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Safety Issues Involving Marine Containers on Chassis

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Jonathan P. Watson, M.S., E.I.T.
Arun Chatterjee, Ph.D., P.E.
David B. Clarke, Ph.D., P.E.

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CHAPTER 1. INTRODUCTION

OVERVIEW

This study performed by The University of Tennessee investigated safety related problems involving chassis used for transporting marine containers on US highways. In recent years, much concern has arisen regarding the safety implications of allegedly substandard container chassis maintenance and inspection practices. This recognition is reflected in the recent effort to pass federal legislation mandating more effective container chassis inspection.

Marine container volumes are growing with the unprecedented increase in foreign trade. While containers on chassis constitute a small proportion of heavy truck traffic nationally, containers account for a high percentage of truck traffic on highways around major ports. Domestic use of containers is also increasing in popularity, albeit at a lesser rate than international shipments. This study focuses on the marine container, which presently accounts for the majority of container usage.

A container chassis consists of a frame, wheels, axles, suspension system, braking system, safety appliances, and other components necessary for highway transport of a container. Figure 1 shows a typical chassis loaded with a container. Marine chassis usually are owned by steamship lines (ocean carriers), but are handled and transported by other entities such as seaports, drayage companies, and railroad companies. Figure 2 shows a collection of chassis of various owners awaiting loading at an intermodal terminal. There also are pools of chassis owned or managed by different groups. Regardless, the major issue with the chassis is maintaining its roadability or suitability for use over the highway in conformance with regulatory requirements and accepted industry standards.

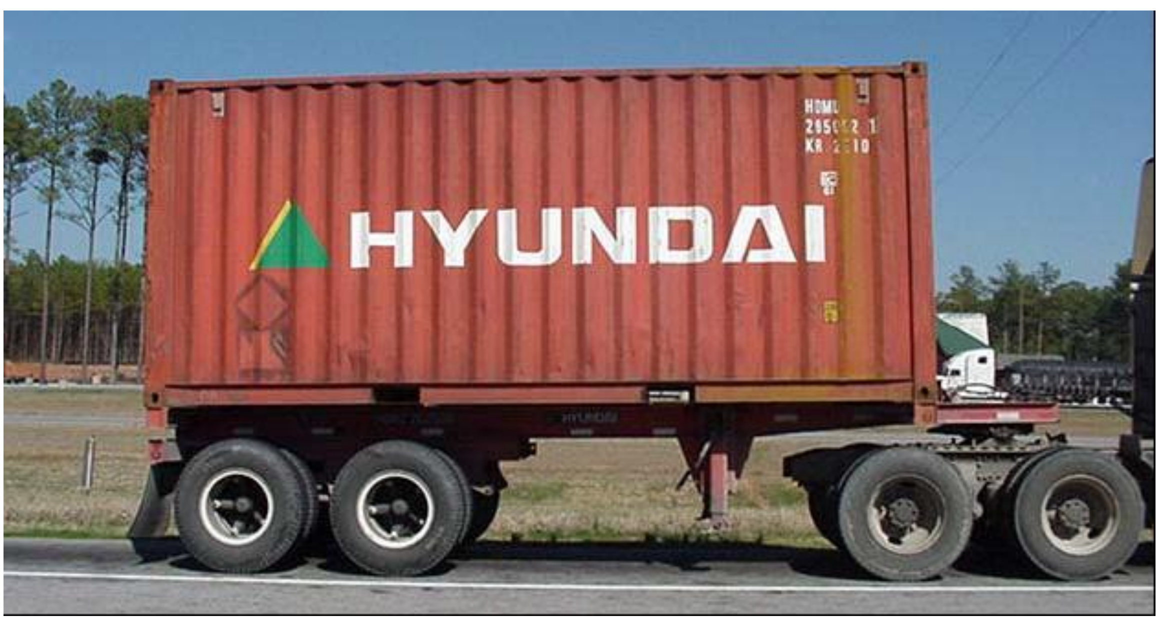

Figure 1. Photograph. Typical Container on Chassis.

Figure 2. Photograph. Chassis Awaiting Loading at an Intermodal Terminal.

Two issues confound the proper maintenance, and thus safety, of chassis. First, the chassis is not viewed as revenue-generating equipment, and therefore owners may be tempted to minimize chassis investment both in initial cost and in maintenance. Second, chassis spend much of their working lives outside the possession of the owner. This increases the likelihood that chassis will not receive proper maintenance attention, since the entity using it does not own it.

There has been much anecdotal evidence that current levels of chassis maintenance are not adequate to maintain safety. Industry testimony before the Federal Motor Carrier Safety Administration (FMCSA) during a 2004 hearing indicated that several large chassis owners spent less than $500 per chassis annually on maintenance. The fact that chassis often spend large amounts of time in the hands of third parties supports the fear that maintenance and inspection are inadequate. Despite these concerns, there appears to have been little formal scientific study of the safety issue.

OBJECTIVES

The objectives of this research are to examine and quantify the safety issues and problems surrounding chassis used for transporting marine containers over highways. Many in the intermodal industry have testified about their concern for chassis safety. Rulemaking has been proposed at the federal level, and a number of states have passed chassis roadability laws. However, there has been little formal study based on reliable data of chassis defects and crash experience of containers moving on highways. One of the underlying purposes of the project is to determine if ‘actual’ problems are similar to ‘perceived’ problems.

There are no uniform and regular maintenance programs for chassis, and therefore, data on common chassis defects are lacking. Further, the crash data recording systems used by state agencies usually do not have specific items for recording defects of chassis found during crash investigation and reporting. There is a need for developing more factual information based on statistical analysis regarding defects commonly found with chassis used for container movement, and the potential impact of these defective chassis on highway safety.

With the help of private companies engaged with the transportation of marine containers and also state agencies involved with crash investigation and roadside inspection of containers and chassis, this research developed information on common types of defects of chassis and the potential for crashes that these defects may contribute to. The study also gathered and examined crash data to identify how much chassis defects may be contributing to crashes. We discovered that existing crash report forms did not adequately record chassis defects found during crash investigation. These findings will help to develop a sound understanding of the state of affairs associated with container chassis and also lead to recommendations regarding changes that should be made on crash reporting procedures for capturing chassis-related information adequately. The methodology used by this study can be used to design and perform a large-scale national study.

