Comprehensive Cost of Rail Incidents in North Carolina

December | 2020

RESEARCH & DEVELOPMENT

Comprehensive Cost of Rail Incidents in North Carolina

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NCDOT Project 2020-44

FHWA/NC/2020-44

December 2020

Technical Report Documentation Page

1. Report No. **FHWA/NC/2020-44**	2. Government Accession No.	3. Recipient's Catalog No.
4. Title and Subtitle **The Comprehensive Cost of Rail Incidents in North Carolina**		5. Report Date **December 28, 2020**
		6. Performing Organization Code
7. Author(s) **Steven Bert, MA, AICP; Claire Keller; Olivia Parsons; Max Randall; James Poslusny, BS; Abhinay Lahare, MS; Manas Salunke, MS; Sarah Searcy, MA; Daniel Findley, PhD, PE**		8. Performing Organization Report No.
9. Performing Organization Name and Address **Institute for Transportation Research and Education** **North Carolina State University** **Centennial Campus Box 8601** **Raleigh, NC**		10. Work Unit No. (TRAIS)
		11. Contract or Grant No.
12. Sponsoring Agency Name and Address **North Carolina Department of Transportation** **Research and Development Unit** **104 Fayetteville Street** **Raleigh, North Carolina 27601**		13. Type of Report and Period Covered **Draft Final Report** **August 2019- December 2020**
		14. Sponsoring Agency Code **2020-44**
Supplementary Notes:		

16. Abstract

This research provides a comprehensive appraisal and cost tool for the broad spectrum of events occurring on North Carolina's rail network. It evaluates costs associated with property damage, casualty, and delay, rerouting, and supply chain events. It also analyzes upstream effects, emissions costs, railroad operating costs, and emergency responder costs. FRA safety database records are used to inventory rail incidents that have occurred in North Carolina, while a collection of journal articles, reports, and other data sources such as Amtrak delay records, American Association of Railroads repair and maintenance costs schedules, and public safety answering point data are used for the analysis.

In 2019, there were 187 rail incidents in North Carolina, imposing a total estimated cost of approximately $258.3 million. Of the costs incurred, casualties comprised the largest cost component valued at a cost of $252,816,000. Property damage costs were approximately $3,651,000; costs associated with delay, rerouting, and supply chain disruptions were approximately $1,572,000; emissions costs were $131,000; operating costs were $73,000; and first and emergency responder costs were an estimated $60,000. From 2010-2019, rail incident costs in North Carolina totaled an estimated $2.4 billion.

Policymakers often underestimate the costs of rail incidents and are thus less inclined to allocate scarce resources to rail safety countermeasures. Thus, accompanying this research, the NCDOT Rail Division will be acquiring a cost tool that can be used to estimate the costs associated with the broad spectrum of events that occur on North Carolina's rail network. The tool can be used to tabulate costs resulting from an individual event or to aggregate costs over a specified time period. Additionally, the tool can be updated as needed with more recent data, making it a living tool that can be useful for years to come.

17. Key Words **Rail, Accidents, Incidents, Crashes, Costs, Equipment Damage, Casualty Costs, Delay and Rerouting Costs, First Responder Costs, Emergency Costs**	18. Distribution Statement		
19. Security Classif. (of this report) Unclassified	20. Security Classif. (of this page) Unclassified	21. No. of Pages **96**	22. Price

Form DOT F 1700.7 (8-72) **Reproduction of completed page authorized**

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Acknowledgements

This research was made possible through ongoing collaboration with the NCDOT Rail Division, including invaluable input by Roger Smock, Alix Demers, Jahmal Pullen, Chris Raichle, and other Rail Division staff. Additionally, Jim Blaze, economist and author at Freightwaves, provided meaningful guidance to the research team, including methodological suggestions for appraising delay and rerouting costs. Shay Callahan, Principal Economist of the Association of American Railroads, provided train component repair and replacement cost schedules, which became key

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inputs for the Comprehensive Costs of Rail Incidents cost tool, which accompanies this research effort. Furthermore, public safety personnel in over 20 counties in North Carolina offered interviews or provided computer aided dispatch records of rail incidents, which were integral to the appraisal of first responder and emergency management costs. Finally, this work was largely made possible due to the groundbreaking research undertaken by the project team for the National Cooperative Highway Research Program Report 755. That report established a number of the fundamental methodologies and approaches used to appraise the comprehensive cost of rail incidents.

Photo source: NCDOT

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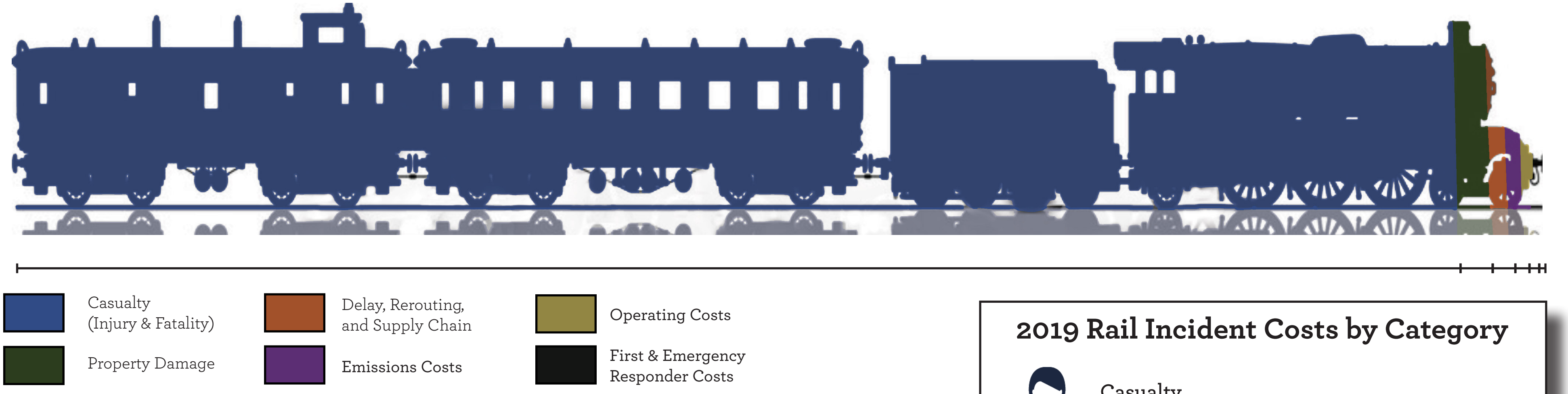
Composition of Rail Incident Costs



Executive Summary

North Carolina's rail network spans over 3,200 miles. It serves five national train routes, two state-supported routes, two Class I railroads, and over 20 short line railroads, which transport thousands of passengers and move over 85 million tons of cargo annually.[1,2] Rail safety not only protects rail passengers traveling to work, leisure, and other destinations, but it also helps protect the $143 billion of goods carried across North Carolina's rail network each year.[3]

In North Carolina, railroad safety incidents have declined notably from 1990 to 2019, falling from 451 total incidents in 1990 to 187 incidents in 2019.[4] However, a closer examination of rail incidents reveals that North Carolina has not sustained safety gains since 2010, averaging 187 rail incidents annually and resulting in 130 injuries and 22 fatalities (see Figures 1 and 2).

A broad spectrum of rail incidents occur on North Carolina's railroad network, including crashes between train and highway users at grade-crossings, collisions on the railroad right-of-way, and trespass or other events along the state's rail corridors. These events may result in physical property damage, health costs associated with injuries or fatalities, and other economic or social costs including supply chain, emissions, and operating costs resulting from incident delay or cargo damage.

In 2019, there were 187 rail incidents in North Carolina, imposing a total estimated cost of approximately $258.3 million. Of the costs incurred, casualties comprised the largest cost component valued at a cost of $252,816,000 (injuries: $13,200,000 | fatalities: $239,616,000), which resulted from 96 injuries and 24 fatalities.

2019 Rail Incident Costs by Category

Casualty (Injury & Fatality)	$252,816,000
Property Damage	$3,651,000
Delay, Rerouting, and Supply Chain	$1,572,000
Emissions Costs	$131,000
Operating Costs	$73,000
First & Emergency Responder Costs	$60,000

Total Costs: $258,303,000

Source: ITRE Analysis

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[1] North Carolina Statewide Multimodal Freight Plan. *Cambridge Systematics.* 2017.
[2] Amtrak Fact Sheet, Fiscal Year 2017: State of North Carolina.
[3] North Carolina Statewide Multimodal Freight Plan. *Cambridge Systematics.* 2017.
[4] Federal Railroad Administration. "Ten Year Accident / Incident Overview by Calendar Year."

Continued from Executive Summary

Property damage costs were approximately $3,651,000; costs associated with delay, rerouting, and supply chain, and upstream and downstream disruptions were approximately $1,572,000; emissions costs were $131,000; operating costs were $73,000; and first and emergency responder costs were an estimated $60,000. **Over the ten-year period from 2010-2019, rail incident costs in North Carolina totaled an estimated $2.4 billion (valued in $2020).**

Figure 1: Prevalence of Rail Incidents from 2010-2019

Category	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	Total	Average
Highway-Rail Incidents	49	45	45	56	52	68	39	43	56	53	506	50.6
Train Incidents (Not at Grade-Xings)	23	20	21	20	30	23	20	23	35	26	241	24.1
Other Incidents	103	100	96	138	123	110	120	123	102	108	1,123	112.3
Totals Incidents	175	165	162	214	205	201	179	189	193	187	1,870	187.0

Source: FRA 2010-2019

Figure 2: Summary of Rail Injury and Fatality Events from 2010-2019

Category	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	Total	Average
Total Injuries	128	115	126	150	132	205	119	133	111	96	1,315	131.5
Total Fatalities	19	16	16	25	24	22	27	19	31	24	223	22.3
Highway-Rail Incident Deaths	*1*	*3*	*2*	*7*	*5*	*9*	*4*	*5*	*12*	*5*	*53*	*5.3*
Train Incident Deaths (Not at Grade-Xings)	*0*	*2*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*2*	*0.2*
Trespass Incident Deaths	*18*	*11*	*14*	*17*	*19*	*13*	*23*	*14*	*18*	*19*	*166*	*16.6*
Other Incident Deaths	*0*	*0*	*0*	*1*	*0*	*0*	*0*	*0*	*1*	*0*	*2*	*0.2*

Source: FRA 2010-2019

Figure 3: Summary of Rail Incident Costs from 2010-2019 (in $2020)

Year	Casualty Costs[1]	Equipment Damage[2]	Delay, Rerouting & Supply Chain[3]	Emissions Costs[4]	Operating Costs[5]	Emergency Responder Costs[6]	Total Costs
2010	$207,296,000	$7,945,000	$776,000	$102,000	$59,000	$63,000	$216,241,000
2011	$175,556,500	$3,631,000	$1,074,000	$112,000	$64,000	$143,000	$180,580,500
2012	$177,069,000	$2,624,000	$658,000	$95,000	$55,000	$74,000	$180,575,000
2013	$270,225,000	$3,195,000	$1,531,000	$146,000	$83,000	$74,000	$275,254,000
2014	$257,766,000	$3,507,000	$1,449,000	$141,000	$81,000	$160,000	$263,104,000
2015	$247,835,500	$4,849,000	$1,484,000	$140,000	$80,000	$90,000	$254,478,500
2016	$285,930,500	$2,919,000	$1,222,000	$117,000	$67,000	$68,000	$290,323,500
2017	$177,069,000	$2,663,000	$1,082,000	$121,000	$69,000	$62,000	$181,066,000
2018	$324,766,500	$10,554,000	$2,585,000	$169,000	$96,000	$164,000	$338,334,500
2019	$252,816,000	$3,651,000	$1,572,000	$131,000	$73,000	$60,000	$258,303,000
Total	$2,376,330,000	$45,538,000	$13,433,000	$1,274,000	$727,000	$958,000	$2,438,260,000

Source: ITRE Analysis

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[1] Monetized cost of injuries using the KABCO injury scale at unknown injury severity and the USDOT value of statistical life for fatalities (see "Monetized Casualty Costs" for methodology)

[2] Equipment damage reported on FRA form 6180.54 and 6180.57 (Train Accidents and Highway-Rail Accidents) from 2010-2019, converted to $2020 (see "Property Damage Costs" for methodology)

[3] Includes value of time for passengers and workers, opportunity, spoilage, useful life, and replacement costs for cargo, and up/downstream delay effects (see "Delay, Rerouting, and Supply Chain Costs" for methodology)

[4] Includes emissions costs resulting from additional locomotive runtime (see "Additional Emissions Costs" for methodology)

[5] Includes fuel and ownership costs resulting from additional locomotive runtime (see "Additional Operating Costs" for methodology)

[6] Includes first responder and emergency personnel and equipment costs resulting from an incident (see "First Responder and Emergency Management Costs" for methodology)

About the Research

This research develops methodologies and a cost tool for estimating and forecasting the comprehensive cost of rail incidents. This information can be used to help illuminate the social and economic impacts to North Carolina and to provide support for countermeasures and expanded safety training.

To the greatest extent possible, the research team used North Carolina specific data to develop the methodology and tool. This included extracting North Carolina specific incident records from the Federal Railroad Administration (FRA) safety database. FRA records from 1990 to 2019, reported via forms 6180.54, 6180.55a, and 6180.57, were used to develop cost projections for property damage and the monetized cost of casualties (injuries and fatalities). The research team corresponded with North Carolina's public service answering points (PSAPs) to develop emergency response cost projections, based on the information provided PSAPs provided through phone interviews, email correspondence and computer aided dispatch (CAD) records. Delay and rerouting costs were developed using a wide array of appraisal methodologies and data sources assembled through the literature and data review component of this research. Additionally, findings from NCHRP 755 and other key literature sources were used as methodological anchors for this research.

