(73.95%)	(19.90%)	(0.00%)	(6.14%)	(100.00%)
2020	4,004,139	1,066,632	0	0	5,070,771
	(78.97%)	(21.03%)	(0.00%)	(0.00%)	(100.00%)
Total	23,265,816	6,197,565	34,422	523,619	30,021,422
	(77.50%)	(20.64%)	(0.11%)	(1.74%)	(100.00%)

One objective of screening before an inspection is to identify trucks that are more likely to have credentialing and safety violations, so the ensuing inspections will detect violations and result in action (e.g., including issuing a citation, suspending operations). After checking a truck against Kentucky and the national database, KATS gives a truck *Pass, Warn*, or *Fail/Fault* grade. The result is recorded as screening status. A *Pass* indicates the truck's associated carrier and/or vehicle has no known safety or credential

[1] inSPECT data were gradually replaced by another database whose records were not available during the study period.

compliance issues. A truck receives a *Warn* if a database issue arose or screening data were unavailable. On the other hand, if KATS finds a potential credential or compliance issue, a truck receives a *Fail/Fault*. Officers can turn specific screening tests on and off, which impacts whether a truck is flagged. A truck with a screening issue for a disabled test will receive a *Fault* instead of a *Fail*, but both messages indicate a potential compliance issue. More detailed information is recorded in the screening message field, such as which credential compliance issue was raised, including KYU, IFTA, UCR, and IRP.

To evaluate the accuracy of screening results, a screening result must be linked to the inspection fundings. Among KATS, PrePass, inSPECT, and DriveWyze records, only vehicles screened by KATS have screening results retained in the Observations and BusinessObjects databases. As such, we focus on KATS screenings and their outcomes. Approximately half of the screenings resulted in *Pass*. *Fail/Fault* screenings varied between 17.27 and 23.29 percent. The percentage of screenings that resulted in *Warning* ranged from 25.78 to 33.68 percent. Variance arises from dynamic changes in compliance levels, changes in screening test algorithms, and the performance of KATS OCR cameras, which can incorrectly flag trucks in some cases due to inaccurately decoding a license plate or USDOT number.

Table 3.2 Observation Count by Screening Result (KATS)

Year	Pass	Warn	Fail/Fault	Total
2017	3,620,749	1,639,492	1,098,208	6,358,449
	(56.94%)	(25.78%)	(17.27%)	(100.00%)
2018	3,378,004	1,862,782	1,357,364	6,598,150
	(51.20%)	(28.23%)	(20.57%)	(100.00%)
2019	2,713,313	2,123,379	1,468,386	6,305,078
	(43.03%)	(33.68%)	(23.29%)	(100.00%)
2020	1,799,230	1,311,802	893,107	4,004,139
	(44.93%)	(32.76%)	(22.30%)	(100.00%)
Total	11,511,296	6,937,455	4,817,065	23,265,816
	(49.48%)	(29.82%)	(20.70%)	(100.00%)

3.2.2 Commercial Truck Inspection Data

KSP-CVE administrators provided CMV inspection data for January 2017 through August 2020. Only a portion of screened trucks is inspected, the results of which are recorded in three datasets: (1) main inspection data, (2) vehicle information data, and (3) violations information data. These datasets are linked with inspection ID numbers and report numbers. Merging main inspection data and violations information data using the common fields let us calculate the number of violations found per inspection. The number of inspections conducted annually has decreased since 2017. Total violations detected have dropped as well (Table 3.3). The inspection and violation counts for 2020 include data from January to August only, but these still show a decreasing number of inspections, as the number of inspections conducted in the first the eight months of 2020 was only slightly more than half the number conducted in 2019 inspections. The average number of violations found during each inspection has varied, but remains slightly above 1.00 consistently.

Table 3.3 Inspection Count

Year	No. of Inspections	No. of Violations	Violations per Inspection
2017	83,851	104,414	1.25
2018	78,946	85,907	1.09
2019	64,091	83,802	1.31
2020	33,331	38,827	1.16

One of objective of this research was to devise strategies to reduce the inspection of trucks without credentialing and safety violations. With an improved screening system, the trucking industry could avoid unnecessary stops, which leads to time and fuel savings. KSP-CVE also benefits by distributing limited resources to the inspections that will result in citations. By doing so, Kentucky could experience improved highway safety and increased revenue. Approximately half of the inspections conducted resulted in no violations. The other half of the inspections resulted in 2.34 to 2.54 violations found per inspection (Table 3.4).

Table 3.4 Kentucky Commercial Vehicle Inspection Outcomes

Year	Inspections	Inspections w/Violations	Inspections w/No Violations	Violations Found	Mean # of Violations
2017	83,851	44,165	39,686	104,414	2.36
		(52.67%)	(47.33%)		
2018	78,946	36,741	42,205	85,899	2.34
		(46.54%)	(53.46%)		
2019	64,091	32,997	31,094	83,801	2.54
		(51.48%)	(48.52%)		
2020	33,331	16,477	16,854	38,827	2.36
		(49.43%)	(50.57%)		

3.3 KATS Effectiveness

Based on the license plate and USDOT numbers, KATS checks the vehicle against the Kentucky and national databases to determine whether there are KYU-, IFTA-, UCR-, and IRP-related credentialing violations. The goal of KATS is to be more efficient in using limited staffing when isolating the best trucks for inspections. If KATS successfully identifies trucks with a higher likelihood of credentialing and safety violations, following inspections will result in improved highway safety and increased revenue.