CHAPTER 2. BACKGROUND

The issue of chassis maintenance and its ramifications on safety have been controversial since the start of the intermodal container boom almost 30 years ago. Today, an estimated 750,000 chassis are in service on the nation's highways. Most of these chassis operate over the highway under the control of drayage firms that, unlike the case with normal trailers, do not own the chassis. Since the 1990s, drayage companies, railroads, and steamship lines have been at odds over who is responsible for the inspection, maintenance, and repair of the trailers and chassis that are used in moving containers to and from intermodal facilities. The following presents the previous and most current rulemakings involving intermodal chassis.

PREVIOUS AND CURRENT RULEMAKING ON INTERMODAL CHASSIS

In 1999, the Federal Highway Administration (FHWA) issued an Advanced Notice of Proposed Rulemaking (ANPRM) concerning inspection, repair, and maintenance of intermodal chassis. This was in response to a petition for a proposed rulemaking by the American Trucking Association (ATA) to make parties that tender intermodal container chassis and intermodal trailers responsible for maintaining it. In 2003, however, the Federal Motor Carrier Safety Administration (FMCSA) withdrew the ANPRM due to insufficient data on chassis inspections and an inability to identify crashes where the chassis was a contributing cause as hindering efforts to clarify the controversy. The main data limitations expressed by the FMCSA are that chassis inspection and accident data are commonly lumped in among regular trailer data, and that relatively few crashes are shown as involving chassis. This is possibly because of the short distances usually traveled by chassis which might reduce crash exposure or possibly because the chassis are categorized as regular trailers in crash reports.

In recent years, Congress and the President demonstrated their interest in ensuring the safety of intermodal equipment moving on the Nation's highways. On August 10, 2005, President George W. Bush signed into law the Safe, Accountable, Flexible, and Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU). SAFETEA-LU authorizes the Federal surface transportation programs for highways, highway safety, and transit from 2005 through 2009. Section 4118 of SAFETEA-LU addresses the safety and roadworthiness of intermodal trailers, chassis, and other trailing equipment. Among other things, SAFETEA-LU establishes that equipment providers are responsible for maintaining intermodal equipment and vests authority with the U.S. Department of Transportation to inspect intermodal equipment and to take out of service equipment that fails to comply with applicable safety regulations.

In 2006, the FMCSA proposed to amend a number of requirements in the Federal Motor Carrier Safety Regulations in a new rulemaking entitled "Inspection, Repair, and Maintenance

Requirements for Intermodal Container Chassis Equipment Providers". This proposed rule would enable the safety performance profile of intermodal equipment providers to be more effectively monitored by the FMCSA by allowing the violations of intermodal equipment found at roadside inspections to be directly tied to the entity controlling its inspection, maintenance, and repair, as well as its transfer to motor carriers.

However, it should be noted that neither the SAFETEA-LU nor the 2006 FMCSA proposed rulemaking relieves commercial motor vehicle drivers or motor carriers of liability for damage they may inflict on intermodal equipment or resulting from crashes, because determination of liability is not the purpose of either. Currently, the insurance liability for a chassis or intermodal trailer is addressed under the provisions of a motor carrier's Trailer Interchange coverage, which covers physical damage to non-owned equipment while in the motor carrier's care, custody, and control. Presently, only five states– California, Illinois, Louisiana, New Jersey, and South Carolina–have passed roadability legislation requiring equipment owners to certify, under penalty of perjury, that their chassis are safe. Similar bills have been proposed in Florida, Pennsylvania, Texas, and Virginia.

CHAPTER 3. LITERATURE REVIEW

PREVIOUS STUDIES

A search of various bibliographic data sources, including the Transportation Research Information Service (TRIS), revealed a few studies that addressed various issues related to intermodal marine containers and chassis safety. These are listed below:

1. Cottrill, K., "Passing the buck: problem of responsibility for faulty intermodal equipment generates much heat, little light," Journal of Commerce, July 1998, p. 125.

2. Flora, W., "ATA: Consensus Lacking in Intermodal Chassis," Transport Topics, December 2003.

3. Keene, Thomas P., Thomas Corsi, and Kristine N. Braaten, "Motor Carrier Industry Profile Study: Evaluating Safety Performance by Motor Carrier Industry Segment, undated report.

4. Swan, P.F., "A Study of the Economic Impact and the Need for Proposed Changes to Intermodal Container Chassis Inspection Rules", undated report.

5. Robinson, Alan M., "Intermodal Truck Equipment Safety: Legislation in the 108th Congress", CRS Report for Congress, May 6, 2004.

6. John A. Volpe National Transportation Systems Center, "Feasibility Study on Collecting Intermodal Chassis Crash and Inspection Data", Final Report, July 2004.

7. John A. Volpe National Transportation Systems Center, "Feasibility Study on Collecting Intermodal Chassis Crash and Inspection Data", Report on RoadCheck 2004 Analysis, November 2004.

8. Federal Motor Carrier Safety Administration, Volpe National Transportation Systems Center, “Notice of Proposed Rulemaking: Inspection, Repair and Maintenance Requirements for Intermodal Equipment Providers”, Regulatory Impact Analysis, April 2006.

9. Federal Motor Carrier Safety Administration, U.S. Department of Transportation, “Requirements for Intermodal Equipment Providers and Motor Carriers and Drivers Operating Intermodal Equipment”, Proposed Rule, December 21, 2006.

FINDINGS

The existing literature on the subject of chassis used for transporting containers recognizes the problem with regard to inadequate maintenance, and also points out the lack of statistically controlled and scientifically valid research on the potential impact of defective chassis on highway safety. The chassis-related safety picture is also clouded either because there are no known current estimates either of the annual number of marine container drays or of the vehicle-miles of travel generated by these dray movements. In specific corridors (especially approaching seaports and major rail intermodal terminals), containers on chassis (COC) undoubtedly account for a high percentage of heavy truck movements. As the domestic leg of an international supply chain, COC is a fast growing traffic sector due to an increase in use by many sectors of the economy. It is logical to assume that a projected doubling of foreign trade within the next twenty years will have a similar effect on COC movements. This indicates there is a need to develop a better understanding of chassis safety issues now.

The most recent study involving intermodal chassis out-of-service rates was performed by the John A. Volpe Transportation Systems Center (the Volpe Center), and was published in reports numbered 6 and 7 of the above listed studies.