It should be noted that the FRA database contains records of safety incidents that are generally not included in rail incident totals reported by NCDOT. These types of incidents are classified as "other incidents" by the FRA and generally result from accidents that occur independently of railroad crashes, collisions, or other events caused by railroad operational issues. These include (but are not limited to): a railroad employee spraining an ankle while dismounting from a train, or accidentally cutting themselves on a sharp edge while on duty; a train passenger tripping over a bag in the aisle, or slipping and falling down the stairs while disembarking; an incident caused by an intoxicated passenger.

These incidents do meet the reporting criteria of the FRA and may result in injury costs, network delays, or other costs. For that reason, all FRA reported incidents were included in this report. However, it should be noted that the rail-related casualty numbers discussed in this study may be higher than what NCDOT typically reports.

Photo source: NCDOT

Introduction

Over the past three decades, train incidents have fallen notably across the United States, from 90,653 incidents in 1978 to 11,701 incidents in 2019 (a decrease of 87 percent).[1] North Carolina's rail safety track record has mirrored the national trend with 1,249 incidents in 1978 and 187 in 2019 (a decrease of 85%).[2] Causes for these improvements have included greater investment in railroad infrastructure in the 1980s (resulting from a more profitable economic climate for freight railroads following deregulation under the Staggers Act), enhanced safety awareness and safety program implementation on the part of railroads and their employees, the implementation of engineering countermeasures (such as at-grade investments and redesigns or positive train control applications that enable automatic risk detection and braking), and safety performance monitoring and standard setting (most Federal Railroad Administration (FRA) safety rules were issued during this period).[3,4] Though the overarching trend paints a great success story, a closer examination of rail safety data demonstrates a pronounced deceleration of safety advances.

Over the past decade, rail safety improvements have plateaued and have even shown incremental movement in the wrong direction. Railroad operations in the United States resulted in 11,631 incidents in 2010, compared to 11,701 incidents in 2019 with an annual average of 11,700

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1. FRA. "Ten Year Accident / Incident Overview." Online: https://safetydata.fra.dot.gov/OfficeofSafety/publicsite/Query/TenYearAccidentIncidentOverview.aspx
2. Ibid.
3. FRA. "FRA's Current Safety Regulations and Rulemaking Proceedings: Appendix I." Online: https://www.transportation.gov/testimony/fras-current-safety-regulations-and-rulemaking-proceedings
4. FRA. "Role of Human Factors in Rail Accidents." Online: https://www.transportation.gov/testimony/role-human-factors-rail-accidents

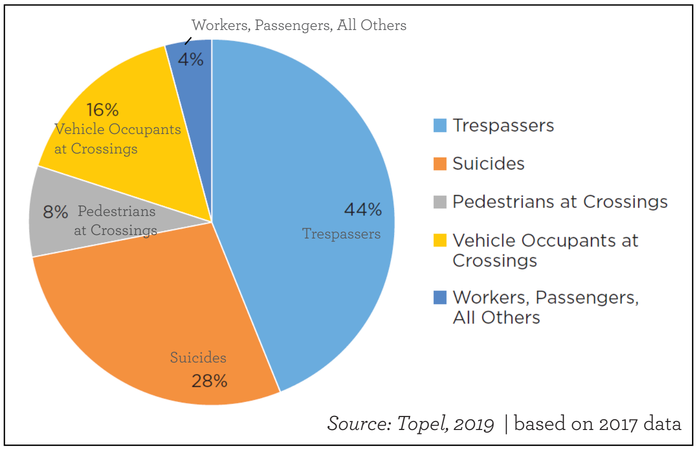
incidents over the 10-year time period.[5] A similar flatlining trend appears in North Carolina, with 175 incidents in 2010 and 187 incidents in 2019 with an annual average of 187 incidents over the 10-year period (see Figure 1).[6]

Railroad casualty events have also remained relatively unchanged over the last decade (see Figure 2). North Carolina averaged 22.3 fatalities and 131.5 injuries, annually, from 2010-2019, with 24 fatalities and 96 injuries in 2019.[7] This equates to a train incident every 1.9 days, an injury every 2.7 days, and a fatality every 15.2 days on North Carolina's rail network.

Railroad safety funding often competes with other transportation needs at both the state and federal levels. This can be problematic because policymakers often underestimate the costs of rail incidents and are thus less inclined to allocate scarce resources to rail safety countermeasures.[8] Research suggests that this has been the case for at-grade rail crossings, which are a primary source of rail incidents in North Carolina (53 of 187 incidents in 2019; 28.3%). [9]

Crashes between trains and road vehicles typically are more severe and more costly than highway crashes. For example, less than one (1) percent of police-reported highway crashes involve fatalities, compared with roughly 10 percent of highway-rail crashes.[10] In addition, the costs of highway-rail crashes can extend well beyond the usual costs of general highway crashes because of (a) damage to railroad equipment and infrastructure; (b) the potential disruption of rail passenger service and the logistics supply chain; and (c) the potential for very rare, catastrophic events, such as multi-passenger casualties or hazardous material (hazmat) spills with major environmental or human health impacts.[11] The persistence of grade crossing safety issues and the necessity of competing for ever-scarcer surface transportation funds suggest the need for refining methods for measuring the costs of highway-rail grade crossing crashes.[12]

Figure 4: Composition of Fatal Rail Incidents



Source: Topel, 2019 | based on 2017 data

Pedestrian rail strikes are even more prevalent than highway-rail collisions. Crossing deaths of pedestrians, as opposed to those of motor vehicle occupants, have increased from approximately 10 percent of total crossing deaths in the late 1970s to 35 percent in the middle 2010s.[13] Rail trespass and suicides comprise over three-quarters of total U.S. rail fatalities, accounting for 79 percent (19 of 24) of North Carolina's rail incident fatalities in 2019.[14,15] As opposed to other rail fatality events, there has been no improvement in the number of rail trespass and suicide deaths since 1975 (see Figure 5).[16]

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5. Federal Railroad Administration. "Ten Year Accident / Incident Overview." Online: https://safetydata.fra.dot.gov/OfficeofSafety/publicsite/Query/TenYearAccidentIncidentOverview.aspx

6. Ibid.

7. ITRE Analysis of the following FRA Source. Federal Railroad Administration. "Ten Year Accident / Incident Overview." Online: https://safetydata.fra.dot.gov/OfficeofSafety/publicsite/Query/TenYearAccidentIncidentOverview.aspx

8. Transportation Research Board. "NCHRP Report 755: Comprehensive Cost of Highway-Rail Grade Crossing Crashes." 2013. Online: http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_755.pdf

9. Federal Railroad Administration. "Ten Year Accident / Incident Overview." Online: https://safetydata.fra.dot.gov/OfficeofSafety/publicsite/Query/TenYearAccidentIncidentOverview.aspx

10. Transportation Research Board. "NCHRP Report 755: Comprehensive Cost of Highway-Rail Grade Crossing Crashes." 2013. Online: http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_755.pdf

11. Ibid.

12. Ibid.

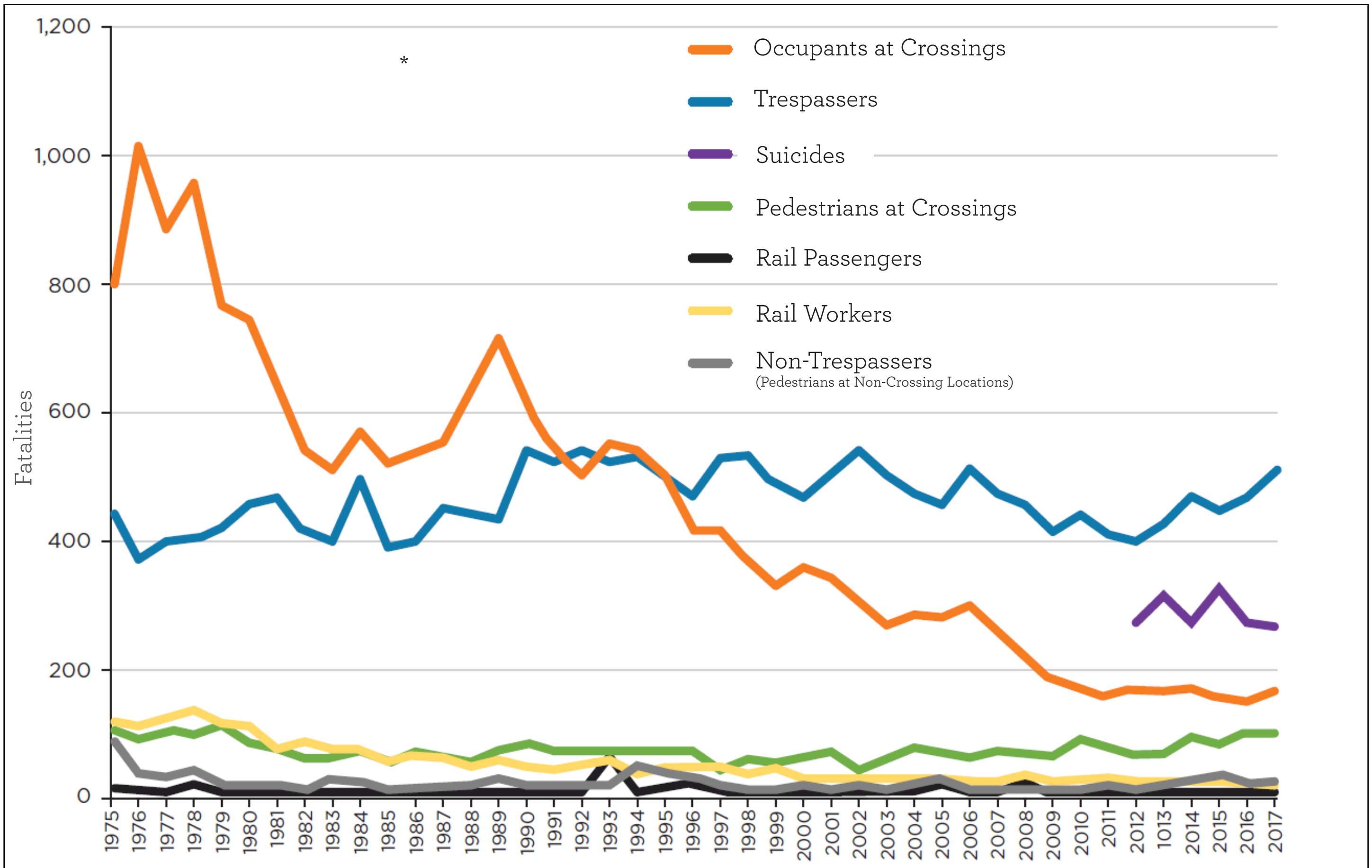
13 Topel, Kurt. "Scope and Trend of U.S. Rail Trespassing and Suicide Fatalities." TR News. 2019. Online: http://www.trb.org/Publications/Blurbs/179487.aspx

14. Ibid.

15. Federal Railroad Administration. "Ten Year Accident / Incident Overview." Online: https://safetydata.fra.dot.gov/OfficeofSafety/publicsite/Query/TenYearAccidentIncidentOverview.aspx

16. Topel, Kurt. "Scope and Trend of U.S. Rail Trespassing and Suicide Fatalities." TR News. 2019. Online: http://www.trb.org/Publications/Blurbs/179487.aspx

Figure 5: Rail Fatalities in the United States over Time (1975-2017)



*Before 2011, Federal Railroad Administration (FRA) policy deemed suicides to be an exception to reporting requirements. Therefore, the number of rail suicide deaths before 2012—the year FRA began to release total year figures—is unknown.

Source: Topel, 2019

More recently, railcar switching operations have been receiving focus due to their higher proclivity for accidents, injuries, and fatalities among railroad workers. Switching occurs when railcars are moved from one location to another for purposes such as storing cars or joining train cars for upcoming cargo movements. Since 1992 there have been more than 210 switching operation fatalities; from January 01 to August 31, 2020 there were 159 switching injuries reported in the United States.[17]

At-grade collisions, pedestrian strikes, and railcar switching operations are a key subset of the many types of rail incidents that occur on North Carolina's rail network. In addition to these types of incidents, understanding the full costs associated with all rail events can help put into perspective the social and economic importance of rail safety. After an extensive literature and data review (see the "Literature Review" section), the research team found that there are five primary cost categories that should be appraised when evaluating the comprehensive cost of rail incidents in North Carolina. The categories include:

- Physical Property Damage
- Monetized Cost of Injury and Fatality
- Delay, Rerouting, and Supply Chain Costs
  - Value of Time (passenger and crew)
  - Shipper Costs (opportunity, spoilage, useful life)
  - Cargo Replacement Costs
  - Upstream and Donstream Delay Costs
- Additional Operating Costs
- Additional Emissions Costs

These cost components are defined and their appraisal methodologies are discussed in the "Rail Incident Components" section of the report.

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[17] Marsh, Joanna. "Three rail switching-related fatalities prompt warning." FreightWaves. December 2020.

Photo source: NCDOT

Literature Review

Context. A combination of 82 journal articles, industry papers, reports, research syntheses, online documentation, and other sources were reviewed to provide context for evaluating the comprehensive cost of rail incidents in North Carolina. The literature was reviewed to gather information that may assist in the identification, qualification, and quantification of the various types of railroad incidents and their associated costs. Resources reviewed provided context and background of crash events, as well as information pertaining to events yielding property damage, injuries and fatalities, and delay costs.