For KATS to check a truck against Kentucky and national databases, the license plate and USDOT number must be decoded correctly and the license plate needs to be associated with the USDOT number. When KATS matches a decoded USDOT number and plate to a carrier and vehicle in the CVIEW database, *Yes* is recorded in the screening data's *Verified* field. The verification rate improved significantly from 2017 to 2018, however, this trend did not hold for the rest of the study period as the verification rate dropped significantly from 2018 to 2019. It improved somewhat in 2020.

Table 3.5 KATS Verification Rate

Year	Verified	Not Verified	Total
2017	1,177,963	5,180,486	6,358,449
	(18.53%)	(81.47%)	(100.00%)
2018	2,194,528	4,403,622	6,598,150
	(33.26%)	(66.74%)	(100.00%)
2019	1,454,895	4,850,183	6,305,078
	(23.07%)	(76.93%)	(100.00%)
2020	1261469	2,742,670	4,004,139
	(31.50%)	(68.50%)	(100.00%)
Total	**6,088,855**	**17,176,961**	**23,265,816**
	(26.17%)	**(73.83%)**	**(100.00%)**

The two main reasons for non-verified screenings are missing license plate information and USDOT number information. About 30.00 percent of the screenings failed to capture license plate numbers, and 34.57 percent of the USDOT numbers were not captured (Table 3.6). In some instances KATS read a license plate and/or USDOT number but failed to associate a license plate number to a USDOT number, which could happen for several reasons. The plate or USDOT number could have been misread by the KATS cameras, preventing a match. The truck could be part of a leasing agreement and the operator forgot to update the new USDOT number. The USDOT number could be in an unusual location or written in a font that is difficult to decode. The license plate could be bent, dirty, or covered in snow. It is also possible the truck was plated in a state without available or reliable license plate data. Overall, the non-verified screening rate was 73.83 percent .

Table 3.6 Percentage of Missing License Plate and USDOT Number in Screening Dataset

Year	License Plate Missing Percentage	USDOT Number Missing Percentage
2017	26.25%	30.64%
2018	30.21%	33.41%
2019	32.66%	37.74%
2020	31.40%	37.74%
Total	30.00%	34.57%

To measure the effectiveness of KATS, we matched screening data to main inspection data. To evaluate how frequently KATS detected trucks having higher probabilities of credentialing and safety violations, linking the screening results to inspection results conducted by an officer at weigh stations is necessary. But matching the datasets is far from ideal. Lack of a unique record identifier that links the two datasets resulted in the loss of more than half of the information available. Only 43.24 percent of the inspections conducted during the study period were matched to the screening data (Table 3.7). Among information stored in both datasets, we selected USDOT number, plate number, weigh station, screening/inspection date, and screening/ inspection start time for matching criteria. First, a screening record sharing the same USDOT number, plate number, weigh station code, and date with an inspection record was matched to the inspection record. Then, inspections and screenings timestamped more than 90 minutes apart from each other were excluded from the dataset, since inspections usually occur soon after screening. We kept inspection and screening matches within 90 minutes of each other regardless of which came first. If the timestamps on screening data and inspection data were recorded in the same zone, inspections should occur after screening. However, screening data were stored using Central time, while inspection data were recorded using Eastern time at some weigh stations in western Kentucky. The mismatched time zones could place inspections before screenings. To avoid losing the correct match of screening and inspection data, we kept inspections that occurred up to 90 minutes before screenings. We used the remaining matched screening and inspection records to determine what percentage of screening results on credentialing violations resulted in the identification of actual violations during inspections.

Table 3.7 Weigh Station Inspections (Roadside Inspections Excluded) Matched to Observation Data

Year	Inspection	Inspections Matched to Observation	Match Rate
2017	46,051	19,798	42.99%
2018	43,985	18,837	42.83%
2019	31,617	14,013	44.32%
2020	17,240	7,413	43.00%
Total	138,893	60,061	43.24%

In biostatistics, sensitivity and specificity are commonly used to determine the effectiveness of screening. The sensitivity of a test is the true positive rate and measures the proportion of positives that are correctly identified. A test's specificity is the true negative rate and measures the proportion of negatives that are correctly identified. In our analysis, sensitivity measures what percentage of credentialing violations found during inspections were correctly identified during the KATS screening process. Specificity measures what percentage of vehicles with no compliance issues during inspections received a *Pass* from KATS. Both sensitivity and specificity measures were derived from analyzing a subset of inspection and screening data where an inspection could be matched to a screening data.

We calculated the sensitivity and specificity of KATS for KYU, IFTA, UCR, and IRP. Of 2,133 inspections that found KYU violations, KATS successfully identified 1,718 (80.54 percent sensitivity) (Table 3.8). Of the 34,499 inspections with no KYU violation found, 31,610 screenings correctly distinguished the trucks with no KYU violations. The specificity of the screenings was 91.63 percent.