In order to assess the condition of intermodal container chassis in the U.S., FMCSA requested that the states conduct inspections of intermodal equipment, where possible and appropriate, as part of the focus of the International RoadCheck 2004, conducted in June 2004, the seventeenth annual inspection effort. Additionally, FMCSA obtained inspection data during the period 2000 to 2003 from four states (California, Louisiana, South Carolina, and Texas) that currently identify intermodal semitrailers in their inspection records. The Volpe Center analyzed the resulting inspection data obtained by the FMCSA. The Volpe Center’s study of the four-state analysis shows that violations cited in inspections of intermodal semitrailers (i.e., COC) were more likely to be lighting-related and less likely to be brake-related than were violations cited in inspections of non-intermodal semitrailers. Their studies also showed that the RoadCheck analysis results were consistent with the four-state analysis in that the intermodal vehicle out-of-service rates were consistently higher than the non-intermodal vehicle out-of-service rates for Unit 2 vehicles (the trailing unit). The vehicle out-of-service rates for the Unit 1 vehicles (the tractors) were similar to the results from the Unit 2 vehicles.

CHAPTER 4. ORGANIZATIONS CONTACTED & INFORMATION GATHERED

In order to gain more insight on the physical defects of chassis and the associated maintenance practices, several different organizations involved with the handling of chassis were contacted.

CONTACTS

The contacted organizations included four drayage motor carriers, a rail company, a chassis pool provider, and a state port authority, as summarized below:

Drayage Motor Carriers

1. David Manning, President, TCW, Inc., Nashville, TN
2. Richard Strobel, Senior Vice-President, G&P Trucking Co., Inc., Gaston, S.C.
3. Phil Byrd, President, Bulldog Hiway Express, Charleston, S.C.
4. Sam Farruggio, President, Farruggio's Express Inc., Bristol, PA.

Rail Carrier

5. Melanie Margol, Terminal Manager, CSX-I, Charleston, S.C.

Chassis Pool Provider

6. Jill McDowell, Trac Lease, Charleston, S.C.

State Port Authority

7. Jeffrey E. Miles and Donna Jones, North Carolina State Port Authority, Wilmington, N.C.

FINDINGS

The completed interviews with officials of the different organizations provided a better general understanding of the defective issues and maintenance practices related to chassis. These findings are presented below.

The chassis is a key element in intermodal container transportation, and chassis availability is an important concern. Traditionally, chassis have been provided by the owners of the containers that ride upon them. At most seaports, the chassis are owned by steamship lines. Railroads also own chassis for handling their domestic containers. Chassis management, including maintenance, may be performed by the owner or, increasingly for steamship owned chassis, by a chassis pool company.

In a non-pooled operation, each container and its associated chassis have the same owner. Each steamship line (or railroads) provides a fleet of chassis to handle its containers. A container generally does not move on a chassis of different ownership. Thus, if a chassis is defective, it must either be repaired or replaced by another chassis from the owner's fleet. Sizing the chassis fleet at a location is a challenge. Containers cannot be moved when chassis are unavailable, but providing extra chassis is costly. If chassis are in short supply (as is frequently the case), the owner may be tempted to risk using a defective chassis rather than delay a shipment.

Port operators can make only limited chassis repairs without authority from the owner. Because the chassis is not viewed as a revenue-generating asset, owners often delay making major chassis repairs. The port must store the defective chassis until repairs are authorized.

Chassis pools are an increasingly popular way for steamship lines to address problems of chassis utilization and maintenance. The port may assign any container owned by a pool member to a chassis in the pool. A pool manager oversees the chassis fleet, ensuring that they receive routine maintenance and meet applicable safety standards.

In our interview, the chassis pool company confirmed that they perform routine chassis maintenance. However, the pool members still must authorize the pool operator to make major repairs to their chassis. The chassis pool operator does remove defective chassis from service pending repair. Since the operator is not constrained by ownership in making chassis assignments, there may be less pressure to use a defective chassis. Some pool managers lease chassis to the pool, either to provide the fleet or to augment the members' chassis fleet. This may offer the highest likelihood that the chassis will receive timely and proper maintenance.

At terminals, the chassis routinely receives a walk-around inspection at check-out and check-in. Some terminals also use video cameras to identify and record chassis damage and to check for expired tags or registration. The visual inspection is intended to find defects involving tires, lights, brakes, brake shoe lining, and FMCSA registration. However, it does not substitute for a comprehensive periodic inspection, and thus may not catch the actual or emerging problems that a periodic inspection would. If a defect is found then the chassis is moved to an on-site maintenance facility to be repaired.

Drayage companies feel that they do not possess the necessary level of control or authority over chassis to assure that chassis are properly maintained and in safe operating order. Though these firms are dedicated to ensuring safe highway operation of chassis, they are not responsible for systematic chassis inspection and maintenance. The driver's cursory visual inspection of the chassis before leaving the intermodal terminal is a drayage company's only safeguard against chassis defects. At many busy terminals, drivers feel pressured to overlook minor chassis defects. If the driver refuses a chassis, the terminal may simply offer the load to a competitor, and the company loses revenue. Waiting for the chassis to be repaired at the terminal results in costly downtime for the driver if no other load is available. As a result, drivers can be tempted to overlook minor defects that do not affect roadability. This is especially true for smaller operators where each load represents critical revenue.

Once the drayage company driver takes possession of a chassis and leaves the intermodal terminal, the company must address any chassis defects found in transport. The driver's pre-trip walk-around inspection of a chassis is all that protects the drayage company from pre-existing defects. All of the drayage motor carriers interviewed operate their own maintenance facilities and routinely repair defects found in intermodal chassis.

The tires, wheels, axles, and brakes of many intermodal chassis differ significantly from those of conventional semi-trailers. These differences may lead to safety problems with intermodal chassis.

Most chassis use bias ply, tube-type, nylon reinforced tires, while normal semi-trailers have steel reinforced, tubeless radial tires. These bias ply tires are an obsolete design no longer manufactured in the U.S. However, chassis owners save money by using them. Tire failure appears to be common problem with intermodal chassis. The tires may be suitable for low speed operation, but at the higher highway speeds typical of chassis service they are prone to overheating and blow-outs. Furthermore, such failures may occur even though the tire visually appears to be in good shape. Drayage firms complain that it is difficult to obtain replacement tires for intermodal chassis and that tire service companies are often unequipped to repair the tires.

Intermodal chassis use an obsolete five-spoke wheel hub to keep the rims fastened to the axle. All other commercial motor vehicles use the Hub Pilot system with ten studs and flange nuts. The five-spoke hub is inferior to the Hub Pilot system. If not tightened equally, this hub allows the rim to wobble during each tire rotation.