The literature review was undertaken to gather information that assisted in developing a methodology for estimating and forecasting the comprehensive cost of rail incidents, helped illuminate the social and economic impacts to North Carolina, and provided support for countermeasures and expanded safety training. Literature and data sources established key inputs, approaches, and methodologies to appraise rail costs.

Key Takeways. Passenger and freight rail operations impose internal costs upon their network infrastructure, employees, and passengers, as well as external costs on society, which can occur through accidents, emissions, noise, and fluctuations in travel time reliability (Forkenbrock, 1999; FRA, 2016; Brod et al., 2013).

Various sources document rail accident costs and the Federal Railroad Administration (FRA) keeps a robust catalogue of train incidents from the 1970s to the present day. The FRA keeps records on the occurrences of physical property damage, injuries, and fatalities, among other incident types to maintain alignment with OSHA's recordkeeping and recording regulations (FRA, 2011). FRA safety records can be analyzed to assess property damage and casualty incident costs. Injury severity scales

Photo source: NCDOT

(KABCO or MAIS) are recommended by USDOT (2020) to estimate the health costs associated with injuries and fatality events.

There have been many attempts to determine the delay costs to railroads, which have resulted in values ranging from $200 to over $1,000 per incident (Schafer and Barkan, 2008; Dingler et al., 2011; Schlake et al., 2011; Lai and Barkan 2009; RSAC, 1999; Smith et al., 1990), but these do not appear to have considered all of the operational costs. Specific costs of train delay have been identified for individual public-private capital projects, such as the Tower Surface Improvement Project (BNSF Railway Company, 2015), and some guidance is given for its calculation by the United States Department of Transportation. Lovett et al. (2015) demonstrate appraisal methodologies for a number of delay cost components, including emissions and operating costs. Brod et al. (2013) and Winston and Shirley (2004) discuss appraisal methodologies for delay, rerouting, and supply chain costs. These costs are manifested in the declining value of goods (useful life), the cost of holding inventory due to uncertainty in delivery times (reliability), rerouting and warehouse costs, cargo spoilage and replacement, as well as the opportunity cost of capital stock.

Crash frequencies and risk have been evaluated by Lu et al. (2016), Macciotta et al. (2017), S.B. Ismail (2016), Liu et al. (2012), Mokkapati et al. (2009), among other researchers. Interventions such as safety-critical control system, track infrastructure improvements, and interventions to mitigate accidents caused by human factors are discussed and can be used in incident forecasting or benefit-cost analysis. Research findings from Lu et al. (2016) demonstrated that rail collision rates have declined from 2000 to 2014 and that the relationship between collision frequency and traffic exposure varies based on the category of the collision. Lu et al. (2016) create a statistical model for collision risk that can be used to determine effectiveness of safety measures. Their methodology can be repurposed for numerous other areas of interest, such as transporting hazardous materials, train derailments, and the consequences of other rail incidents.

The full Literature Review can be found in the appendices (A-22).


Photo source: NCDOT

Incident Cost Components

Property Damage. Occurring at highway-railroad grade crossings or elsewhere on the railroad right-of-way, railroad incidents may result in a wide range of property damage costs. For example, at-grade collisions may result in high severity events that impact cars, trucks, buses, trains, surface transportation infrastructure, and hazardous materials. On the opposite end of the spectrum, train movements producing friction and heat may create a brush fire in the railroad right-of-way, which may have relatively low property damage costs.

An analysis of FRA incident records was used to estimate the property damage costs resulting from rail events in North Carolina. Each record contained the estimated property damage that had resulted from the train incident being documented. Observations from 1990 to 2019 (documented in FRA form 6180.54) were used, and the property damage values were converted to 2020 dollars. It was found that rail property damage incidents in North Carolina have a wide range of impacts from an estimated $3,520 to $7.8 million per occurrence (see Figure 6).

There are a number of contributing factors that lead the variation in property damage costs. For this study, FRA safety database records were

Property Damage Cost Summary: A Decade in Review

Timeframe: 2010-2019

Total number of incidents: 1,870

Total estimated cost: $45,538,000

Review of 2019: In 2019 there were 187 rail incidents in North Carolina that resulted in an estimated $3,651,000 in property damages. There were 175 events that resulted in property damage costs less than $50,000 (ranging from $250 to $48,000), 7 events that resulted in property damage costs between $50,000 and $150,000 (ranging from $56,200 to $130,000); and 4 events that resulted in property damage costs above $150,000 (ranging from $168,100 to $742,000).

Figure 6: Summary Property Damage Cost Statistics of Rail Events in North Carolina*

Minimum	Percentile (10)	Percentile (25)	Mean	Median*	Mode	Percentile (75)	Percentile (90)	Maximum	No. of Observations
$3,520	$13,000	$17,370	$122,120	$31,920	$48,010	$79,820	$221,330	$7,869,740	1,125

*Estimates were obtained using 1,125 property damage records in North Carolina from years 1990-2020. Property damage occurrences were reported to the FRA through form 6180.54.

Source: ITRE Analysis

Figure 7: Regression Analysis Summary Output for Rail Events in North Carolina*

Variable	Additional Cost per Unit Occurence	R^2 value	Model P-value	Records Analyzed	Data Source
Train Car Releasing Hazmat	$332,662	0.99	<0.0001	97,184	FRA 6180.54 (1990-2019)
Locomotive Unit Derailed	$152,630	0.71	0.02	97,203	FRA 6180.54 (1990-2019)
Loaded Freight Car Derailed	$63,020	0.94	<0.0001	43,413	FRA 6180.54 (1990-2019)
Empty Freight Car Derailed	$30,760	0.78	<0.0001	27,159	FRA 6180.54 (1990-2019)
Train Car Derailed (Not Specified)	$54,000	0.86	<0.0001	97,160	FRA 6180.54 (1990-2019)

*Analyis was conducted using property damage records across the United States from years 1990-2020. Property damage occurrences were reported to the FRA through form 6180.54.

Source: ITRE Analysis

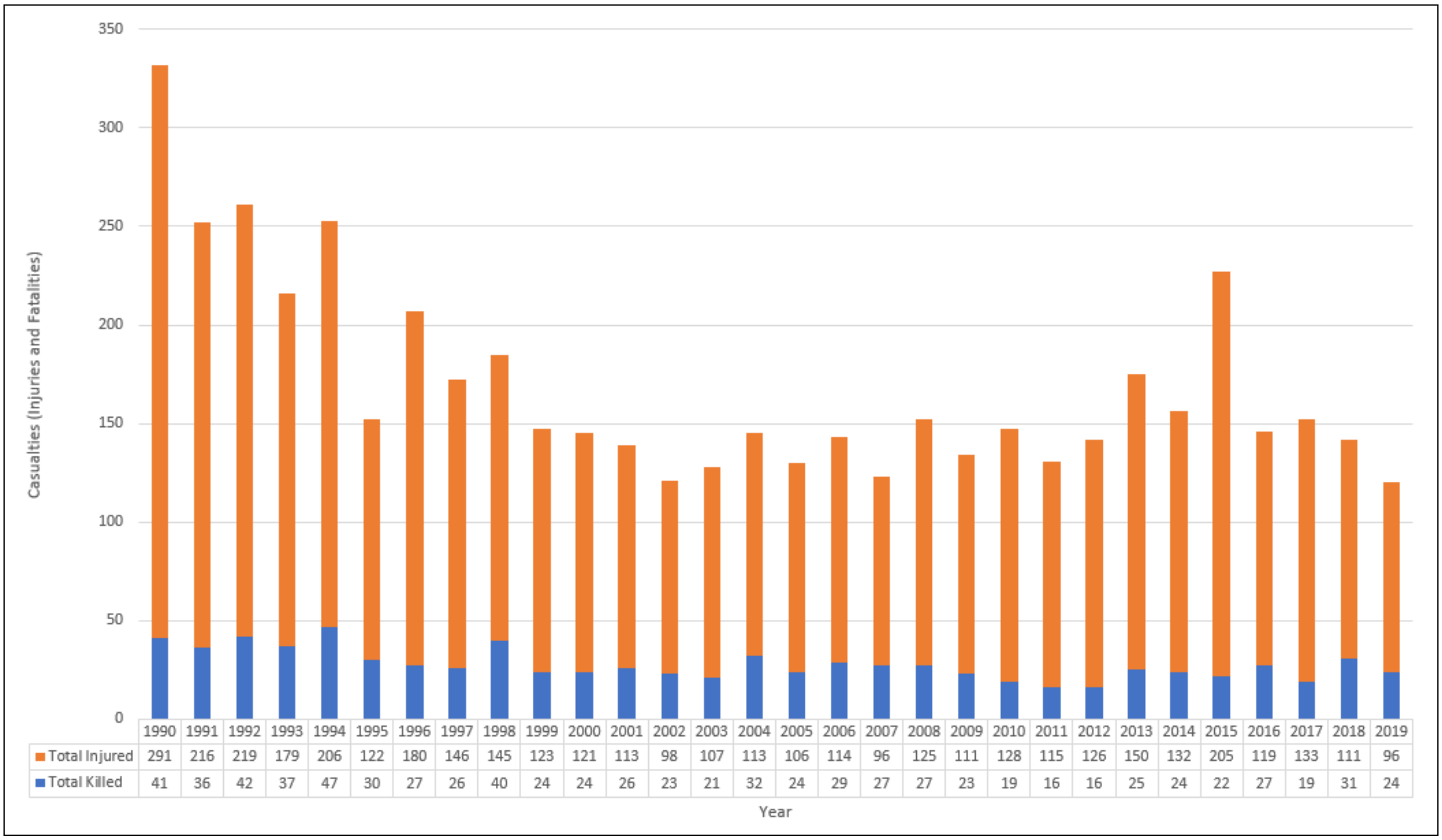
analyzed and over a dozen variables were tested to determine causal relationships between incidents and damages incurred. Property damage values were adjusted to 2020 dollars, and then the average property damage values per incident type were evaluated. Regression analysis was performed to test the relationship between variables recorded in the FRA safety database (form 6180.54 records) and property damage costs. Five variables were found to be statistically significant, with R-squared values > 0.71 (see Figure 7). These variables included:

- Number of train cars releasing hazardous materials
- Number of locomotive units derailed
- Number of loaded freight cars derailed
- Number of empty freight cars derailed
- Number of train cars derailed (type not specified)

Findings indicate that for every rail event that resulted in a rail car releasing hazmat, property damages increase by approximately $333,000. Findings also indicate a hierarchy of costs are associated with the varying magnitudes of train derailments. For every locomotive unit derailed, property damages increase by approximately $153,000. Furthermore, for every loaded freight car derailed, costs would go up by approximately $63,000, and for every empty freight car derailed, costs would increase by approximately $31,000. For additional information on the regression output for these variables, including trendlines, intercept values, and the number observations see the appendix (A-16).

In addition to projected rail incident cost values derived from econometric modeling, rail damage costs can be found using the American Association of Railroads' schedule of repair and maintenance costs. This list contains over 1,000 price estimates for repairing and replacing train components and is found in the appendix (see A-54).

Figure 8: Number of Injuries and Fatalities Resulting from Rail Incidents in North Carolina Over Time



	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
■ Total Injured	291	216	219	179	206	122	180	146	145	123	121	113	98	107	113	106	114	96	125	111	128	115	126	150	132	205	119	133	111	96
■ Total Killed	41	36	42	37	47	30	27	26	40	24	24	26	23	21	32	24	29	27	27	23	19	16	16	25	24	22	27	19	31	24

Source: FRA Ten Year Accident / Incent Overview, 1990-2019

Casualty Costs. Injury and loss of human life can be unfortunate consequences of rail incidents. These casualty events may occur from highway-rail collisions, train collisions, pedestrian strikes, or other incidents within the railroad right-of-way.

On North Carolina's rail network, the probability of an injury occurrence is once every 2.7 days, and the probability of a fatality occurrence is once every 15.2 days.[1] A review of casualty records kept by the FRA (form 6180.55a) demonstrates that casualty events have been decreasing since they were first recorded in the 1970s. However, the incidence of rail trespass injuries and fatalities has gone relatively unchanged since the 1970s.[2]

An analysis of FRA casualty records in conjunction with the appraisal methodology recommended within USDOT's Benefit Cost Analysis Guidance documentation was used to monetize casualty costs resulting from rail events in North Carolina.[3] The statistical value for an unknown injury event on the KABCO scale and USDOT's value of statistical life (adjusted to 2020 dollars) were used to estimate costs.[4]

Casualty Cost Summary:
A Decade in Review

Timeframe: 2010-2019

Total number of injuries: 1,315

Total number of fatalities: 223

Total estimated cost: $2,376,330,000

Review of 2019: In 2019, there were 119 rail incidents in North Carolina, resulting in 96 injuries and 24 fatalities. The monetized cost of injuries was approximately $13.2 million and the cost of fatalities was approximately $239.6 million for the year.

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1. Federal Railroad Administration. "Ten Year Accident / Incident Overview." Online: https://safetydata.fra.dot.gov/OfficeofSafety/publicsite/Query/TenYearAccidentIncidentOverview.aspx

2. Topel, Kurt. "Scope and Trend of U.S. Rail Trespassing and Suicide Fatalities." TR News. 2019. Online: http://www.trb.org/Publications/Blurbs/179487.aspx

3. Sources: FRA Form 6180.55a records and USDOT BCA Guidance for Discretionary Grant Programs. 2020. Online: https://www.transportation.gov/sites/dot.gov/files/2020-01/benefit-cost-analysis-guidance-2020_0.pdf

4. An injury event with unknown severity is monetized at $137,500 and a fatality is monetized at $9,984,000 in 2020 dollars.