Table 3.8 KYU Compliance Issue Found by KATS and Inspections

	Inspection Positive	Inspection Negative	Total
KATS Positive	1,718	2,889	4,607
KATS Negative	415	31,610	32,025
Total	2,133	34,499	36,632

Table 3.9 provides the sensitivity and specificity for KYU, IFTA, UCR, and IRP. Specificity for all credentials of interest is close to 90 percent or above 90 percent. Ninety percent specificity is commonly used as a criterion for a good screening test, KATS satisfies this benchmark. However, sensitivity rates tell a different story. The specificity for IRP is alarming — 20.83 percent sensitivity means that 79.17 percent of trucks with IRP violations were not screened by KATS. In calculating the sensitivity for IRP, violations that KATS is not designed to detect were excluded. For example, drivers are required to keep a paper copy of a valid registration in the vehicle, and failure to present a valid registration during an inspection could lead to a citation. But violations recorded during the inspection due to the failure to present a valid registration were not included in the sensitivity analysis since KATS cannot detect this violation. Further analysis is needed to determine the root cause of the low sensitivity rate for IRP, but we suspect data quality issues are a primary cause. Most screening data are tied into a carrier's USDOT number, and current IRP

agreements do not require jurisdictions to submit their carriers' USDOT numbers along with their IRP and IFTA status information.

Table 3.9 Effectiveness of KATS on Credentialing Violations (Verified KATS Results Only)

Credential	Sensitivity	Specificity
KYU	80.54%	91.63%
IFTA	87.56%	98.39%
UCR	88.28%	97.76%
IRP	20.83%	97.79%

We also wanted to see if KATS screening results are effective in detecting vehicle safety violations. Level 2 and 3 inspection results were excluded from analysis since the Level 1 inspection is the most thorough. The Level 2 inspection is a walk-around inspection. Unless there is a major visible issue with vehicle safety, vehicle safety violations are rarely detected during a Level 2 inspection. The Level 3 inspection is a driver-only inspection and focuses on the driver's credentials (e.g., CDL, medical card, hazardous material requirements, hours of service documentation). Since Level 2 and 3 inspections are not structured to identify vehicle safety violations, we excluded them from this analysis.

As the number of credentialing violations detected by KATS increased, the percentage of inspections resulting in no vehicle safety violations decreased. Of the 18,796 Level 1 inspections conducted despite no credentialing violations being detected by KATS, 73.24 percent found no vehicle safety violations (Table 3.10). Of the 469 Level 1 inspections conducted after KATS detected two credentialing violations, 68.23 percent identified no vehicle safety violations. Moreover, the percentage of inspections resulting in more than five vehicle safety violations increased as the number of credentialing violations detected by KATS increased, indicating the positive relationship between the number of credentialing violations and vehicle safety violations.

We performed a Chi-squared test to determine whether there is a statistically significant positive relationship between the number of credentialing violations detected by KATS and vehicle safety violations found during inspections. The Chi-squared test determines whether the observed dispersal of cases differs significantly from the expected pattern if there were no relationship between the independent variable and dependent variable. Here, the test determines whether the cross-tabulation in Table 3.10 differs markedly from the expected pattern if there were no relationship between the credentialing violations found by KATS and vehicle safety violations found during level 1 inspections. If there were no relationship, the distribution of the screenings in each row (f_o: observed frequency) should be the same as the total distribution at the bottom (f_e: expected frequency) of the table below. A wider gap between the observed frequency and the expected frequency increases the Chi-square value, which is compared to a critical value to determine the statistical significance ($\chi^2=\sum(f_o-f_e)^2/f_e$). If the Chi-squared value is larger than the critical value, the relationship between the independent and dependent values is statistically significant (Pollock III, 2016). In the analysis, the calculated Chi-squared value was 451.1542, which was larger than the critical value of 83.675. Therefore, the positive relationship between the credentialing violations found by KATS and the vehicle safety violations identified during inspections is statistically significant, meaning that using KATS to screen vehicles with a higher possibility of vehicle safety violations has been effective.

Table 3.10 Effectiveness of KATS on Vehicle Safety Violations Screening for Level 1 Inspections

		Vehicle Safety Violations						
		0	*1*	*2*	*3*	*4*	*>=5*	*Total*
Credentialing Violations Found by KATS	*0*	13,766	2,161	1,222	649	398	600	18,796
		73.24%	11.50%	6.50%	3.45%	2.12%	3.19%	100.00%
	1	2,163	349	234	140	112	171	3,169
		68.25%	11.01%	7.38%	4.42%	3.53%	5.40%	100.00%
	2	320	51	38	18	17	25	469
		68.23%	10.87%	8.10%	3.84%	3.62%	5.33%	100.00%
	3	51	5	5	4	5	9	79
		64.56%	6.33%	6.33%	5.06%	6.33%	11.39%	100.00%
	4	2	0	0	1	0	0	3
		66.67%	0.00%	0.00%	33.33%	0.00%	0.00%	100.00%

3.4 Relationship Between Credentialing Violations and Safety Violations

Among inspections that resulted in violations, we tabulated those that resulted in credentialing violations. In 2017, 6.65 percent of 83,851 inspections raised the KYU compliance issue (Table 3.11). The next most frequent credentialing violations were IFTA violations (2.72 percent). The pattern remained unaltered in 2018, 2019, and 2020.