Intermodal chassis axles represent another obsolete design. They have large inner bearings and very small outer bearings that are lubricated using an oil splash bath. The smaller outer bearings do not get lubricated evenly in the oil cavity and are prone to failure. This can fail the axle, allowing the wheel assembly to separate. Interestingly, the chassis title is linked to the axles. Grandfathering provisions in certain safety regulations mean that chassis do not have to meet modern standards so long as the original axles are present. This accounts for the continued use of obsolete axle sets.

Most intermodal chassis do not have anti-lock brake systems, while these brakes are required on semi-trailers. The grandfathering provision allows chassis built without anti-lock brakes to continue in operation so long as the original axles are in use.

New chassis are required to employ the same safety systems as standard semi-trailers. As old chassis (and their axles) are retired, the equipment differences between the chassis fleet and other semi-trailers will gradually disappear. It is uncertain how long this will take.

CHAPTER 5. DATA COLLECTED FROM SOUTHEASTERN STATES

APPROACH

This study originally intended to obtain roadside inspection data directly from state agencies in the southeast U.S.A., which are responsible for roadside inspections of commercial vehicles. These roadside inspection reports should identify physical defects of chassis and how frequently they are placed out-of-service (OOS) due to the defects found during an inspection. In addition to data on OOS occurrences of COCs, which would reveal potential safety problems, this study also attempted to obtain crash data along a few highway corridors in the southeast U.S.A. that carry a large amount of COC traffic.

The collection of the roadside inspection and crash data proved more difficult than anticipated. After contacting DOTs of a few states, it became clear that none of these states (with the exception of South Carolina) identifies intermodal chassis in their inspection records. Other than South Carolina, the remaining state DOTs identified COC as semitrailers, and there was no way to distinguish these from non-intermodal semitrailers since they are both identified with the same code. This was unexpected and it hindered our ability to gather appropriate data for this analysis as planned initially. The study teams did obtain crash data from Georgia DOT and roadside inspection data from South Carolina DOT.

FINDINGS

The Georgia DOT provided three years of crash data for sections of I-16 and I-75 in Georgia. The crash data was reduced to include only crashes that involved a tractor hauling a semitrailer; however, the data did not distinguish regular tractor-semitrailers from containers on chassis. Attempts were made to obtain the actual police reports for these crashes in order to determine which of the crashes might have involved intermodal COC. However, the requested police reports were never obtained.

The South Carolina DOT contributed OOS rates for all non-intermodal commercial motor vehicles (CMVs) and for intermodal COC movements during the period 2004 to 2006. Table 1 shows the total number of inspections and the out-of-service rates for intermodal COC and non-intermodal CMV movements. The table shows that the overall OOS rate for intermodal COC were higher than the OOS rate for non-intermodal CMVs. The overall intermodal COC OOS rate was 4.0 percent greater than the overall non-intermodal CMVs OOS rate. A z-test statistical analysis was performed on the percent difference in the OOS rates to determine whether they were statistically significant. Results indicate that the percent difference in the OOS rates between intermodal COC and non-intermodal CMVs to be statistically significant at a confidence of 99.0 percent.

However, this data did not accurately depict the comparison of out-of-service rates between intermodal COC and non-intermodal CMVs that this study was attempting to discover. This roadside inspection data included inspections of both the tractors (Unit 1) and the trailing units (Unit 2) for the intermodal and non-intermodal movements. In addition, this data included inspections of levels 1, 2, 3, and 4 (full inspection, walk-around inspection, driver-only inspection, and special study inspections, respectively).

The non-intermodal CMVs category also included all types of non-intermodal commercial motor vehicles that are inspected, not just semitrailer inspections.

Table 1. Out-of Service Rates for Intermodal COC and Non-Intermodal CMV's in South Carolina.

Unit 1 & 2 - Tractors and Trailing Unit						
	Intermodal (I) COC		Non-Intermodal (NI) CMVs		Difference in OOS Rates (I - NI) (%)	Is the Difference in the OOS Rates Statistically Significant?
	Number of Inspections	Out-of-Service Rate (%)	Number of Inspections	Out-of-Service Rate (%)		
Total	1738	46.7%	18074	42.7%	4.0%	Yes, $p < 0.005$

Therefore, this data was not appropriate because this study involved comparing the OOS rates of only the trailing units (Unit 2) between intermodal COC and non-intermodal semitrailers. In addition, this study does not involve inspections of level 3 (driver-only inspections) because these inspections have nothing to do with violations associated with the trailing unit (Unit 2).

For this study, the non-intermodal vehicle inspections desired are only for movements involving semitrailers as the trailing unit. For these reasons, these data were not applicable in this study.

CHAPTER 6. DATA OBTAINED FROM MCMIS DATABASE

OVERVIEW

Roadside inspection data from the Motor Carrier Management Information System (MCMIS) database provided a comparison of vehicle OOS rates between intermodal COC and non-intermodal semitrailers. FMCSA maintains MCMIS to provide a comprehensive safety record of for-hire and private property and passenger carriers subject to the Federal Motor Carrier Safety Regulations (FMCSR). The system's company safety profile includes general carrier census information, roadside inspection data, and crash data provided by states. The roadside inspection and crash data in MCMIS compensated for the lack of specific data from the states.

The MCMIS database provided company safety profiles for five intermodal and five non-intermodal carriers. The five intermodal carriers have been confirmed to deal strictly with intermodal COC movements, and the five non-intermodal carriers have been confirmed to deal strictly with non-intermodal semitrailer movements. The carriers are:

Intermodal

1. Bridge Terminal Transport Inc. – USDOT # 688143
2. CSX Intermodal Inc. – USDOT # 185796
3. Devine Intermodal – USDOT # 118022
4. Farruggio's Express Inc. – USDOT # 111029
5. Pacer Cartage – USDOT # 50242

Non-Intermodal

1. Maverick Transportation LLC. – USDOT # 178538
2. Star Transportation Inc. – USDOT # 222454
3. Stevens Transport Inc. – USDOT # 79466
4. Venture Express Inc. – USDOT # 192068
5. Western Express Inc. – USDOT # 511412

The inspection and crash data for the five intermodal carriers were combined to form a database to represent the general characteristics of intermodal COC movements. The same process was performed for the five non-intermodal carriers to represent the overall characteristics of non-intermodal semitrailer movements.