Delay, Rerouting, and Supply Chain. A rail incident can create sizeable delays impacting train passengers, rail employees, freight cargo, as well as train movements upstream and downstream of the incident. Additionally, delays may result in increased locomotive engine runtime, leading to additional operating costs and air pollutant emissions. Major determining factors of delay often include the nature of the incident, its duration, and the need for (a) emergency services (e.g., ambulance, fire, and spill cleanup); (b) clearance of disabled or damaged vehicles; and (c) crash scene preservation for investigation.[1]

The FRA's databases do not indicate line disruption, duration, or the impact of the resulting delays to trains or passengers. Thus, determining the impacts of incident delay requires analyzing multiple data sources and implementing numerous appraisal methodologies. There are several cost components associated with delay that should be evaluated to obtain a comprehensive cost of rail incidents. These cost components include:

- **Value of Time Costs** for train and passengers and crew members experiencing delay.
- **Shipper Costs** for businesses waiting to unload or receive cargo that has spoiled, deteriorated, or has lost a portion of its useful life.
- **Cargo Replacement Costs** due to cargo that has been destroyed and requires replacement.
- **Operating Costs** for train operators who undergo additional engine runtime due to delay.
- **Emissions Costs** for additional train locomotive runtime resulting from a delay event
- **Up/Downstream Costs** for the value of time or shipper costs experienced by up/downstream freight or passenger trains, as the train incident's delay impacts extend to the next train operation(s).

Value of Time Costs. The US Department of Transportation conceptualizes travel time as having a negative demand. This is because consumers are willing to pay more to spend less time traveling.[2] The costs incurred from experiencing additional travel time adhere to three principles. First, time expended on travel could be dedicated to production, yielding a monetary benefit to either travelers or their employers. Second, it could be spent in recreation or other enjoyable or necessary leisure activities, which individuals value and are thus willing to pay for. Third, the conditions of travel during part or all of a trip may be unpleasant and involve tension, fatigue, or discomfort. Reducing the time spent while exposed to such conditions may be more valuable than saving time on more comfortable portions of the trip. These principles underlie the distinctions among values recommended in USDOT's benefit-cost analysis guidance.

The research team used USDOT's BCA guidance methodology to estimate time costs experienced by train passengers and crew members. This involves multiplying the quantity of time delayed by the hourly wage rate of the individual delayed.

Value of Time Costs =
(No. of Individuals) x
(Wage Rate) x
(Quantity of Time Delayed)

Summary of Costs from Incident-Related Delay: A Decade in Review

Timeframe: 2010-2019

Delay, Rerouting, & Supply Chain Costs[1]:	$13,433,000
Train Operating Costs:	$727,000
Train Emissions Costs:	$1,274,000
Total Costs from Incident-Related Delay:	**$15,434,000**

Review of 2019: In 2019, there were 187 rail incidents in North Carolina that resulted in number of delay-associated costs. This included $1,572,000 in delay, rerouting, and supply chain costs, $131,000 in emissions costs, and $73,000 in operating costs.

[1] This category includes shipper costs, which pertain to the amount of useful life cargo loses by being held up in transit from obsolescence, changes in market needs, and spoilage. It pertains to replacement costs which are applied to cargo that is damaged and requires resplacement. It also applies to the value of time costs for passengers and crew, as well as any similarly occuring upstream and downstream costs resulting from incident delay.

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1. Brod, Daniel et al. Comprehensive Costs of Highway-Rail Grade Crossing Crashes. Vol. 755. Transportation Research Board, 2013. Online: http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_755.pdf
2. USDOT. "Revised Value of Travel Time Guidance." 2016. Online: https://www.transportation.gov/sites/dot.gov/files/docs/2016%20Revised%20Value%20of%20Travel%20Time%20Guidance.pdf

Additional explanation of methodology and sources can be found in the appendices (A-02).

Shipper Costs (Opportunity, Useful Life, Spoilage). Railroad shippers incur inventory devaluation costs associated with delay. Every product has a useful life, either because it is perishable or becomes obsolete. The longer the good takes to arrive at the destination where it can be used, the less of that useful life is available for the end consumer. Different types of products have varying useful lives, and therefore different discount rates. For example, gravel could have a low discount rate because an additional day in transit would not have much effect on its useful life, but it would affect the shipper's ability to sell it.[3] However, fruit would have a much higher discount rate because it is perishable.[4] While these costs are incurred any time goods are transported, shippers are more concerned with irregular delays (resulting from rail incidents) because they result in additional transportation costs not already considered in their supply chain plans.

The research team used the appraisal methodology of Winston and Shirley (2004) to estimate shipper costs associated with rail delay. This methodology is implemented in NCHRP Report 755 and the research of Lovett et al. (2015). Shipper costs are calculated as follows:

Shipper Costs =
(Value of Freight Cargo per Ton) x
(Freight Tons per Carload) x
(Freight Carloads per Train) x
(Total Time of Cargo Delayed) x
(Cargo Discount Rate)

Consistent with freight delay research, only delays totaling 60 minutes or greater were assumed to accrue shipper costs. Further explanation of shipper cost methodologies and sources can be found in the appendices (A-04).

Cargo Replacement Costs. Cargo replacement costs accrue above and beyond shipper costs incurred from cargo loss of useful life and spoilage. These costs are applied to the specific cargo units within the train cars that have been badly damaged during a rail incident. Replacement costs are a direct function of the severity of the crash and secondarily of the fragility of the freight. As a general rule, cargo replacement will occur when (a) there is both substantial damage to rail cars, and (b) affected goods are manufactured products or perishables, versus bulk commodities.[5]

Cargo replacement costs are tabulated as follows:

Cargo Replacement Costs =
(Value of Freight Cargo per Ton) x
(Freight Tons per Carload) x
(Damaged Freight Cars per Incident) x
(Cargo Replacement Rate)

Further explanation of cargo replacement cost methodologies and sources can be found in the appendices (A-06).

Operating Costs. Similar to an automobile, train cars and locomotives are subject to wear and tear, fuel, and financing costs. The greater amount of time that train cars and locomotives are in use, the greater the operating costs. Lovett et al. (2015) estimate rail operating costs for locomotive ownership, leasing, and fuel, as well as the cost for operating other rail cars. Their research findings are used in conjunction with incident delays (see "Value of Time Costs") to estimated rail operating costs. Rail operating costs are estimated as follows:

Operating Costs =
[(Locomotive Ownership or Lease Cost) x
(No. of Locomotive Units) x
(Additional Runtime)] +
[(No. of Locomotive Units) x
(Locomotive Fuel Cost) x
(Additional Runtime)] +
[(Other Car Costs) x
(Additional Runtime)]

Further explanation of operating cost methodologies and sources can be found in the appendices (A-07).

Emissions Costs. Emissions costs include potential impacts to health, property value, and climate change. The cost of emissions and their appraisal methodologies are provided in the USDOT BCA Guidance document. When trains are delayed, they produce more locomotive emissions because they are on the railway for a longer duration of time. Based on the operating characteristics of the SD-70 locomotive and the USDOT emissions costs,

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[3] Lovett, A., Dick, C., Barkan, C. "Determining Freight Train Delay Costs on Railroad Lines in North American." 2015. Online: https://railtec.illinois.edu/wp/wp-content/uploads/2019/01/Lovett-et-al-2015-IAROR.pdf

[4] Winston, C. and Shirley, C. The Impact of Congestion on Shipper' Inventory Costs: Final Report to the Federal Highway Administration. February 2004. Online: https://www.fhwa.dot.gov/policy/otps/060320d/060320d.pdf

[5] Brod, Daniel et al. Comprehensive Costs of Highway-Rail Grade Crossing Crashes. Vol. 755. Transportation Research Board, 2013. Online: http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_755.pdf

Lovett et al. (2015) estimated the emissions costs for an average hour of locomotive operation.[6] Research findings from Lovett et al. (2015) are adjusted to 2020 dollars and used to appraise emissions costs. Emissions costs are estimated as follows:

» Emissions Costs = (Number of Locomotives) x (Additional Locomotive Runtime) x (CO2 cost per minute) x (NOx cost per minute) x (PM cost per locomotive minute)

Further explanation of cargo replacement cost methodologies and sources can be found in the appendices (A-06).

Upstream and Downstream Costs. Rail incidents that result in substantial delays may impact rail movements up/downstream. For example, severe incidents may require substantial emergency management and cleanup activities that close the train tracks to other scheduled train movements. Incidents may also lead to trip cancellations, or require train passengers to be rerouted via buses.

There are four primary categories of up/downstream costs for passenger and freight trains:

- Passenger and crew value of time costs imposed for the next scheduled passenger or freight train as it waits for the tracks to be cleared
- Delay and operational costs imposed for rerouting passengers via bus
- Delay and operational costs for cancelling a passenger train trip
- Cargo delay and rerouting costs imposed for the next scheduled freight train[7]

Further explanation of up/downstream cost methodologies and sources can be found in the appendices (A-07).

Emergency Responder Costs. These costs begin with a first responder unit being dispatched to the scene of an incident. Costs can then increase notably if police, paramedics, medical evacuation helicopters, fire suppression, or hazmat cleanup teams are needed to address a rail incident.

Major determining factors for emergency responder costs are the nature of the rail incident, its duration, and the need for emergency services, clearance of disabled or damaged vehicles, or crash scene preservation for investigation.

For this study, North Carolina's public safety answering points (PSAPs) provided information through phone interviews, email correspondence, and computer aided dispatch records. This information was used to estimate first responder costs in conjunction with findings from the literature and data review.

Emergency responder costs are tabulated as follows:

» Emergency Responder Personnel Costs = (No. Emergency Personnel) x (Value of Time) x (Time Involved with Incident)
» Emergency Responder Equipment Costs = (Quantity of Emergency Equipment) x (Equipment Time Costs) x (Time Involved in Incident)

Further explanation of emergency responder cost methodologies and sources can be found in the appendices (A-09).

Emergency Cost Summary
A Decade in Review

Timeframe: 2010-2019

Total estimated cost: $958,000

Review of 2019: In 2019, there were 187 rail incidents in North Carolina that resulted in a total $60,000 of emergency responder costs. Costs ranged from $100 to $1,330 per incident with emergency response times ranging from 18 minutes to 7 hours and 40 minutes (from dispatch to close). Emergency response personnel and equipment costs varied depending on the incident severity.

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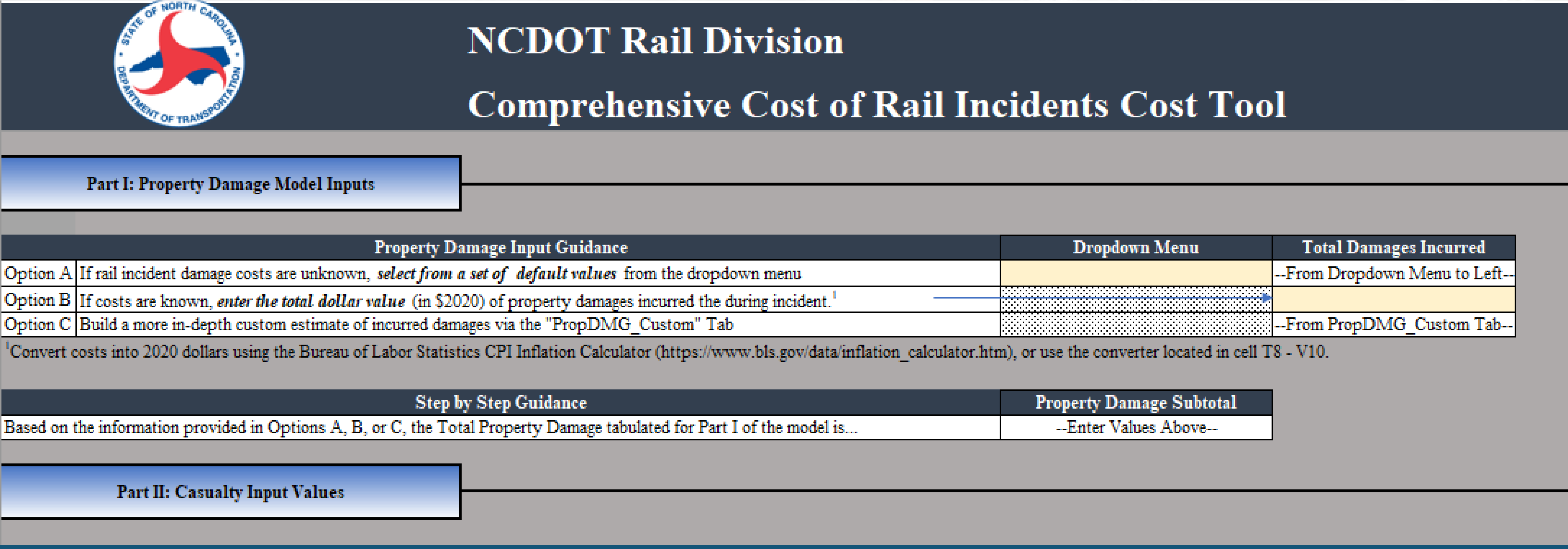
[6] See the Glossary (page A-75) for a description of the SD-70 locomotive.

[7] It should be noted that limited data were available for estimating upstream and downstream delay costs. Delays experienced by the next scheduled train departures were evaluated. However, the ripple effects of delay imposed upon other frequencies were unable to be obtained. For this analysis, upstream and downstream costs operate as a lower bound of the true costs of delay resulting from a train incident.