Table 3.11 Credentialing Violations by Type

Year	Inspections	Inspections Resulted in			
		KYU Violation	IFTA Violation	UCR Violation	IRP Violation
2017	83,851	5,575	2,284	981	1,072
		(6.65%)	(2.72%)	(1.17%)	(1.28%)
2018	78,946	3,969	1,909	857	910
		(5.03%)	(2.42%)	(1.09%)	(1.15%)
2019	64,091	5,269	2,475	1,065	846
		(8.22%)	(3.86%)	(1.66%)	(1.32%)
2020	33,331	2,657	1,209	526	389
		(7.97%)	(3.63%)	(1.58%)	(1.17%)
Total	260,219	17,470	7,877	3,429	3,217
		(6.71%)	(3.03%)	(1.32%)	(1.24%)

To examine the relationship between credentialing violations and safety violations, inspection records were aggregated for each motor carrier (as opposed to individual inspections) (Table 3.12). In 2017, vehicles of 26,065 motor carriers were inspected. With 83,851 inspections that year, many carriers had multiple vehicles inspected. Data show 18.67 percent of the motor carriers had KYU compliance issues. The percentage of motor carriers with KYU compliance issues dropped from 18.67% in 2017 to 16.68% in 2020. The 2020 numbers should be interpreted with caution because (1) there are only eight months of data, and (2) the COVID-19 pandemic sometimes resulted in relaxed enforcement protocols. The IFTA compliance rate increased over the same period but dipped in 2020.

Table 3.12 Motor Carriers with Credentialing Violations by Type

Year	MCs Inspected	No. of Motor Carriers with			
		KYU Violation	IFTA Violation	UCR Violation	IRP Violation
2017	26,064	4,865	1,934	866	904
		(18.67%)	(7.42%)	(3.32%)	(3.47%)
2018	24,780	3,568	1,649	771	784
		(14.40%)	(6.65%)	(3.11%)	(3.16%)
2019	23,057	4,669	2,036	939	740
		(20.25%)	(8.83%)	(4.07%)	(3.21%)
2020	14,380	2,399	1,040	487	349
		(16.68%)	(7.23%)	(3.39%)	(2.43%)
Total	88,281	15,501	6,659	3,063	2,777
		(17.56%)	(7.54%)	(3.47%)	(3.15%)

To quantify the relative vehicle safety of motor carriers, we calculated the vehicle-safety-violation-to-power-unit ratio for carriers in 2019. Data on the number of power units a motor carrier operates were obtained from the Kentucky Transportation Cabinet in September 2020. It is reasonable to assume that the number of power units for each motor carrier in 2019 would be close to the number of power units recorded in the available dataset. Inspections from 2017 and 2018 were excluded from analysis due to concerns over a more significant change of the number of power units over a longer period.

We calculated the number of vehicle safety violations per power unit for each motor carrier that received KYU, IFTA, UCR, and IRP violations (Table 3.13). We added the calculated ratio, and the sum was divided by the number of motor carriers in the violation category to determine the average-safety- violation-to-power-unit ratio for each credentialing violation type. On average, motor carriers without KYU violations in 2019 received less than one citation for vehicle safety violations (0.524). However, motor carriers with at least one KYU violation received 0.979 citations for vehicle safety violations. To determine if the average ratio of vehicle safety violations to power units for motor carriers without KYU violations was statistically and significantly different from that of motor carriers with at least one KYU violation, we used a Student's t-test. The calculated t-value was -9.68; the absolute value of which exceeds the critical value (1.96 with degrees of freedom of 14230). When the calculated t-value is larger than the critical value, the averages of the two groups are significantly different from each other (Pollock III, 2016). Thus, motor carriers with at least one KYU violation received more vehicle safety violations per power unit compared to motor carriers without KYU violations. The percentage increase (86.83 percent) was calculated by dividing the difference between the two averages (0.445) by the average of the motor carriers without KYU violations (0.524). As such, motor carriers with at least one KYU violation received 86.83 percent more citations for violating vehicle safety compared to motor carriers without KYU violation records.

T-tests were performed for motor carriers with IFTA, UCR, and IRP violations as well. Results show that the average for motor carriers with at least one credentialing violation differed significantly from those of motor carriers with no credentialing violations. Motor carriers with at least one IFTA violation were 91.09 percent more likely to be cited for a vehicle safety violation than motor carriers without an IFTA violation. A similar pattern was found for UCR and IRP as well. Motor carriers with at least one KYU, IFTA, UCR, or IRP violation were 111.16 percent more likely to be cited for a vehicle safety violation than motor carriers without any credentialing violations.

Table 3.13 T-Test Results for Vehicle-Safety-Violation-to-Power-Unit Ratio

	Carrier Count	Ratio	t	p-value
With NO KYU Violations	11,350	0.524	-11.4346	<0.0000***
With at least 1 KYU Violation	1,459	0.979		
With NO IFTA Violations	12,160	0.550	-8.7063	<0.0000***
With at least 1 IFTA Violation	649	1.051		
With NO UCR Violations	12,419	0.551	-10.8644	<0.0000***
With at least 1 UCR Violation	390	1.348		
With NO IRP Violations	12,570	0.561	-8.2913	<0.0000***
With at least 1 IRP Violation	239	1.329		
With NO KYU, IFTA, UCR, OR IRP Violations	10,373	0.475	-16.5249	<0.0000***
With at least 1 KYU, IFTA, UCR, OR IRP Violation	2,436	1.003		

*Significant at 0.1; **Significant at 0.05; ***Significant at 0.01

Regression analysis that controls for the number of power units a motor carrier operates found that KYU, IFTA, and IRP violations are positively related to vehicle safety violations. Three out of four credentialing violations have a relationship with vehicle safety violations (Table 3.14). All credentialing violations except the UCR violation are statistically significant. Coefficients of the regression model indicate the amount by which changes in credentialing violations must be multiplied to determine the corresponding average change in vehicle safety violations. For example, the KYU coefficient is 1.0081, meaning that for every additional KYU violation found, the number of vehicle safety violations is expected increase by an average of 1.0081 (Schroeder et al., 2016). The IFTA coefficient is 4.2043 and the IRP coefficient is 8.8701. Our analysis shows that violations of IRP and vehicle safety violations are significantly related and that the size of the impact is larger than for other credentialing violations. This analysis does not demonstrate a causal relationship. To prove causality, credentialing violations would need to precede the vehicle safety violations and no third factor should affect credentialing and vehicle safety violations. Limitations in available data prevent us from demonstrating this. Therefore, correlation is being demonstrated here, not causation.