CONTENT OF SAFETY PROFILE

Each company's FMCSA safety profile included violations found during roadside inspections during the most recent twenty-four months before the date when each carrier's report was prepared. Roadside inspections of trucks vary as to the level of details. For our analysis, we used inspection data for inspection levels 1, 2, or 5, which represent full inspections, walk-around inspections, or terminal inspections, respectively. The inspection data also had to be for inspections involving vehicles whose unit number was “2” (trailing unit), whose unit type was “ST” (semitrailer) or “IC” (intermodal chassis) for intermodal inspections and “ST” for non-intermodal inspections, and whose cargo was not identified as being hazardous. The vehicle violations from the MCMIS database are categorized into sixteen different violation types. However, for this study we combined the violation types of “Brakes, All Others” and “Brakes, Out of Adjustment” into one category called “Brakes”. This reduced the number of different violation types to fifteen.

Intermodal vehicle inspections commonly list the unit type as “ST”, but some of the inspections list it as “IC”. The unit type “IC” is not a standard MCMIS unit type, but it was used in the FMCSA’s International RoadCheck 2004 study as a way to identify intermodal chassis. This unit type sometimes appears in MCMIS inspection data because some roadside inspectors obviously choose to continue distinguishing intermodal chassis as a separate unit type. Since most roadside inspection reports record intermodal COC as having unit type “ST” (semitrailer), and because chassis are a type of semitrailer, this report will refer to intermodal COC as intermodal semitrailers in subsequent analysis of the roadside inspection data and vehicle related violations.

Crash data involving intermodal and non-intermodal semitrailers were included in each MCMIS company safety profile. This crash data included a detailed set of crash data over the most recent two years, where the two year period is defined as the total of twenty-four months before the date when each carrier’s report was prepared.

The data obtained from each MCMIS company safety profile includes each company’s Vehicle Safety Evaluation Area (SEA) score. The Vehicle SEA is a Motor Carrier Safety Status measurement system (SafeStat) composite value calculated based on the Vehicle Inspection Indicator (VII) and the Vehicle Review Indicator (VRI). The VII is based on the number of vehicle roadside OOS inspection violations and the VRI is based on violations of vehicle-related acute and critical regulations discovered during compliance reviews. Each inspection is weighted by how long ago the inspection occurred and the number of vehicle OOS violations found, and then normalized by the number of vehicle inspections within the last 30 months. A lower Vehicle SEA value indicates better safety performance.

CHAPTER 7. ANALYSIS OF OVERALL ROADSIDE INSPECTION DATA

OVERVIEW

This section contains an analysis of the roadside inspection data of intermodal semitrailers and non-intermodal semitrailers over the twenty-four months of data preceding of each carrier’s most recent report. The data came from the MCMIS database.

Using the MCMIS roadside inspection data, the intermodal and non-intermodal vehicle out-of-service (OOS) and violation rates were calculated and compared for the semitrailers (Unit 2) and their associated tractors (Unit 1). This analysis considered vehicle related violations only; driver related violations were not included. The average Vehicle SEA scores were calculated and compared for the intermodal and non-intermodal carriers reviewed. Two-tailed z-tests were conducted to determine whether there were statistically significant differences between intermodal and non-intermodal OOS and violation rates. See Appendix A for a brief explanation of the z-test procedure.

FINDINGS

Table 2 shows the total number of inspections and the vehicle out-of-service rates for intermodal and non-intermodal semitrailers (Unit 2). The overall OOS rate for intermodal semitrailers was 7.8 percent higher than that of non-intermodal semitrailers. A two-tailed z-test indicated that this difference in the OOS rates is statistically significant at a confidence interval of 99.0 percent.

Table 2. Vehicle Out-of-Service Rates of Intermodal and Non-Intermodal Semitrailers.

Unit 2 - Semitrailers						
	Intermodal (I)		Non-Intermodal (NI)		Difference in OOS Rates (I - NI) (%)	Is the Difference in the OOS Rates Statistically Significant?
	Number of Inspections	Out-of-Service Rate (%)	Number of Inspections	Out-of-Service Rate (%)		
Total	5236	17.9%	8422	10.1%	7.8%	Yes, $p < 0.005$

Table 3 shows the total number of inspections and the vehicle out-of-service rates for tractors (Unit 1) that were hauling the intermodal and non-intermodal semitrailers (Unit 2). The overall OOS rate for tractors hauling intermodal semitrailers was 9.3 percent higher than the rate for tractors hauling non-intermodal semitrailers. A statistical analysis indicated that the difference in these OOS rates was statistically significant. A trucking company official knowledgeable of maintenance practices hypothesized that this finding may be influenced by the heavy use of owner-operators by the five intermodal carriers examined. Owner-operators may not maintain their tractors as well as a large carrier would.

Table 3. Vehicle Out-of-Service Rates of Tractors Hauling Intermodal and Non-Intermodal Semitrailers.

Unit 1 - Tractors Hauling Semitrailers						
	Intermodal (I)		**Non-Intermodal (NI)**		**Difference in OOS Rates (I - NI) (%)**	**Is the Difference in the OOS Rates Statistically Significant?**
	Number of Inspections	**Out-of-Service Rate (%)**	**Number of Inspections**	**Out-of-Service Rate (%)**		
Total	5236	13.6%	8422	4.3%	9.3%	Yes, $p < 0.005$

Table 4 shows the total number of inspections and the average number of vehicle violations per inspection for intermodal and non-intermodal semitrailer (Unit 2) inspections. These vehicle violations included all types, either OOS or non-OOS. The table shows that intermodal semitrailers have 0.44 more vehicle violations per inspection than non-intermodal semitrailers. This difference in the violation rates is statistically significant at a confidence level of 99.0 percent.

Table 4. Vehicle Violations per Inspection of Intermodal and Non-Intermodal Semitrailers.

Unit 2 - Semitrailers						
	Intermodal (I)		**Non-Intermodal (NI)**		**Difference in Violations* per Inspection (I - NI)**	**Is the Difference in the Violations* per Inspection Statistically Significant?**
	Number of Inspections	**Violations* per Inspection**	**Number of Inspections**	**Violations* per Inspection**		
Total	5236	0.82	8422	0.38	0.44	Yes, $p < 0.005$

* - Includes both out-of-service (OOS) and non-out-of-service (non-OOS) violations.