NCDOT Rail Division

Comprehensive Cost of Rail Incidents Cost Tool

Part I: Property Damage Model Inputs

Property Damage Input Guidance		Dropdown Menu	Total Damages Incurred
Option A	If rail incident damage costs are unknown, ***select from a set of default values*** from the dropdown menu		--From Dropdown Menu to Left--
Option B	If costs are known, ***enter the total dollar value*** (in $2020) of property damages incurred the during incident.[1]		
Option C	Build a more in-depth custom estimate of incurred damages via the "PropDMG_Custom" Tab		--From PropDMG_Custom Tab--

[1]Convert costs into 2020 dollars using the Bureau of Labor Statistics CPI Inflation Calculator (https://www.bls.gov/data/inflation_calculator.htm), or use the converter located in cell T8 - V10.

Step by Step Guidance	Property Damage Subtotal
Based on the information provided in Options A, B, or C, the Total Property Damage tabulated for Part I of the model is...	--Enter Values Above--

Part II: Casualty Input Values

Cost Estimation Tool

Rail incidents can result in property damage, injuries and fatalities, delay and rerouting, and emergency responder costs. Valuing the full spectrum of costs that result from an incident is critical for communicating the importance of rail safety and determining safety countermeasures that can help reduce these costs. As a culmination of the appraisal methodologies discussed and implemented in this report, a spreadsheet cost tool was created. The tool can be used estimate costs resulting from an individual event or it can be used to aggregate costs over a specified time period.

Cost Estimation Tool Video Tutorials

https://go.ncsu.edu/railcost_tutorials

Video tutorials for the *Comprehensive Cost of Rail Incidents: Cost Tool* can be accessed online. Tutorials provide overall guidance on how to use the tool and specific guidance for estimating property damage, injury and fatality, delay and rerouting, and emergency responder costs.

Flexibility was a key development criteria for the tool. It was built so that any known values for property damage, injuries and fatalities, delay and rerouting, or emergency responder costs could be readily inputted. Meanwhile, if values were unknown, then the tool comes equipped with expected cost values based on statistical averages, ranges, or modeled cost values. The tool was built to estimate the following costs associated with a rail incident:

- Property damage costs
- Injury and fatality costs
- Delay and rerouting costs
    - Passenger and freight train delay: value of time costs
    - Bus rerouting and additional value of time costs
    - Passenger and freight rail delay up/downstream costs
    - Shipper costs (opportunity, spoilage, useful life)
    - Replacement costs (damaged or destroyed cargo)
    - Passenger and freight rail operating costs
    - Passenger and freight rail emissions costs
- Emergency responder costs (personnel and equipment)

It was built to be an updatable, living tool that can be useful for years to come. Video tutorials that explain how to calculate property damage, injury, delay and rerouting, and emergency responder costs can be accessed online.


Photo source: NCDOT

Conclusions

Since the late 1970s, North Carolina rail incident costs have fallen substantially in real terms. This coincides with a decrease in rail incidents, which have resulted from higher levels of investment in rail infrastructure following rail deregulation in the 1980s, enhanced safety awareness programs, the implementation of engineering countermeasures, and safety performance monitoring and standard setting. Though the overarching trend seems to be one of success, a closer examination of rail safety data demonstrates a pronounced deceleration of safety advances.

From 2010-2019, rail safety improvements have plateaued. In 2010, there were 175 rail incidents compared to 187 incidents in 2019, with an annual average of 187 incidents over the 10-year period. Pedestrian strikes are a key contributor to this trend. Crossing deaths of pedestrians, as opposed to those of motor vehicle occupants, have increased from approximately 10 percent of total crossing deaths in the late 1970s to 35 percent in the middle 2010s. Rail trespass and suicides comprise over three-quarters of total U.S. rail fatalities and accounted for 79 percent (19 of 24) of North Carolina's rail incident fatalities in 2019.

In 2019, there were 187 rail incidents in North Carolina, imposing a total estimated cost of approximately $257.6 million. Meanwhile, from 2010-2019, rail incident costs in North Carolina totaled an estimated $2.4 billion.

Policymakers often underestimate the costs of rail incidents and are thus less inclined to allocate scarce resources to rail safety countermeasures. Thus, accompanying this research, the NCDOT Rail Division will be acquiring a cost tool that can be used to estimate the costs associated with the broad spectrum of events that occur on North Carolina's rail network. The tool can be used to tabulate costs resulting from an individual event or to aggregate costs over a specified time period. Additionally, the tool can be updated as needed with more recent data, making it a living tool that can be useful for years to come.

Appendices

Methodology Supplement

Figure 9: Estimated Passenger Train Delay Resulting from Rail Incidents in North Carolina (in Minutes)

Min	10th Percentile	25th Percentile	Median	Mode	75th Percentile	90th Percentile	Max	Count
15	24	35	74	49	110	174	334	119

Sources: FRA safety database records (forms 6180.54, 6180.57, and 6180.55a), Passenger delay records were retrieved from: "Amtrak Status Maps Archive Database: Historical Amtrak On-time Performance Data." Online: https://juckins.net/amtrak_status/archive/html/home.php

Figure 10: Estimated Freight Train Delay Resulting from Rail Incidents in North Carolina (in Minutes)

Low	Medium	High	Injury Event	Fatality Event	Rare, Very High Impact
35	43	84	83	284	925

Sources: See footnotes 2 and 3

Value of Time Costs. The research team used USDOT's BCA guidance methodology to estimate time costs experienced by train passengers and crew members. This involves multiplying the quantity of time delayed by the hourly wage rate of the individual delayed.

» Value of Time Costs = (No. of Individuals) x (Wage Rate) x (Quantity of Time Delayed)

Passenger and crew delay estimates were derived using third party data containing scheduled and actual Amtrak arrivals. Third party data were available from 2007 to 2019 and these data were paired with incidents within the FRA database. The research team used dates and time stamps to isolate 119 records that appeared to be a match between the third-partydata and the FRA database.[1] It was found that the median delay time resulting from a passenger train incident was approximately 74 minutes (see Figure 9).

Freight train crew delay estimates were assembled from computer aided dispatch (CAD) records, phone interviews, and email correspondence between the research team and Public Safety Answering Points (PSAPs) in North Carolina. The research team analyzed delay time associated with 40 train incidents in North Carolina with information provided by 20 computer aided dispatch records, six (6) phone interviews, and two (2) lines of email correspondence (see Figure 11).[2] These data were used to derive low, medium, and high estimates of delay. The research team also evaluated datapoints found within journal articles, news reports, and industry papers. Estimated delay times associated with injury, fatality, and rare, very high impact events, as documented in NCHRP Report 755 and a rail emergencies special report published by Homeland Security, were also included in the cost appraisal.[3]

It should be noted that the research team attempted to reach CSX and Norfolk Southern to obtain dispatch records for estimating train delay, but was unsuccessful. Further research would benefit from a more comprehensive dataset

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[1] Passenger delay records were retrieved from: "Amtrak Status Maps Archive Database: Historical Amtrak On-time Performance Data." Online: https://juckins.net/amtrak_status/archive/html/home.php

[2] CAD records offered time stamps for emergency responders from their time of dispatch to their time of "close" when the scene had been cleared. Phone interviews and email correspondence collected accounts of the total time it took emergency personnel to clear an incident. The total time from dispatch to close was used to quantify delay.

[3] Freight Train Delay Sources: Brod, Daniel et al. Comprehensive Costs of Highway-Rail Grade Crossing Crashes. Vol. 755. Transportation Research Board, 2013. http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_755.pdf
U.S. Fire Administration Technical Report Series - Special Report: Rail Emergencies. Homeland Security. February 2003. Online: https://www.usfa.fema.gov/downloads/pdf/publications/tr-094.pdf

Figure 11: Emergency Response Organizations and Types of Data Inputs Gathered

County / Organization	Recorded Events	Type
Guilford County	10	Computer Aided Dispatch
Lincoln County	5	Computer Aided Dispatch
Cumberland County	3	Computer Aided Dispatch
Burke County	2	Computer Aided Dispatch
Rutherford County	5	Phone Interview
Moore County	4	Phone Interview
Mitchell County	3	Phone Interview
Cleveland County	2	Phone Interview
Warren County	2	Phone Interview
Hoke County	1	Phone Interview
Wake County	1	Phone Interview
Pitt County	1	Phone Interview
Rockingham County	1	Phone Interview
Edgecombe County	Provided Context	Phone Interview
Forsyth County	Provided Context	Phone Interview
Granville County	Provided Context	Phone Interview
Macon County	Provided Context	Email Information
Perquimans County	Provided Context	Phone Interview
Stanly County	Provided Context	Phone Interview
Wilkes County	Provided Context	Email Information
NC Association of Police and Fire Chiefs	Provided Context	Phone Interview
21	40	

Average passenger train occupancy values were obtained from historic passenger surveys of North Carolina's state-supported Amtrak service routes (the Carolinian and Piedmont). These values were then used to estimate the number of passengers and crew members onboard a passenger train trip (see Figure 12). FRA safety database records were used to determine a freight train occupancy of two engineers.

Figure 12: Passenger Train Occupancies (Passengers and Crew)

Minimum	10th Percentile	25th Percentile	Median	Mode	75th Percentile	90th Percentile	Maximum	Count
6	13	14	17	14	21	25	275	3,100

Source: NCDOT, 2013

The Bureau of Labor Statistics’ May 2019 State Employment and Wage Estimates for North Carolina were used to assign hourly wage rates for passengers. The hourly median rate for BLS Occupational code 00-0000 (All Occupations) was used ($17.75). NCDOT Short Line Infrastructure Assistance Program (SIAP) grant values were used for the hourly wage rate of crew members ($41.60).

Shipper Costs. The research team used the appraisal methodology of Winston and Shirley (2004) to estimate shipper costs associated with rail delay.[1] This methodology is implemented in NCHRP Report 755 and Lovett et al.'s research on freight train delay costs in North America, among other research. Shipper costs are calculated as follows:

- Shipper Costs = (Value of Freight Cargo per Ton) x (Freight Tons per Carload) x (Freight Carloads per Train) x (Total Time of Cargo Delayed) x (Cargo Discount Rate).

Value of Freight Cargo per ton was estimated using STCG subcode values (see Figure 13), the North Carolina Statewide Multimodal Freight Plan, a waybill sample from the Norfolk Southern H Line, Norfolk Southern Main Line, and CSX A Line, NCHRP Report 755, and the Bureau of Transportation Statistics Freight Facts and Figures.

Figure 13: Value of Freight Cargo per Ton by Percentile

Percentile	Freight Value per U.S. Ton
10th	$217
20th	$415
30th	$890
40th	$1,255
50th	$3,403
60th	$3,699
70th	$7,046
80th	$8,416
90th	$13,447

Derived using STCG subcode values. Source: U.S. Department of Transportation, Research and Innovative Technology Administration, Bureau of Transportation Statistics and U.S. Department of Commerce, U.S. Census Bureau, 2012 Economic Census: Transportation Commodity Flow Survey, Preliminary Release, December 2013.

Figure 14: Sample Set of Values of Freight Cargo per Ton

Monetization Factor	Average Value per U.S Ton ($2020)
Annual NC Rail Cargo[1]	$1,851
NCHRP 755 Generalized Value of Cargo[2]	$1,613
Value of Annual US Rail Cargo[3]	$1,109
NC Waybill Data Sample NS H Line (Derived)	$2,080
NC Waybill Data Sample NS Main Line (Derived)	$2,143
NC Waybill Data Sample CSX A Line (Derived)	$1,805
NC Waybill Data Sample Aggregate (Derived)	$1,979

[1] North Carolina Statewide Multimodal Freight Plan. Cambridge Systematics. November 2017.
[2] NCHRP Report 755: Comprehensive Cost of Highway-Rail Grade Crossing Crashes. 2013. Online: http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_755.pdf
[3] Freight Facts and Figures. Table 2-9. Bureau of Transportation Statistics. 2017. Online: https://www.bts.dot.gov/sites/bts.dot.gov/files/docs/FFF_2017.pdf

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1. Winston, C. and Shirley, C. The Impact of Congestion on Shipper' Inventory Costs: Final Report to the Federal Highway Administration. February 2004. Online: https://www.fhwa.dot.gov/policy/otps/060320d/060320d.pdf

Figure 15: Sample Set of Train Cargo Capacity

Item	Pounds	U.S. Tons	Tare Weight (Empty/ Deadweight)	Cargo "Payload" Weight (U.S. Tons)
Max Freight Car Load[1]	315,000	157.5	32	125.5
Max Freight Car Load[2]	263,000	131.5	31.5	100
Average Freight Car Load (Box Car)[3]	145,000	72.5	27.5	45
Average Freight Car Load (Covered Hopper)[3]	260,000	130	30	100
Average Freight Car (Unspecified)[3]	190,000	95	30	65
NC Waybill Data Sample CSX A Line (Derived)	16,194,455	17,851,326	$30,979,220,000	$1,805
NC Waybill Data Sample Aggregate (Derived)	34,231,712	37,733,992	$71,786,930,000	$1,979

[1] *NCDOT Rail Division, 2020*

[2] *SIAP Application Data References. NCDOT.*

[3] *Jim Bernier. "Average Rail Car Weight. Model Railroader. April 2010. Online: http://cs.trains.com/mrr/f/13/t/172738.aspx*

Figure 16: Sample Set of Cargo Capacity by Train Type

Train Type	Average Metric Tons per Train	Average U.S. Tons per Train	Estimated Car Loads per Freight Train (Derived)	Estimated Cargo Weight per Train (U.S. Tons)
Double Stack Container Train[1]	4,800	5,291	37.00	4,107
Manifest Train[1]	8,200	9,039	63.21	7,016
Grain Train[1]	9,900	10,913	76.31	8,471
Coal, Sulphur, and Potash (CSP) Train[1]	10,200	11,244	78.63	8,728

[1] *"Railway Capacity Background and Overview." Quorumcorp. October 2005. Online: http://www.quorumcorp.net/Downloads/Papers/RailwayCapacityOverview.pdf*

Figure 17: Estimated Freight Train Delay Resulting from Rail Incidents in North Carolina (minutes)

Low	Medium	High	Injury Event	Fatality Event	Rare, Very High Impact
35	43	84	83	284	925

Figure 18: Discount Rate for Cargo per Minute of Delay (Only Applied to Delays > 60 minutes)

Perishable	Bulk	Other	NC Waybill Commodity Mix	NCHRP 755
0.0104%	0.0035%	0.0069%	0.0066%	0.0067%

Freight tons per carload were derived using NCDOT's SIAP Grant Application, average rail car weights from Model Railroader, and the Railway Capacity and Background documentation by Quorumcorp (see Figures 15 and 16).