Table 3.14 Regression Analysis Summary for Predictors of Vehicle Safety Violations

Explanatory Variable	Coefficient	t	p-value	[95% conf. interval]	
(Constant)	1.6850	14.570	< 0.000***	1.464052	1.91555
KYU	1.0081	4.900	< 0.000***	.586995	1.396773
IFTA	4.2043	9.190	0.002**	3.310676	5.103022
UCR	0.0571	0.100	0.917	-1.021725	1.133209
IRP	8.8701	5.460	< 0.000***	5.686139	12.05432
Power Unit	0.0006	1.910	0.056*	-.0000148	.001206

*Significant at 0.1; **Significant at 0.05; ***Significant at 0.01; F= 29.48; df (5, 10,049); $p < 0.000$; R^2= 0.2998.

We observed a similar pattern between credentialing violations and driver safety violations. Student's t-tests showed that the average ratio of driver safety violations to power units of a motor carrier with credentialing violations significantly differs from that of a motor carrier without the same type of credentialing violation. Motor carriers with at least one KYU violation were 24.21 percent more likely to receive a citation for driver safety violations compared to the motor carriers without KYU violations (Table

3.15). To calculate the percentage increase, the difference between the two averages (0.023) was divided by the average of the motor carriers without KYU violations (0.095), resulting in a 24.21 percent increase. Motor carriers with at least one IFTA violation were 149.45 percent more likely to get receive a citation related to driver safety compared to motor carriers without an IFTA violation. Comparing motor carriers with any kind of credentialing violation to those without any indicated that motor carriers with at least one credentialing violation were 112.50 percent more likely to receive a citation related to driver safety.

Table 3.15 T-Test Results for Driver Safety Violation to Power Unit

	Carrier Count	Ratio	t	p-value
With NO KYU Violations	11,350	0.095	-2.2608	0.0238**
With at least 1 KYU Violation	1,459	0.118		
With NO IFTA Violations	12,160	0.091	-9.4349	<0.0000***
With at least 1 IFTA Violation	649	0.227		
With NO UCR Violations	12,419	0.089	-15.2011	<0.0000***
With at least 1 UCR Violation	390	0.365		
With NO IRP Violations	12,570	0.096	-3.6311	0.0003***
With at least 1 IRP Violation	239	0.180		
With NO KYU, IFTA, UCR, OR IRP Violations	10,373	0.080	-11.1961	0.0000***
With at least 1 KYU, IFTA, UCR, OR IRP Violation	2,436	0.170		

*Significant at 0.1; **Significant at 0.05; ***Significant at 0.01

Regressing the number of driver safety violations found during Level 1 inspections on the number of KYU, IFTA, UCR, and IRP violations — and controlling for the number of power units a motor carrier operates as a proxy for the company size — four explanatory variables relate significantly to the number of driver safety violations (Table 3.16). KYU, IFTA, and UCR violations have a significant relationship with driver safety violations. The KYU coefficient in the regression is 0.1764, which means that for every additional KYU violation found, the number of driver safety violations is expected to increase by an average of 0.1764. The IRP coefficient was 2.5447, meaning that for every additional IRP violation found, the number of driver safety violations is expected to increase by an average of 2.5447.

Table 3.16 Regression Analysis Summary for Predictors of Driver Safety Violations

Explanatory Variable	Coefficient	t	p-value	[95% conf. interval]	
(Constant)	0.6090	18.67	<0.000***	.5482847	.6742419
KYU	0.1764	2.90	<0.004***	.0489429	.2895729
IFTA	1.3196	8.41	<0.000***	1.012212	1.628255
UCR	0.3188	1.87	<0.062*	-.0135679	.6547428
IRP	2.5447	7.32	<0.000***	1.864343	3.229998
Power Unit	0.0004	5.08	<0.000***	.0002573	.0005805

*Significant at 0.1; **Significant at 0.05; ***Significant at 0.01; F= 27.55; df ((5, 10,050);
$p < 0.000$; R^2= 0.2798.

We also looked into the relationship between credentialing violations and hazardous materials (Hazmat) violations. Student's t-tests were used to determine if the average Hazmat-violation-to-power- unit-ratio for motor carriers with credentialing violations differed from motor carriers without credentialing violations of the same type. Among the four credentialing violation types, only the average Hazmat-violation-to-power- unit-ratio for motor carriers with at least one IFTA violation was different from that of motor carriers without IFTA violations. Motor carriers with at least one IFTA violation were 240.89 percent more likely receive a citation for Hazmat violations compared to motor carriers without IFTA violations. With respect to KYU, UCR, and IRP violations, we cannot say that there is a significant relationship between the credentialing violations and Hazmat violations.