Table 5 shows the total number of inspections and the average number of vehicle violations per inspection for tractors (Unit 1) hauling intermodal and non-intermodal semitrailers with any vehicle violations, either OOS or non-OOS. The results for the Unit 1 vehicles (tractors) were similar to the results for the Unit 2 vehicles (semitrailers) because the number of vehicle violations per inspection for intermodal tractors with any vehicle violations, either OOS or non-OOS, was higher than the number of vehicle violations per inspection for non-intermodal tractors with any vehicle violations. Intermodal tractors had an average of 0.88 more vehicle violations per inspection than non-intermodal tractors. The difference in the violation rates between tractors hauling intermodal and non-intermodal semitrailers is statistically significant at a confidence interval of 99.0 percent.

Table 5. Vehicle Violations per Inspection of Tractors Hauling Intermodal and Non-Intermodal Semitrailers.

Unit 1 - Tractors Hauling Semitrailers						
	Intermodal (I)		**Non-Intermodal (NI)**		**Difference in Violations* per Inspection (I - NI)**	**Is the Difference in the Violations* per Inspection Statistically Significant?**
	Number of Inspections	**Violations* per Inspection**	**Number of Inspections**	**Violations* per Inspection**		
Total	5236	1.25	8422	0.37	0.88	Yes, $p < 0.005$

* - Includes both out-of-service (OOS) and non-out-of-service (non-OOS) violations.

Table 6 shows the average Vehicle SEA scores for the intermodal and non-intermodal carriers. The difference in Vehicle SEA scores between intermodal and non-intermodal carriers was 39.1. This difference in Vehicle SEA scores between intermodal and non-intermodal carriers is statistically significant at a confidence of 99.0 percent.

Table 6. Vehicle SEA Score of Intermodal and Non-Intermodal Carriers.

Vehicle SEA				
	Intermodal (I)	**Non-Intermodal (NI)**	**Difference in Vehicle SEA Scores (I - NI)**	**Statistically Significant?**
Score	67.3	28.2	39.1	Yes, $p < 0.005$

CHAPTER 8. ANALYSIS OF ROADSIDE INSPECTION VIOLATIONS

OVERVIEW

This section contains an analysis of vehicle violations cited during roadside inspections of intermodal semitrailers and non-intermodal semitrailers over the twenty-four months before the date of each carrier's most recent report. This data were obtained from MCMIS.

Using the MCMIS roadside inspection data, we examined the intermodal and non-intermodal semitrailer violations found during these inspections to determine the types of problems found with semitrailers (Unit 2). This was not done for the corresponding tractors (Unit 1). This analysis dealt only with vehicle related violations and driver related violations were not considered.

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Table 7 shows the total number of inspections of intermodal semitrailers and the resulting number of Unit 2 vehicle violations identified during the inspections.

Table 7. Intermodal Semitrailer Inspections and Violations.

Unit 2 -Semitrailers		
	Number of Intermodal Inspections	**Number of Intermodal Violations***
Total	5,236	4,269

* - Includes both out-of-service (OOS) and non-out-of-service (non-OOS) violations.

Table 8 shows the types of vehicle violations that were analyzed. These include both OOS and non-OOS violations found during roadside inspections of intermodal semitrailers. The most frequently cited violation was “Lights”, which comprised 48.8 percent of all violations. The second most frequently cited violation, “Brakes,” accounted for 22.3 percent of the total violations. The tire-related violation accounted for 9.9 percent of all violations, while the load securement violation accounted for 7.8 percent of all violations.

Table 9 shows the total number of inspections of non-intermodal semitrailers and the resulting number of Unit 2 vehicle violations identified during the inspections.

Table 10 shows the types of vehicle violations (both OOS and non-OSS) of the non-intermodal semitrailers from the roadside inspection data that was analyzed. The most frequently cited violation, “Lights”, comprised 30.9 percent of all violations. The second most frequently cited violation was “Brakes”, accounting for 21.3 percent of violations. The tire-related violation accounted for 17.3 percent and the load securement violation accounted for 12.2 percent of violations.

Table 8. Violation Types of Intermodal Semitrailers.

Unit 2 - Semitrailers			
Violation Type	**Rank**	**Count**	**Percent of Total**
Lights	1	2,082	48.8
Brakes	2	954	22.3
Tires	3	422	9.9
Load Securement	4	335	7.8
All Other Vehicle Defects	5	323	7.6
Periodic Inspection	6	56	1.3
Wheels	7	36	0.8
Suspension	8	32	0.7
Frames	9	22	0.5
Coupling Devices	10	5	0.1
Fuel Systems	11	1	0.0
Exhaust Discharge	12	1	0.0
Emergency Equipment	13	0	0.0
Steering Mechanism	14	0	0.0
Windshield	15	0	0.0
Total*		4,269	100.0

* - Includes both out-of-service (OOS) and non-out-of-service (non-OOS) violations.

Table 9. Non-Intermodal Semitrailer Inspections and Violations.

Unit 2 -Semitrailers		
	Number of Non-Intermodal Inspections	**Number of Non-Intermodal Violations***
Total	8,422	3,182

* - Includes both out-of-service (OOS) and non-out-of-service (non-OOS) violations.

Table 10. Violation Types of Non-Intermodal Semitrailers.

Unit 2 - Semitrailers			
Violation Type	**Rank**	**Count**	**Percent of Total**
Lights	1	982	30.9
Brakes	2	678	21.3
Tires	3	549	17.3
Load Securement	4	389	12.2
All Other Vehicle Defects	5	336	10.6
Suspension	6	102	3.2
Periodic Inspection	7	85	2.7
Wheels	8	28	0.9
Frames	9	19	0.6
Coupling Devices	10	5	0.2
Fuel Systems	11	5	0.2
Emergency Equipment	12	3	0.1
Exhaust Discharge	13	1	0.0
Steering Mechanism	14	0	0.0
Windshield	15	0	0.0
Total *		3,182	100.0

* - Includes both out-of-service (OOS) and non-out-of-service (non-OOS) violations.

Comparison of Tables 8 and 10 reveals that the five most frequently cited violations in intermodal inspections were exactly the same five most frequently cited violations in non-intermodal inspections. These violations accounted for 91.7 percent of all violations involving intermodal semitrailers and 89.5 percent of al violations involving non-intermodal semitrailers.

Table 11 shows the percentage distribution of violations cited in the intermodal and non-intermodal inspections by type of violation. Violations cited in inspections of intermodal semitrailers were more likely to be lighting-related than were violations cited in inspections of non-intermodal semitrailers.