Total time of cargo delay was estimated using information provided by Public Safety Answering Points, NCHRP Report 755 report findings, and delay values reported in a Homeland Security report (see Figure 17 and the "Value of Time Costs" appendix (A-02) for more information).

The Winston and Shirley (2004) discount rates for perishable, bulk, and other cargo were used in this analysis. The NCHRP Report 755 discount rate for cargo was also used in this analysis. Additionally, Winston and Shirley's discount methodology was applied to a North Carolina specific freight commodity mix, derived from NC Waybill data, to create a North Carolina-specific discount value, which was also used in this analysis. See Figure 18 for the discount rate of cargo per minute (shipper costs are only applied for delays that total 60 minutes or greater.)

Cargo Replacement Costs. Cargo replacement costs are tabulated as follows:

- Cargo Replacement Costs = (Value of Freight Cargo per Ton) x (Freight Tons per Carload) x (Damaged Freight Cars per Incident) x (Cargo Replacement Rate)

It is important to be aware that appraisal techniques containing shipper and cargo replacement costs may result in double counting if precise and conservative estimates are not implemented. It may be helpful to recall, shipper costs take into account the incremental loss of useful life and spoilage accruing to all cargo that is tied-up in transit. Meanwhile, replacement costs account for the costs associated with replacing only the cargo that has been damaged or destroyed during an incident.

The longer goods are delayed the more their useful life deteriorates. For this study, it is assumed that damaged cargo has only 50 percent of its useful life remaining (thus, only 50 percent of its value is counted in the replacement cost appraisal). This is a conservative estimate, but it is used to ensure double counting will not occur.

Freight cars damaged per rail incident were estimated using the FRA safety database. North Carolina train incident records submitted via form 6180.54 from 1990-2019 were used. FRA records demonstrate that there are an estimated 43.6 train cars per train with an estimated 25.6 cars loaded with cargo (see Figure 19). Furthermore, approximately 2.63 freight cars containing cargo are damaged per rail incident in North Carolina (see Figure 20).

Figure 19: North Carolina Freight Statistics

Ave. Number of Loaded Cars	Ave. Number of Empty Cars	Ave. Number of Total Cars	Percent Carrying Cargo	Number of Observations
25.6	18.0	43.6	58.7%	1,088

Source: FRA (form 6180.54)

Figure 20: Average of Damaged Freight Cars Containing Cargo by Rail Incident Type

Other	Side collision	Broken train collision	Fire/violent rupture	Raking collision	Head on collision	Rear end collision	Default Event	Highway-Rail Crossing	Explosion-Detonation	Obstruction	Derailment	No. of Observations
1.77	1.86	1.87	2.00	2.09	2.47	2.62	2.63	2.66	2.75	2.86	2.93	111

Source: FRA (form 6180.54)

Emissions Costs. Emissions costs take into account potential impacts to health, property value, and climate change. The cost of emissions and their appraisal methodologies are provided in the USDOT BCA Guidance document.[1] When trains are delayed, they produce more locomotive emissions because they are on the railway for a longer duration of time. Based on the operating characteristics of the SD-70 locomotive and the USDOT emissions costs, Lovett et al. (2015) estimated the emissions costs for an average hour of locomotive operation. Lovett et al. (2015) research findings are adjusted to 2020 dollars and used to appraise emissions costs (see Figure 22). Emissions costs are estimated as follows:

- Emissions Costs = (Number of Locomotives) x (Additional Locomotive Runtime) x (CO2 Cost per Minute) x (NOx Cost per Minute) x (PM Cost per Minute)

FRA safety database records were used to estimate the average number of locomotives for passenger and freight trains (see Figure 21). Additional locomotive runtime was assumed to equal the amount of delay resulting from a train incident (see "Value of Time Costs" for the estimated passenger and freight train delay values). Emission costs for carbon dioxide (CO2), nitrogen oxide (NOx), and particulate matter costs values from the research of Lovett et al. (2015) were adjusted to 2020 dollars and used for this analysis.

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[1] "Benefit-Cost Analysis Guidance for Discretionary Grant Programs." U.S. Department of Transportation. January 2020. Online: https://www.transportation.gov/sites/dot.gov/files/2020-01/benefit-cost-analysis-guidance-2020_0.pdf

Figure 21: Locomotives per Train Type

Train Type	Ave. of Number of Locomotives
Freight Train	2.3
Passenger Train	1.5

Source: FRA 6180.54 1990-2019

Figure 22: Emissions Costs per Minute of Locomotive Runtime

Pollutant	Cost per Minute
CO2	$0.46
NOx	$1.89
PM	$3.22
Total	$5.57

Source: FRA 6180.54 1990-2019

Operating Costs. The greater amount of time that train cars and locomotives are in use, the greater the operating costs. Lovett et al. (2015) estimate rail operating costs for locomotive ownership, leasing, and fuel, as well as the cost for operating other rail cars. Their research findings are used in conjunction with incident delays (see "Value of Time Costs") to estimated rail operating costs. Rail operating costs are estimated as follows:

» Operating Costs = [(Loco Ownership or Lease Cost) x (No. of Locomotive Units) x (Additional Runtime)] + [(No. of Locomotive Units x Locomotive Fuel Cost) x (Additional Runtime)] + [(Other Car Costs x Additional Runtime)]

Railroad Operating Costs can be found in Figure 23 and the number of locomotive units can be found in Figure 21.

Figure 23: Railroad Operating Costs

Factor	Value per Hour	Value per Minute
Locomotive Ownership	$30.05	$0.50
Locomotive Leasing	$76.07	$1.27
Locomotive Fuel	$210.90	$3.52
Other Train Car Costs	$0.66	$0.01

Source: Lovett, A., Dick, C., Barkan, C. "Determining Freight Train Delay Costs on Railroad Lines in North American." 2015. Online: https://railtec.illinois.edu/wp/wp-content/uploads/2019/01/Lovett-et-al-2015-IAROR.pdf

Upstream and Downstream Costs. Rail incidents that result in substantial delays may impact rail movements up/downstream. There are four primary categories of upstream and downstream costs for passenger and freight trains:

- Passenger and crew value of time costs imposed for the next scheduled passenger or freight train as it waits for the tracks to be cleared
- Delay and operational costs imposed for rerouting passengers via bus
- Delay and operational costs for cancelling a passenger train trip
- Cargo delay and rerouting costs imposed for the next scheduled freight train

Passenger and crew value of time costs imposed on the next scheduled passenger or freight train are estimated by using the following equations:

» Up/Downstream VOT CostsPax = (Train Occupancy) x (Passenger Value of Time) x (Total Delay Time)

» Up/Downstream VOT CostsFreight = (Train Occupancy) x (Crew Value of Time) x (Total Delay Time)

Passenger train occupancy values are estimated using findings from Amtrak passenger surveys (see "Value of Time Costs" for the appraisal methodology). Passenger VOT is estimated using the Bureau of Labor Statistics' May 2019 State Employment and Wage Estimates for North Carolina and crew VOT with NCDOT SIAP Grant values (see "Value of Time Costs" for the appraisal methodology). Freight train occupancies are estimated to be two crew members, using FRA safety database records. Total delay time for up/downstream events were calculated by using third party data and pairing them with FRA records. There were 40 instances within the third party dataset where rail incidents lead to upstream and downstream impacts (see Figure 24) with a minimum delay of 16 minutes and a maximum up/downstream delay of 149 minutes.

Figure 24: Upstream and Downstream Delay Associated with a Rail Incident on an Amtrak Line

Category	Count	Minimum	10th Percentile	25th Percentile	Median	Mode	75th Percentile	90th Percentile	Maximum
Delay From Rail Incident: Awaiting Station (minutes)	119	15	24	35	74	49	110	174	334
Delay Up/downstream: Next Fre-quency (minutes)	40	16	17	19	26	26	39	64	149

Sources: FRA safety database records (forms 6180.54, 6180.57, and 6180.55a), Passenger delay records were retrieved from: "Amtrak Status Maps Archive Database: Historical Amtrak On-time Performance Data." Online: https://juckins.net/amtrak_status/archive/html/home.php

Figure 25: Potential Passenger Trips Booked by Carolinian and Piedmont Train Passengers

Station	State	Miles	HH:MM	Minutes
New York (NYP)	NY	646	9:49	589
Newark (NWK)	NJ	633	9:30	570
Trenton (TRE)	NJ	565	8:52	532
Philadelphia (PHL)	PA	536	8:28	508
Wilmington (WIL)	DE	504	7:55	475
Baltimore (BAL)	MD	429	6:43	403
Washington DC (WAS)	DC	398	6:11	371
Alexandria (ALX)	VA	391	6:01	361
Quantico (QAN)	VA	367	5:42	342
Fredericksburg (FBG)	VA	347	5:13	313
Richmond (RVR)	VA	290	4:12	252
Petersburg (PTB)	VA	266	3:56	236
Rocky Mount (RMT)	NC	223	3:19	199
Wilson (WLN)	NC	216	3:14	194
Selma (SSM)	NC	195	2:58	178
Raleigh (RGH)	NC	163	2:32	152
Cary (CYN)	NC	157	2:26	146
Durham (DNC)	NC	139	2:08	128
Burlington (BNC)	NC	108	1:45	105
Greensboro (GRO)	NC	89.1	1:27	87
High Point (HPT)	NC	74.6	1:16	76
Salisbury (SAL)	NC	39.9	0:41	41
Kannapolis (KAN)	NC	24.8	0:31	31
Charlotte (CLT)	NC	n/a	n/a	n/a

Delay and operation costs imposed for rerouting passengers via bus are tabulated using the following equation:

» Passenger Train Rerouting Costs = [(No. of Buses Required for Reroute) x (Bus Operating Costs per Mile) x (Number of Miles Rerouted via Bus)] + [(Passenger VOT costs) x (Additional Travel Time)]

The numbers of buses required during a rerouting decision is based on the number of buses needed to transport the scheduled train passengers. It is estimated that one bus will transport up to 60 passengers and will cost $1.24 per mile to operate.[1,2] The number of miles rerouted will depend on the trip that is booked by train passengers (see Figure 25).

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[1] "Overview of Transit Vehicles. Colorado Department of Transportation. Online: https://www.codot.gov/programs/commuterchoices/assets/documents/trandir_transit.pdf

[2] "Transportation Benefit Cost Analysis." Online: http://bca.transportationeconomics.org/parameters

The average travel distance between Charlotte and other North Carolina stations is used for this analysis (130 miles). Value of time costs are estimated to be $0.30 per minute using the Bureau of Labor Statistics' May 2019 State Employment and Wage Estimates for North Carolina. It is estimated that passengers will experience 15 to 60 minutes of additional delay traveling via bus, instead of as originally planned by train.

Incident delays could result in trip cancellations, which impose a wide range of costs. These costs are a function of whether a train passenger has an available substitute for travel and how important it is for the passenger to reach their planned destination without delay. The research team did not have either of these pieces of information available for this analysis, so a simplified and conservative approach was used. For this analysis, it was assumed that all passengers would be able to find alternative trips within a planning period of 15 to 60 minutes. Passenger VOT costs were applied to the planning time required to find alternate travel. It was also assumed that passengers would undergo a 25% increase in costs in a low alternative, 50% additional cost in a recommended, and 100% increase (doubling of costs) in a high alternative transport cost scenario (see Figure 26). It is assumed that the passenger will receive a 100% refund for the trip that has been cancelled.

Figure 26: Trip Cancellation and Rebooking Costs

Cost Type	Existing Cost	Low Alternative	Recommended Alternative	High Alternative
Total Cost for Alternative Transport	$34.63	$43.29	$51.95	$69.27
Net Cost to Passenger after Ticket Refund	$0.00	$8.66	$17.32	$34.63

Up/downstream cargo delay costs result when an incident delays an upstream or downstream freight train by more than 60 minutes. When this is the case, shipper costs appraisal methodologies are applied to the up/downstream freight train. See "Shipper Costs" for the appraisal methodology used to estimate up/downstream cargo delay costs. The research team was not able to obtain up/downstream delay data for freight trains. For this analysis, Amtrak delay records were used (see Figure 24). Future research would benefit from freight-specific data on up/downstream train

Emergency Responder Costs. For this study, North Carolina's public safety answering points (PSAPs) provided information through phone interviews, email correspondence, and computer aided dispatch records, which was used to estimate first responder costs. This information was supplemented by findings from a literature and data review of emergency personnel and equipment costs.