Table 3.17 T-Test Results for Hazmat Violation to Power Unit

	Carrier Count	Ratio	t	p-value
With NO KYU Violations	11,350	0.001310	0.3054	0.7601
With at least 1 KYU Violation	1,459	0.001059		
With NO IFTA Violations	12,160	0.001142	-2.2827	0.0225**
With at least 1 IFTA Violation	649	0.003893		
With NO UCR Violations	12,419	0.001216	-1.3909	0.1643
With at least 1 UCR Violation	390	0.003361		
With NO IRP Violations	12,570	0.001272	-0.2663	0.7900
With at least 1 IRP Violation	239	0.001784		

*Significant at 0.1; **Significant at 0.05; ***Significant at 0.01

The last safety violation category we looked at was overweight/over-dimension (OW/OD) permit violations. Student's t-tests showed the average OW/OD-permit-violation-to-power-unit ratio of motor carriers with at least one IFTA or IRP violation differed from motor carriers without any IFTA or IRP violations, respectively. However, the average OW/OD-permit-violation-to-power-unit ratio for motor carriers without KYU violations was not different from motor carriers with at least one KYU violation, and it was true for UCR violations as well. Table 3.18 shows that IFTA and IRP violations were positively related to the OW/OD violation. Motor carriers with at least one IFTA or IRP violation were more likely receive a citation for OW/OD violations. Motor carriers with at least one IFTA violation were 160 percent more likely to get a citation for OW/OD violations then compliant motor carriers.

Table 3.18 T-Test Results for OWOD Violation to Power Unit

	Carrier Count	Ratio	t	p-value
With NO KYU Violations	11,350	0.006	0.3069	0.7590
With at least 1 KYU Violation	1,459	0.005		
With NO IFTA Violations	12,160	0.005	-2.2475	0.0246**
With at least 1 IFTA Violation	649	0.013		
With NO UCR Violations	12,419	0.005	-1.5024	0.1330
With at least 1 UCR Violation	390	0.012		
With NO IRP Violations	12,570	0.005	-2.4173	0.0157**
With at least 1 IRP Violation	239	0.018		

*Significant at 0.1; **Significant at 0.05; ***Significant at 0.01

3.5 Relationship Between Credentialing Violation and Crashes

We retrieved data on CMV crashes nationwide in the FMCSA Analysis & Information Portal (10/30/2020 data snapshot). This portal does not capture all crashes. It only includes CMV crashes resulting in injury, fatality, or an incapacitated vehicle having to be towed away. Minor crashes were not included. We were particularly interested in total crashes for June 2019 – August 2020. The positive relationship between credentialing violations and safety violations described in the previous section prompted us to investigate whether there is a positive relationship between credentialing violations and the number of crashes that result from safety violations. First, we obtained the crash-to-power-unit ratio by dividing the total number of crashes for a motor carrier by the number of power units it operated in 2020 (data snapshot as of 9/29/2020). Then, the ratio for each motor carrier was added together to calculate the average crash-to-power-unit ratio for each credential violation type. Last, the total ratio was divided by the number of motor carriers in the category to evaluate the relationship between specific credentialing violations and crash rates, controlling for company size by using the number of power units as a proxy.

Table 3.19 captures the relationship between Kentucky-based credentialing violations and the average crash-to-power-unit ratio for motor carriers. While credentialing violations are limited to Kentucky, the number of crashes recorded for each motor carrier includes crashes that occurred nationwide. Motor carriers with at least one KYU compliance issue were 29.67 percent more likely to be involved in a crash than motor carriers without KYU compliance issues. Motor carriers with a credentialing violation were more likely to have a crash record than motor carriers without any credentialing violations, and the average crash-to-power-unit ratios were quite different. On average, motor carriers with at least one credentialing violation had 0.237 crash records for each power unit they operated over the 15-month study period, while motor carriers without credentialing violations had 0.175 crash records per power unit they operated (Table 27).

Table 3.19 T-Test Results for Crash to Power Unit

	Carrier Count	Ratio	t	p-value
With NO KYU Violations	6,466	0.182	-4.3923	<0.0000***
With at least 1 KYU Violation	1,837	0.236		
With NO IFTA Violations	7,505	0.190	-2.0069	0.0448**
With at least 1 IFTA Violation	798	0.229		
With NO UCR Violations	8,126	0.192	-3.1828	0.0015**
With at least 1 UCR Violation	177	0.316		
With NO IRP Violations	8,020	0.192	-2.0479	0.0406**
With at least 1 IRP Violation	283	0.256		
With NO KYU, IFTA, UCR, OR IRP Violations	5,733	0.175	-3.1457	<0.0000***
With at least 1 KYU, IFTA, UCR, OR IRP Violation	2,570	0.237		

*Significant at 0.1; **Significant at 0.05; ***Significant at 0.01

3.6 Conclusion

This chapter presented our assessments of the relationship between bad credentials and safety violations. The four credentialing violations of interest were KYU, IFTA, UCR, and IRP, and the four safety violations we focused on were vehicle safety, driver safety, Hazmat, and OW/OD violations. In most cases, motor carriers with at least one credentialing violation were more likely to have safety violations than motor carriers without credentialing violations. Two exceptions were the relationships between KYU and Hazmat permit violations and KYU and OW/OD permit violations.