Surprisingly, intermodal semitrailers were less likely to have tire-related violations than did non-intermodal semitrailers. This finding is contrary to the experience of the officials of trucking companies whom we interviewed for this research. These differences in percent of

Table 11. Percent of Intermodal and Non-Intermodal Semitrailer Violations by Type.

Unit 2 -Semitrailers				
Type of Violation	**Percent of Intermodal (I) Violations***	**Percent of Non-Intermodal (NI) Violations***	**Difference in Percent of Violations* (I- NI)**	**Is the Difference in Percent of Violations* (I- NI) Statistically Significant?**
Lights	48.8	30.9	17.9	Yes, $p < 0.005$
Brakes	22.3	21.3	1.0	No, $p > 0.005$
Tires	9.9	17.3	-7.4	Yes, $p < 0.005$
Other	19.0	30.6	-11.6	Yes, $p < 0.005$

* - Includes both out-of-service (OOS) and non-out-of-service (non-OOS) violations.

Percentages may not add up to 100 due to rounding.

violations between intermodal and non-intermodal semitrailers are statistically significant at a confidence level of 99.0 percent.

The table also shows that brake-related violations have relatively the same proportion for both intermodal and non-intermodal semitrailers. This is also somewhat surprising because intermodal semitrailers do not have the modern anti-skid brakes common to non-intermodal semitrailers.

This comparison of vehicle violation frequencies may suffer from sampling related issues. The way that inspectors of commercial motor vehicles select trucks for inspection is not random. Inspectors tend to select those vehicles that appear to be poorly maintained. They also use a company's "safety score" to help in making their selection of which vehicles to inspect. Whether this selection bias toward companies known to be lax with maintenance affects both intermodal and non-intermodal vehicles is unknown.

CHAPTER 9. ANALYSIS OF DETAILED CRASH DATA

OVERVIEW

This section contains an analysis of the detailed crash data involving intermodal chassis and non-intermodal semitrailers. As with previous analysis in our study, the crash data comes from MCMIS and represents the twenty-four months prior to the date of the carrier's latest report. The original sources of crash data are the police reports for individual crashes, which are filed and stored by appropriate state agencies. State agencies then provide FMCSA with any crash reports involving commercial motor carriers.

Using the MCMIS crash data, we developed various crash statistics and crash rates for the intermodal and non-intermodal carriers. Two-tailed z-tests were performed to determine whether there were statistically significant differences between intermodal and non-intermodal crash rates. See Appendix A for a brief explanation of the z-test procedure.

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Table 12 shows the detailed crash data over the previous two years for the intermodal and non-intermodal carriers. Each crash was counted only once according to the highest severity occurrence in the crash (Fatality, Injury, or Tow-away).

Table 12. Detailed Crash Data of Intermodal and Non-Intermodal Carriers.

Detailed Crash Data - previous two years						
	Intermodal			Non-Intermodal		
Type	Number of Crashes	Number of Crashes Citing Equipment Failure	% of Crashes Citing Equipment Failure	Number of Crashes	Number of Crashes Citing Equipment Failure	% of Crashes Citing Equipment Failure
Fatality	5	0	0	27	0	0
Injury	90	2	2.2	275	3	1.1
Tow-away	122	3	2.5	396	0	0
Total	217	5	4.7	698	3	1.1

The crash data was analyzed to determine whether the crash occurrences were caused by "Equipment Failure" (code EQF). The MCMIS data describes an equipment failure as a brake failure, blown tire, etc. The figure shows that, over the previous two years, the percent of crashes citing "Equipment Failure" as a crash cause was higher for intermodal carriers than for non-intermodal carriers. For crashes involving intermodal carriers, 4.7 percent of these crashes cited equipment failure as a cause, while crashes involving non-intermodal carriers cited that only 1.1 percent of these crashes cited equipment failure as a cause. However, this crash data from intermodal and non-intermodal carriers cannot be statistically compared because these values do not take into account the number of vehicle-miles traveled by each mode.

In order to perform valid statistical comparison, crash rates involving fatalities, equipment failures, and total crashes were calculated for the intermodal and non-intermodal carriers. For intermodal and non-intermodal modes, the Fatal Crash Rate is the average number of fatal crashes per year divided by the total vehicle-miles traveled per year by each mode. Similarly, the Equipment Failure Crash Rate is the average number of crashes per year involving equipment failures divided by the total vehicle-miles traveled per year by each mode, and the Total Crash Rate is the average total number of crashes per year divided by the total vehicle-miles traveled per year by each mode. The total vehicle-miles traveled per year of the intermodal carriers were determined by combining the last reported total vehicle-miles traveled by each carrier. The total vehicle-miles traveled per year by the non-intermodal carriers were also determined by combining the last reported total vehicle-miles traveled by each carrier. The total vehicle-miles traveled were reported to the MCMIS by the motor carriers, and these values were available in the company safety profiles, which we obtained from FMCSA.

Table 13 presents the crash rates for the intermodal and non-intermodal carriers. The difference in the crash rates of intermodal and non-intermodal carriers is not statistically significant at a confidence level of 95.0 percent. This shows that an intermodal COC movement is as likely as a non-intermodal semitrailer movement to be involved in a crash. A crash resulting from an equipment failure is statistically as likely for an intermodal COC movement as a non-intermodal semitrailer movement.

Table 13. Crash Rates of Intermodal and Non-Intermodal Carriers.

Crash Rates				
Type	**Intermodal (I)**	**Non-Intermodal (NI)**	**Difference in Crash Rate (I - NI)**	**Statistically Significant?**
Fatal Crash Rate*	1.0	2.1	-1.1	No, p > 0.025
Equipment Failure Crash Rate*	1.0	0.2	0.8	No, p > 0.025
Total Crash Rate*	45.4	54.9	-9.5	No, p > 0.025

CHAPTER 10. CONCLUSIONS & RECOMMENDATIONS

SUMMARY OF FINDINGS

This study investigated the premise that intermodal containers chassis are not maintained adequately for various reasons and are more accident-prone than conventional semi-trailers. Officials of drayage trucking firms pointed to the tires used for marine chassis as a serious problem. Obsolete bias-ply tires imported from other countries are used on marine container chassis. These are allegedly not as reliable as the radial tires used on all other commercial trucks. Trucking officials allege that chassis tires have caused serious safety problems for their drivers and maintenance personnel.

The analysis performed with MCMIS data did confirm that the OOS rate for intermodal trailing units is significantly higher than that of non-intermodal trailing units. The OOS rate is indicative of chassis maintenance standards. The defects of a trailing unit that lead to its out-of-service status usually involve the chassis on which the container is placed. This finding is consistent with the findings of a few other studies that examined this issue.