Emergency responder costs were tabulated as follows:

» Emergency Responder Personnel Costs = (No. Emergency Personnel) x (Value of Time) x (Time Involved with Incident)
» Emergency Responder Equipment Costs = (Quantity of Emergency Equipment) x (Equipment Time Costs) x (Time Involved in Incident)

The research team analyzed first responder information for 40 North Carolina rail incidents contained within 20 computer aided dispatch records, six (6) phone interviews, and two (2) threads of email correspondence (see Figure 11).[1] This information enabled the research team to evaluate:

- The type and number of emergency response personnel that were dispatched to an incident
- The type and number of emergency response vehicles/equipment were dispatched to an incident
- The amount of time emergency response personnel and vehicles spent addressing a rail incident

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1. CAD records offered time stamps for emergency responders from their time of dispatch to their time of "close" when the scene had been cleared. Phone interviews and email correspondence collected accounts of the total time it took emergency personnel to clear an incident. The total time from dispatch to close was used to quantify delay.

A total of 246 time stamps (provided in CAD records) for personnel and vehicles responding to an incident were contained within the CAD records. This information was used in conjunction with phone interviews and email correspondence. After evaluating the CAD records, phone interviews, and email correspondence, the research team grouped rail incidents into low-impact, medium-impact, and high-impact rail incidents based on the severity of the incident and the number of emergency responders that were dispatched to the scene.[2] In total, the research team obtained information on 37 rail incidents and derived a total of 373 instances of personnel and vehicles responding to these incidents.

This information was then supplemented with emergency management studies and reports to derive emergency responder costs. Estimated delay times associated with injury, fatality, and rare, very high impact events, as documented in NCHRP Report 755 and a rail emergencies special report published by Homeland Security, were also included in the cost appraisal.[3] FEMA's schedule of equipment rates (2019) was used to appraise emergency equipment costs (see Figure 43).[4]

It should be noted that the research team attempted to reach CSX and Norfolk Southern to obtain dispatch records for estimating train delay, but was unsuccessful. Further research would benefit from a more comprehensive dataset of delay records.

The following pages contain tables that distill emergency responder costs into the following categories:

- Number of Emergency Personnel Responding to Rail Incidents by Impact Category
- Time Involved for Emergency Personnel Responding to Rail Incidents by Impact Category
- Number of Vehicles/Equipment Responding to Rail Incidents by Impact Category
- Time Involved for Vehicles/Equipment Responding to Rail Incidents by Impact Category

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[2] In total, 11 records were designated as high-impact events, 19 records were designated as medium-impact events, and 7 records were designated as low-impact events. These records were supplemented by 6 very-high-impact events assembled from various sources (events did not occur within North Carolina).

[3] Freight Train Delay Sources: Brod, Daniel et al. Comprehensive Costs of Highway-Rail Grade Crossing Crashes. Vol. 755. Transportation Research Board, 2013. http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_755.pdf
U.S. Fire Administration Technical Report Series - Special Report: Rail Emergencies. Homeland Security. February 2003. Online: https://www.usfa.fema.gov/downloads/pdf/publications/tr-094.pdf

[4] FEMA Schedule of Equipment Rates 2019." Federal Emergency Management Agency. August 2019. Online: https://www.fema.gov/media-library-data/1566918062583-b079c79b86366aa3819da87b011dbe73/FEMA_Schedule_of_Equipment_Rates_2019_508clean_081319.pdf

Number of Emergency Personnel Responding to Rail Incidents by Impact Category

Figure 27: Low Impact Personnel Response

Incident Response Type	Minimum	Mean	Maximum
Law Enforcement / Sheriff's Office / Highway Safety Patrol	0.0	1.4	5.0
EMS / Medic / County Rescue	0.0	1.0	2.0
Fire Department	0.0	2.0	5.0
Contract Workers or Other Safety Response Personnel	0.0	0.0	0.0
Hazmat Team	0.0	0.0	0.0

Figure 28: Medium Impact Personnel Response

Incident Response Type	Minimum	Mean	Maximum
Law Enforcement / Sheriff's Office / Highway Safety Patrol	0.0	1.8	6.0
EMS / Medic / County Rescue	0.0	1.6	7.0
Fire Department	0.0	5.5	11.0
Contract Workers or Other Safety Response Personnel	0.0	0.0	0.0
Hazmat Team	0.0	0.1	1.0

Figure 29: High Impact Personnel Response

Incident Response Type	Minimum	Mean	Maximum
Law Enforcement / Sheriff's Office / Highway Safety Patrol	2.0	8.0	20.0
EMS / Medic / County Rescue	2.0	3.7	8.0
Fire Department	0.0	6.5	20.0
Contract Workers or Other Safety Response Personnel	0.0	1.0	3.0
Hazmat Team	0.0	0.3	3.0

Figure 30: Very High Impact Personnel Response

Incident Response Type	Minimum	Mean	Maximum
Law Enforcement / Sheriff's Office / Highway Safety Patrol	10.0	15.0	20.0
EMS / Medic / County Rescue	5.0	30.9	70.0
Fire Department	6.0	25.2	70.0
Contract Workers or Other Safety Response Personnel	1.0	24.8	100.0
Hazmat Team	4.0	4.0	4.0

Time Involved for Emergency Personnel Responding to Rail Incident (HH:MM:SS)

Figure 31: Low Impact Personnel Time Involved in Incident

Incident Response Type	Minimum	Mean	Maximum
Law Enforcement / Sheriff's Office / Highway Safety Patrol	00:11:59	01:12:12	02:12:24
EMS / Medic / County Rescue	00:17:58	00:19:29	00:17:58
Fire Department	00:08:49	00:14:15	00:19:41
Contract Workers or Other Safety Response Personnel	00:11:59	01:12:12	02:12:24
Hazmat Team	00:00:00	00:00:00	00:00:00

Figure 32: Medium Impact Personnel Time Involved in Incident

Incident Response Type	Minimum	Mean	Maximum
Law Enforcement / Sheriff's Office / Highway Safety Patrol	00:37:07	00:51:19	01:13:25
EMS / Medic / County Rescue	00:05:14	00:26:40	00:45:53
Fire Department	07:27:00	00:50:48	03:21:18
Contract Workers or Other Safety Response Personnel	00:37:07	00:51:19	01:13:25
Hazmat Team	00:10:00	00:10:00	00:10:00

Figure 33: High Impact Personnel Time Involved in Incident

Incident Response Type	Minimum	Mean	Maximum
Law Enforcement / Sheriff's Office / Highway Safety Patrol	01:05:57	02:49:44	07:39:15
EMS / Medic / County Rescue	00:11:34	00:55:25	01:30:00
Fire Department	00:36:55	01:36:37	04:09:16
Contract Workers or Other Safety Response Personnel	01:30:00	01:30:00	01:30:00
Hazmat Team	00:10:00	00:10:00	00:10:00

Figure 34: Very High Impact Personnel Time Involved in Incident

Incident Response Type	Minimum	Mean	Maximum
Law Enforcement / Sheriff's Office / Highway Safety Patrol	01:30:00	15:25:00	48:00:00
EMS / Medic / County Rescue	01:30:00	15:25:00	48:00:00
Fire Department	01:30:00	15:25:00	48:00:00
Contract Workers or Other Safety Response Personnel	01:30:00	15:25:00	48:00:00
Hazmat Team	01:30:00	15:25:00	48:00:00

Number of Vehicles/Equipment Responding to Rail Incidents

Figure 35: Low Impact Equipment Response

Emergency Response Vehicle	Minimum	Mean	Maximum
Ambulance / EMS	1.0	0.6	2.0
Fire Engine	0.0	0.6	2.0
Fire Rescue Truck (Ladder Truck)	0.0	0.0	0.0
Police Cars	1.0	1.0	3.0
Helicopter	0.0	0.0	0.0
*Other	0.0	0.7	2.0

*Other vehicles in include SUVs, pickup trucks, and heavy trucks

Figure 36: Medium Impact Equipment Response

Emergency Response Vehicle	Minimum	Mean	Maximum
Ambulance / EMS	1.0	1.0	1.0
Fire Engine	1	0.8	4.0
Fire Rescue Truck (Ladder Truck)	0.0	0.4	1.0
Police Cars	1.0	1.6	3.0
Helicopter	0.0	0.0	0.0
*Other	0.0	1.1	4.0

*Other vehicles in include SUVs, pickup trucks, and heavy trucks

Figure 37: High Impact Equipment Response

Emergency Response Vehicle	Minimum	Mean	Maximum
Ambulance / EMS	1.0	1.7	5.0
Fire Engine	1.0	1.8	4.0
Fire Rescue Truck (Ladder Truck)	0.0	0.5	2.0
Police Cars	1.0	5.4	13.0
Helicopter	0.0	0.1	1.0
*Other	0.0	1.3	7.0

*Other vehicles in include SUVs, pickup trucks, and heavy trucks

Figure 38: Very High Impact Equipment Response

Emergency Response Vehicle	Minimum	Mean	Maximum
Ambulance / EMS	5.0	30.9	70.0
Fire Engine	6.0	25.2	70.0
Fire Rescue Truck (Ladder Truck)	1.0	2.4	4.0
Police Cars	10.0	10.0	10.0
Helicopter	0.0	7.5	20.0
*Other	0.0	5.5	10.0

*Other vehicles in include SUVs, pickup trucks, and heavy trucks

Time Involved for Vehicles/Equipment Responding to Rail Incidents (HH:MM:SS)

Figure 39: Low Impact Equipment Response Time

Emergency Response Vehicle	Minimum	Mean	Maximum
Ambulance / EMS	00:17:01	00:19:40	00:22:00
Fire Engine	00:13:11	00:16:26	00:19:41
Fire Rescue Truck (Ladder Truck)	00:00:00	00:00:00	00:00:00
Police Cars	00:14:06	00:43:40	02:12:24
Helicopter	00:00:00	00:00:00	00:00:00
*Other	00:18:55	00:18:55	00:18:55

*Other vehicles in include SUVs, pickup trucks, and heavy trucks

Figure 40: Medium Impact Equipment Response Time

Emergency Response Vehicle	Minimum	Mean	Maximum
Ambulance / EMS	00:07:12	00:25:31	00:50:06
Fire Engine	00:09:48	00:47:47	02:47:17
Fire Rescue Truck (Ladder Truck)	00:10:09	00:45:29	02:39:42
Police Cars	00:40:00	01:00:36	01:13:25
Helicopter	00:00:00	00:00:00	00:00:00
*Other	00:07:14	00:24:18	01:05:23

*Other vehicles in include SUVs, pickup trucks, and heavy trucks

Figure 41: High Impact Equipment Response Time

Emergency Response Vehicle	Minimum	Mean	Maximum
Ambulance / EMS	00:11:34	0:57:11	1:30:00
Fire Engine	00:13:24	00:49:55	01:16:40
Fire Rescue Truck (Ladder Truck)	00:11:20	00:35:58	01:30:00
Police Cars	01:05:57	03:06:32	08:49:11
Helicopter	00:36:51	00:36:51	00:36:51
*Other	00:06:00	00:48:00	01:30:00

*Other vehicles in include SUVs, pickup trucks, and heavy trucks

Figure 42: Very High Impact Equipment Response Time

Emergency Response Vehicle	Minimum	Mean	Maximum
Ambulance / EMS	1:30:00	15:25:00	48:00:00
Fire Engine	1:30:00	15:25:00	48:00:00
Fire Rescue Truck (Ladder Truck)	1:30:00	15:25:00	48:00:00
Police Cars	1:30:00	15:25:00	48:00:00
Helicopter	1:30:00	15:25:00	48:00:00
*Other	1:30:00	15:25:00	48:00:00

*Other vehicles in include SUVs, pickup trucks, and heavy trucks

Figure 43: Equipment Operating Costs (Dollars per Hour)

Emergency Response Vehicle	Low	Medium	High
Ambulance / EMS[1,2]	$28.09	$34.64	$41.18
Fire Engine[3]	$126.00	$133.00	$140.00
Fire Rescue Truck (Ladder Truck)[4]	$131.50	$164.90	$198.30
Police Cars[5]	$16.05	$16.05	$16.05
Helicopter[6]	$625.35	$625.35	$625.35
Other[7]	$19.62	$33.99	$48.35

[1,2] Hourly equipment rates for ambulance and EMS vehicles were sourced from the *Ambulance Cost History Analysis* conducted by the City of Harrisonville and the FEMA schedule of equipment rates. Values were adjusted to 2020 dollars. Sources are included below:
"Public Safety Committee Regular Meeting." City of Harrisonville, Mo. January 20, 2014. Online: http://www.ci.harrisonville.mo.us/ArchiveCenter/ViewFile/Item/908
"FEMA Schedule of Equipment Rates 2019." Federal Emergency Management Agency. August 2019. Online: https://www.fema.gov/media-library-data/1566918062583-b079c79b86366aa3819da87b011dbe73/FEMA_Schedule_of_Equipment_Rates_2019_508clean_081319.pdf

[3,4,5,6] Hourly equipment rates for fire rescue ladder trucks, polic cars, and helicopters were sourced from the FEMA schedule of rates and were adjusted to 2020 dollars.

[7] Other equipment was estimated using the estimated hourly rates for trucks (pickup and heavy duty).