Given the positive relationship between safety violations and credentialing violations, we recommend using KATS screening results to select vehicles for inspection when resources for full inspections are limited. Prioritizing vehicles that failed to receive a *Pass* from KATS with a higher number of credentialing violations for full inspections will help detect more safety-related violations. This will also improve safety and generate revenue for Kentucky. At the same time, the effectiveness of KATS needs to be improved if its screening results are to be an important criterion for distinguishing vehicles subject to full inspections. About 30.00 percent of KATS screenings failed to capture license plate numbers, while 34.57 percent of the USDOT numbers were not captured. This resulted in a 73.83 percent non-verified screening rate. Significant effort should be made to improve the verification rate, so KATS can function at its best.

We also calculated the sensitivity and specificity of KATS for KYU, IFTA, UCR, and IRP. The sensitivity of KATS for KYU violations was 80.54 percent and the specificity was 91.63 percent. Unlike the high sensitivity rate for KYU violations, the sensitivity for IRP was 20.83 percent, which reflects poor data quality. KATS uses data tied to the carrier's USDOT number, but motor carriers are not required to record USDOT numbers when they file IRP and IFTA, which prevents a smooth linkage between USDOT numbers and IRP and IFTA account numbers. IRP and IFTA data used in KATS need to be improved significantly to bolster sensitivity, which will result in better detection of credentialing violations during inspections following KATS screenings. Regression analysis examining the relationship between different types of credentialing violations and the number of citations for vehicle safety violations found that for every additional IFTA and IRP violation found, we can expect the number of citations for vehicle safety violations to increase by 4.2043 and 8.8701, respectively. The magnitude of impact is significantly larger for IFTA and IRP than KYU. A targeted effort to improve IFTA and IRP data quality will improve detection of vehicle safety violations relative to other credentialing violations.

Chapter 4 Best Practices

Our analysis of relationships between screening and inspection data and between safety and credentialing violations revealed:

- Both strengths and weaknesses with current CMV screening and inspection data.
- Several linkages between credentialing and safety violations for vehicles inspected in Kentucky that had long been suspected by the CMV enforcement community.
- Connections between credentialing violations and driver safety violations for vehicles inspected in Kentucky.
- Carriers with Kentucky credentialing violations were more frequently involved in CMV crashes nationwide.

Based on our findings, we recommend several best practices for Kentucky's ITD Team Members — particularly for KSP-CVE officers and inspectors and KYTC Division of Motor Carriers administrators.

Continue Data Quality Improvement Efforts

Maximizing the efficacy of roadside screening systems requires sustained efforts by KYTC and KSP administrators, Office of Information Technology (OIT) and Commonwealth Office of Technology (COT) analysts and developers, KTC researchers, and other vendors contracted to develop and maintain ITS-CVO applications and data. Current efforts related to safety and credentialing data include frequent data baselines, communication between all stakeholder groups concerning data quality issues, improved system architecture, and routine data quality checks. Group members are now talking about how to improve the reporting tool for Kentucky's CVIEW software and potentially using machine learning algorithms to identify data quality issues more efficiently and uncover emerging data quality issues that might not be apparent to human eyes. Researchers and analysts should continue evaluating data quality issues such as accuracy, validity, integrity, completeness, uniqueness, and timeliness. Members of Kentucky's ITD Team should also continue to plan and apply for funds to pursue data quality improvement projects.

Address IRP Data Sensitivity Issues

The data sensitivity metric for IRP was significantly lower than for KYU, IFTA or UCR violations, resulting in many false negatives for carriers with compliance issues for IRP credentials. When screening data do not generate reliable information on possible violations, they lose credibility with enforcement officers. Nor does the information provide efficient enforcement of the credential. Therefore, ITD Team members should work to address data quality issues in this realm. KTC is completing a study of IRP data quality that will illuminate some of these issues. IRP, Inc. is also transitioning to a new IRP Clearinghouse that will house more versatile and reliable data sources once jurisdictions provide files consistent with the new architecture. It will also replace SAFER IRP data, which has more data quality issues than the IRP Clearinghouse database. Enhancing data quality for these programs will require greater interaction and cooperation with other states and Canadian provinces as only the base jurisdiction is capable of fixing data quality issues.

Increase Scrutiny of IRP Violations

Addressing IRP data sensitivity issues will let KSP-CVE focus more investigations on potential IRP violations. KSP-CVE officers tend to concentrate more on KYU and UCR violations because (1) the data are more reliable and easier to find, and (2) in the case of KYU potential revenue generated through impounds is greater than for other credentials. Our analysis shows, however, that significant safety violations — while corresponding to most types of credentialing violations — are most strongly associated with IRP non-compliance. A greater focus on this violation during front-end screening efforts will help enforcement officers identify carriers well-suited to a safety inspection. Even setting aside the potential safety benefits, data quality and resource constraints have made enforcement of IRP more difficult in recent years for all jurisdictions. As data quality improvements are implemented there will be ample opportunities to identify violations for both of these credentials. Kentucky's ITD stakeholders will need to continuously communicate current developments and data quality issues to KSP-CVE so they can place greater emphasis on compliance with IRP requirements and monitor the safety performance of those carriers.