This study did not find enough evidence to support the premise that inadequate maintenance makes containers on chassis more accident-prone while moving on highways. Crash data obtained from MCMIS for selected companies showed no significant difference between crash involvement of intermodal and non-intermodal trucking companies. However, it should be noted that since crashes do not occur frequently, the sample size in our case may not be sufficient.

The MCMIS data did not reveal any effects of the alleged poor quality of bias-ply chassis tires. Roadside inspection data showed that the percent of tire-related defects found during roadside inspections was smaller for intermodal trailing units than for non-intermodal trailing units. However, the issue involving the poor quality of the bias-ply chassis tires might not be apparent in tire-related defects found during roadside inspections because the inspectors perform visual inspections looking at tread depth and other surface damages. Bias-ply tires and wheel hubs may perform well when traveling at low speeds, but chassis movement routinely requires high-speed highway travel that results in high tire stresses. Bias-ply tires may simply show few visual sign of surface defects during roadside inspections. Instead, they might experience sudden and catastrophic failure ("blow-outs") while traveling at high speeds on the roadway. Further engineering study focusing on the construction and safety of the bias-ply tires used on intermodal chassis is needed.

The data used in this study was influenced by a few factors that might skew some of the results. One factor that could have affected the data was that the five intermodal carriers whose data we used rely mostly on owner-operators to transport cargo. Owner-operators usually do not maintain their tractors as well as an established carrier would maintain its vehicles. This could have resulted in the greater number of violations among intermodal tractors than among non-intermodal tractors. Another factor is that the sampling method used for determining which vehicles to select for inspection is not random. The inspectors of commercial motor vehicles tend to select those vehicles that appear to be poorly maintained, and they use a company's "safety score" to help distinguish companies with poor maintenance histories. Whether this selection bias toward companies known to be lax with maintenance affects both intermodal and non-intermodal vehicles equally is not known.

RECOMMENDATIONS FOR IMPROVING THE COLLECTION OF CHASSIS DEFECT RELATED DATA

So that a robust database can be developed for statistical analysis, there should ideally be a uniform procedure for chassis inspection and the storage of data related to chassis defects for all states. This would benefit both the Federal Motor Carrier Safety Administration and state agencies involved with the inspection of commercial motor carriers.

The implementation of the 2006 FMCSA proposal to amend a number of requirements in the Federal Motor Carrier Safety Regulations by the rulemaking entitled "Inspection, Repair, and Maintenance Requirements for Intermodal Container Chassis Equipment Providers" would be beneficial. Some of the changes included in the proposed rule would require intermodal equipment providers to identify themselves by submitting a Motor Carrier Identification Report, to display a USDOT identification number on their intermodal equipment, and to establish and maintain documentation of a systematic inspection, repair, and maintenance program to ensure the safe operating conditions of each chassis. This rule proposal would also identify a specific list of intermodal equipment items or components that the driver would be responsible for inspecting and determining if they are in good working order before operating the intermodal equipment. This proposed rule would enable the FMCSA to monitor more effectively the safety performance profile of intermodal equipment providers by allowing the violations of intermodal equipment found at roadside inspections to be directly tied to the entity controlling its inspection, maintenance, and repair, as well as its transfer to motor carriers.

Another recommendation would be the permanent addition of "intermodal chassis" (IC) as a vehicle unit type in all federal and state roadside inspection forms. This would allow researchers to better identify intermodal COC inspections and violations from those of non-intermodal semitrailers. The addition of this vehicle unit type would require that all federal and state motor carrier inspectors be advised of the change and for them to be properly trained in distinguishing between intermodal chassis and non-intermodal semitrailers.

RECOMMENDATIONS FOR IMPROVING THE COLLECTION OF CHASSIS CRASH DATA

A uniform procedure for the collection of chassis crash data and the storage of data related to chassis crashes for all states would facilitate statistical analysis. The implementation of uniform crash reports for all federal, state, and local agencies would be an excellent first step. These reports should include "intermodal chassis" as a vehicle type so that an intermodal COC could be distinguished from non-intermodal semi-trailers. Implementation would require that all federal, state, and local crash inspectors and police be advised of the change and properly trained in distinguishing between intermodal COC and non-intermodal semi-trailers.

A uniform procedure among the states for chassis inspection and the storage of data related to chassis defects would facilitate statistical analysis of crash data.

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APPENDIX A. TESTING FOR THE DIFFERENCE BETWEEN TWO SAMPLE PROPORTIONS

The statistical analysis performed for this study involves ‘proportions’ such as ‘out of service rate’ and ‘proportion of violations’ of a particular type; and the question that this study attempted to answer is whether these proportions are significantly different for intermodal and non-intermodal semi-trailers respectively. These proportions were estimated based on samples of data. The statistical test involves hypotheses related to the difference between two sample proportions.

Using the following notations:

(a) x_1 and x_2 are the number of successes (cases) observed for each type of chassis (semi-trailer) in large independent random samples of size n_1 and n_2 respectively, and

(b) p_1 [$=x_1/n_1$] and p_2 [$= x_2/n_2$] are the corresponding probabilities for success on an individual trial,

the sampling distribution of the difference between the two sample proportions [$x_1/n_1 - x_2/n_2$] can be approximated with a normal distribution having the mean $p_1 - p_2$ and the standard deviation of:

$$\sqrt{\left(\frac{p_1(1-p_1)}{n_1}+\frac{p_2(1-p_2)}{n_2}\right)}$$

Figure 3. Equation 1.

Using the above formulation, we can now base large-sample z-tests concerning the equality of two sample proportions. For the OOS rates, violations per inspection, and crash rates, which were examined in this study, the null and alternative hypotheses for testing the difference between intermodal and non-intermodal proportions are:

$$H_0 : p_1 - p_2 = 0$$
$$H_1 : p_1 - p_2 \neq 0$$

Figure 4. Equation 2.

The test statistic used to test this null hypothesis is:

$$z = \frac{\frac{x_1}{n_1} - \frac{x_2}{n_2}}{\sqrt{p(1-p)\left(\frac{1}{n_1}+\frac{1}{n_2}\right)}}$$

Figure 5. Equation 3.

where,

$$p = \frac{x_1 + x_2}{n_1 + n_2}$$

Figure 6. Equation 4.

is the pooled sample proportion.