Continued Analysis of KATS, PrePass, DriveWyze and RIMS Observation Data

Observation and inspection data are critical for understanding long-term patterns and trends in CMV enforcement, including carrier behaviors, enforcement performance, and data quality metrics. Data should be routinely analyzed to determine medium- and long-term compliance trends for both safety and credentialing requirements at fixed weigh stations and roadside inspection points. Another issue is that currently analysts and researchers can only access partial screening records from PrePass and DriveWyze. PrePass and DriveWyze include data such as the USDOT number, vehicle plate, state, time, date, and location. But they do not include data on whether a vehicle received a pass or fail – nor do they include information about vehicles passing closed stations. Unlike KATS records, these records are automatically verified as the accuracy rate for vehicle identification is 99.9 percent. They are also more reliable than unverified KATS records, even though KATS provides useful supplemental screening records for most carriers that do not use a preclearance service. The BusinessObjects reporting system contains intermittent data gaps for PrePass, DriveWyze, and RIMS data. And RIMS screening data have never been made available to researchers since Kentucky switched to RIMS development from the previous roadside inspection software.

Enhancements of KATS, PrePass, DriveWyze and RIMS Observation Data

Because screening and inspection data reside in two separate databases, linking a specific file to the inspection is often difficult — only about half of records can be linked using existing fields. At a minimum, the ITD Team should develop a unique identifier field common to screening and inspection data so ITS administrators and researchers can match all or nearly all screening and inspection records. Data could be enhanced by automatically populating RIMS with KATS screening data. This will expedite report completion for officers and inspectors and reduce the chances of spurious data entry. ITD Team members can develop and implement new and/or enhanced reporting tools for each of these systems. KTC researchers and other users can obtain observational data from KATS, PrePass and DriveWyze through the BusinessObjects' TED system and the Observations System (for a shorter period). However, RIMS data are not accessible to KTC researchers via TED. Although they obtain inspection data via KSP-CVE, RIMS screening results are not available.

Revisit Automated Enforcement and Screening

Andrew et al. (2015) recommended that Kentucky consider implementing an automated enforcement component where KYU violators confirmed as having gone through a station with known KYU violations can be cited and fined even if they are not stopped or inspected at the weigh station. Adopting this change will likely require statutory and/or regulatory action. Issuing an administrative penalty of $65 could generate up to $4.2 million a year in additional revenue. Until such a policy could be implemented, KSP-CVE officers and inspectors should continue to select a significant number of trucks registered to carriers with suspected KYU violations given that KYU enforcement generates the most revenue. These carriers may also have safety issues, although the number of safety violations for the average truck with KYU compliance issues is less than those with IFTA or IRP compliance issues.

Improve KATS Data Verification Rate

During our study period just 26% of KATS observations were verified (i.e., the USDOT number and license plate number were both found in the system database and that the vehicle is in fact registered to the carrier with the same USDOT number). Verified observation records are far more reliable than unverified records, which are prone to inaccurately decoded USDOT numbers and license plates. Unverified records are therefore more likely to indicate a false positive for a potential screening issue. If not detected, these can result in officers or inspectors pulling in vehicles for inspections without having accurate screening information. Improved data verification rates will lead to better inspection selection and a more efficient use of resources. Verified data can also be more reliably used for audits and jeopardy assessments. Increasing the data verification rate will require:

- Training officers and inspectors to verify records that populate when monitoring KATS
- Improving the performance of KATS technology
- Incentivizing carriers to use preclearance services (e.g., PrePass and DriveWyze)
- Dedicating staff to verify records post-screening for audits and jeopardy assessments

For the last option, automated or semi-automated enforcement of KYU violations could fund additional personnel to review records and improve data verification rates.

Improve KATS LPR/USDOT Capture Rate

About 30% of license plate numbers and 34.57% of USDOT numbers were missing from KATS data. There is some overlap between these two missing datapoints, but the practical implication is that KATS cannot obtain vehicle or carrier information 30% of the time. This limits the efficacy of the screening system because officers and inspectors cannot screen using complete data without both data elements, unless they have the bandwidth to discern missing USDOT number or license plate number from a manual review of images. Given the time constraints between the point of screening and deciding whether a vehicle should be inspected, it is not always practical to address the issue. However, officers and inspectors should attempt to enter missing data whenever feasible. KYTC and KTC need to work with vendors of license plate and USDOT number readers to determine why missing data are so prevalent and improve the data capture rate for both. Previously identified causes include missing plates, dirty plates, bent plates, inclement weather, illegible USDOT font styles, and unconventional USDOT number placement. Regulatory action could standardize the placement of USDOT numbers, but any changes would have to be implemented at the federal level.

Capture Roadside Screening Data

Matching CMV screening data and inspection data is currently only possible for inspections at fixed weigh stations. Patterns and trends related to safety and credential violations shown in our study are only generalizable to those matched with Level 1 inspections at weigh stations. Roadside enforcement inspections were omitted from our study because we only analyzed inspections with applicable screening data. From 2017 to 2019 there were 193,083 Level 1 inspections; of those about 26.34% occurred at roadside locations. When an officer screens a vehicle in their cruiser, results should be archived and stored in the Observations database along with KATS, PrePass and DriveWyze data. Presently there are no screening data from RIMS in the Observations or TED databases. Capturing roadside screening data requires a technological solution and an operational solution. The technological solution is establishing archival capabilities in RIMS and exporting records to the Observations and TED databases. The operational solution is to ensure officers always screen vehicles in RIMS before inspections, which will require training on the value of the data and importance of always screening a vehicle before interrogating the driver or conducting a roadside inspection. Capturing the additional data will let researchers determine if patterns found in weigh station screening data hold for roadside inspections.

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