Appendices

Property Damage: Regression Analysis Supplement

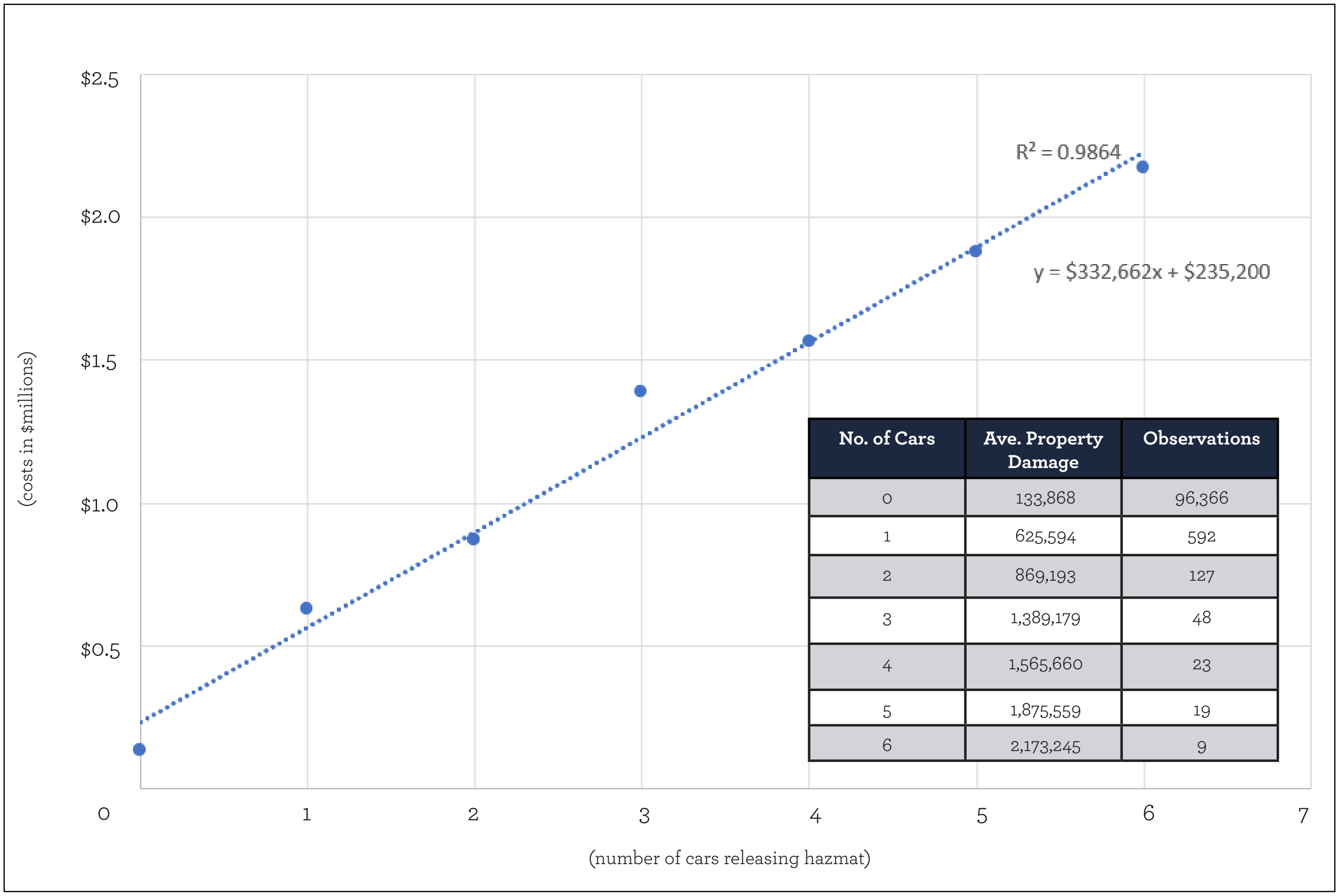
A primary component of this research involved understanding the relationship between train incidents and the property damage associated with those incidents. The research team conducted regression analysis to model the relationship between variables recorded in the FRA safety database (form 6180.54 records) and property damage costs.

The research team first attempted to analyze North Carolina-specific records in the database from years 1990 to 2019. When conducting the analysis, it became apparent that the number NC-specific records were too limited to test for statistical significance among variables that may affect incident cost. The research team then casted a wider net, analyzing incident records from across the United States from 1990 to 2019. The research team tested over a dozen variables in the FRA safety database (form 6180.54 records) and five were found to be statistically significant, with R-squared values > 0.71. These variables included:

- Number of train cars releasing hazardous materials
- Number of locomotive units derailed
- Number of loaded freight cars derailed
- Number of empty freight cars derailed
- Number of train cars derailed (type not specified)

Regression analysis results are shown in Figures 44-47, of the following pages.

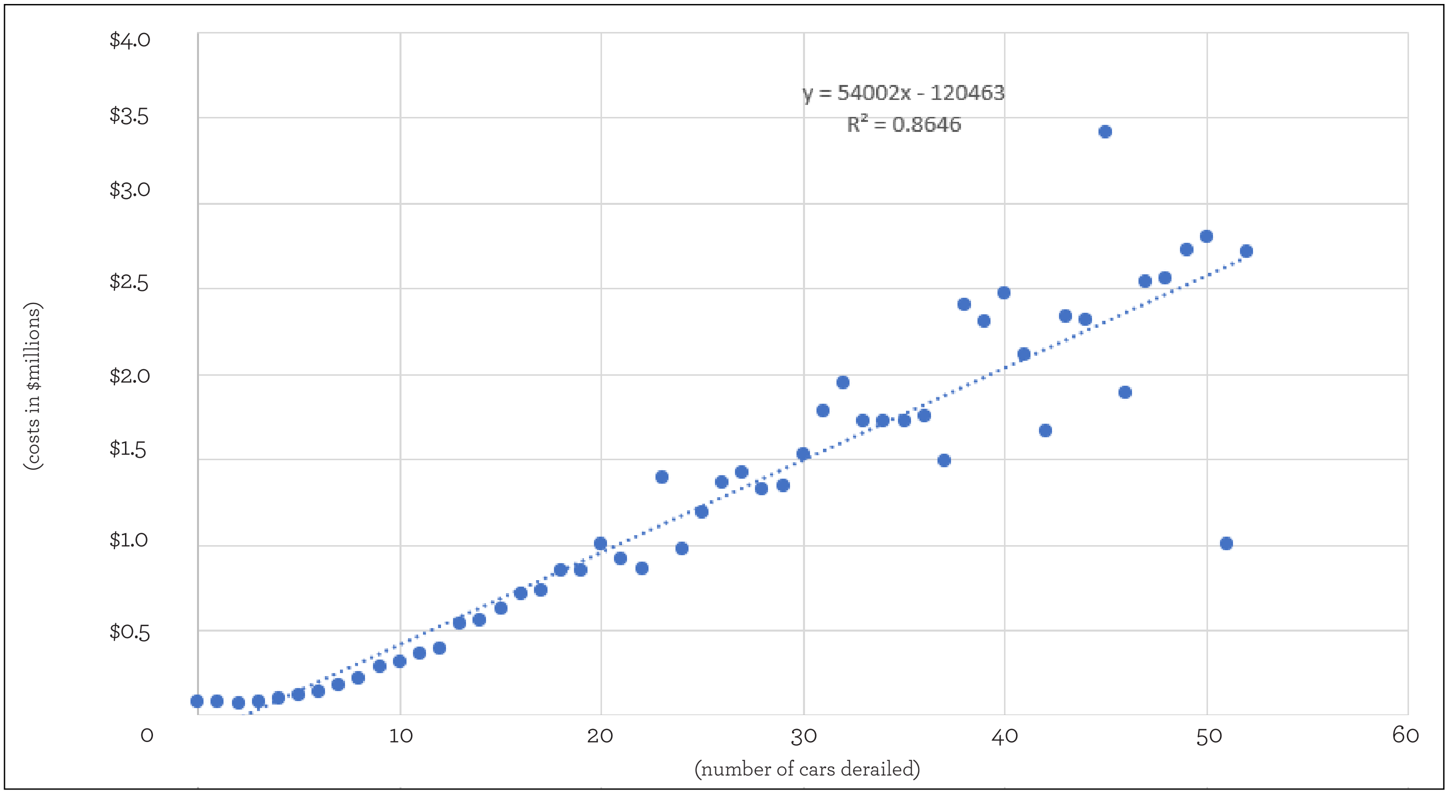
Figure 44: Average Incident Cost per Train Car Releasing Hazmat



No. of Cars	Ave. Property Damage	Observations
0	133,868	96,366
1	625,594	592
2	869,193	127
3	1,389,179	48
4	1,565,660	23
5	1,875,559	19
6	2,173,245	9

If a train car releases hazmat, it is projected to result in an event with substantial property damage costs. If one car releases hazmat it is projected that the event will cost a total of approximately $567,860 (y = $332,662 x (1) + $235,200). Each additional train car that releases hazmat will add $332,662 to the total event cost.

Figure 45: Average Incident Cost per Train Car Derailed

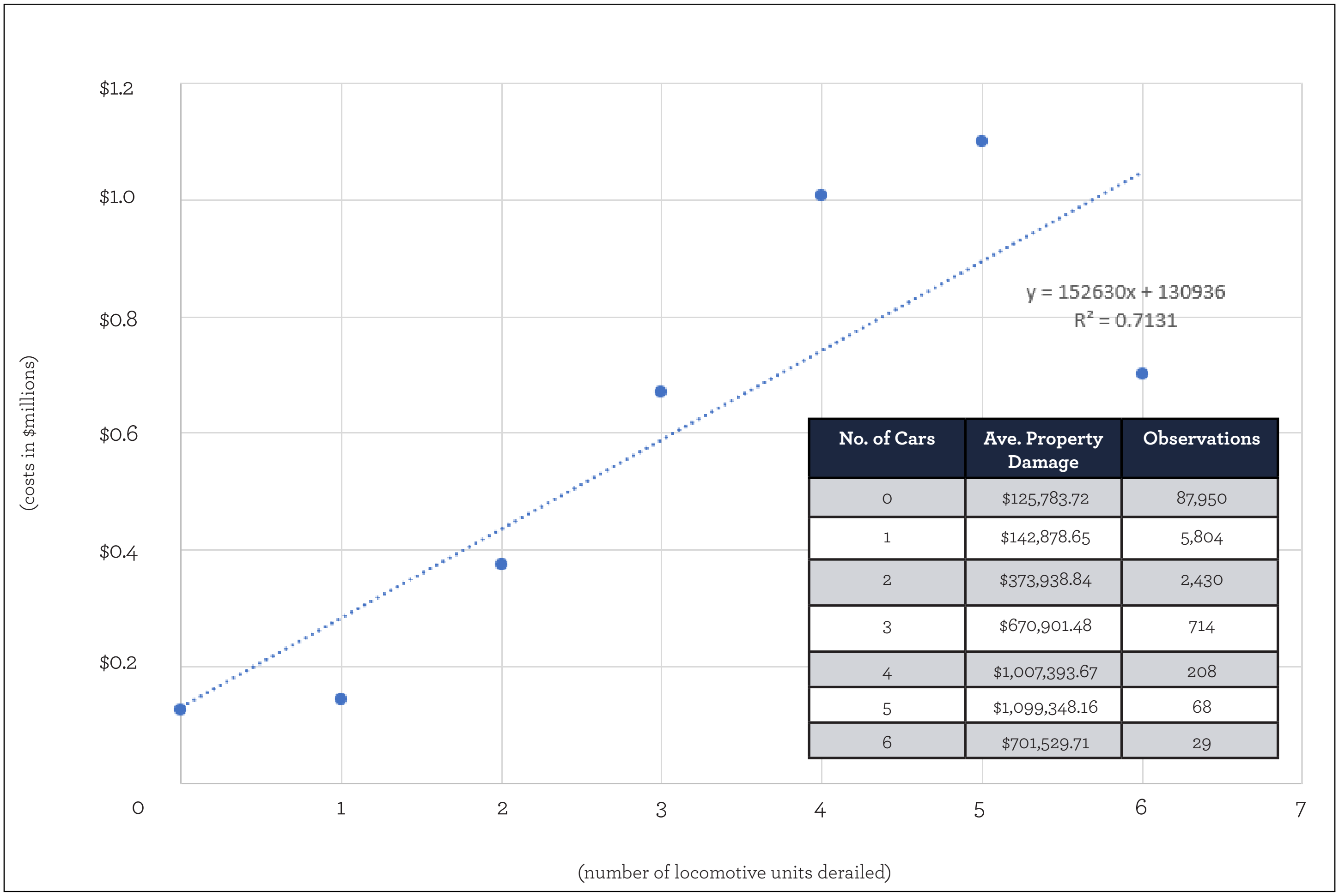


If train cars derail, it is projected to result in an event with notable property damage costs. If three cars derail, it is projected that the event will cost a total of approximately $41,543 (y = $54,002 x (3) - $120,463). Each additional train car that derails will add approximately $54,000 to the total event cost. It should be noted that costs remain relatively flat from 1-6 train cars derailed and increase linearly thereafter. This may due to relatively low-impact train incidents, which inflict minimal damage and result in a small cluster of train cars being derailed. Once the type of incident escalates from a low-impact to a medium- or high-impact event, more substantial costs accrue, which is likely reflected in the linear cost relationship shown above.

No. of Cars	Ave. Property Damage	Observations
1	$79,997	13,889
2	$69,240	10,047
3	$83,201	7,915
4	$97,662	6,747
5	$116,574	5,268
6	$135,509	3,682
7	$183,862	2,767
8	$220,324	1,989
9	$283,038	1,431
10	$310,368	1,111
11	$360,418	833
12	$394,273	670
13	$534,622	585
14	$558,778	494
15	$625,127	347
16	$711,347	328
17	$733,254	255
18	$851,863	211
19	$851,048	209
20	$1,002,685	177
21	$921,831	165
22	$861,675	154
23	$1,391,072	115
24	$977,248	111
25	$1,185,274	117
26	$1,364,267	89
27	$1,423,706	95
28	$1,330,552	72
29	$1,345,836	80
30	$1,532,085	54
31	$1,780,802	66
32	$1,947,088	68
33	$1,728,196	50
34	$1,719,891	29
35	$1,727,338	35
36	$1,751,679	35
37	$1,486,363	24
38	$2,405,777	24
39	$2,307,119	24
40	$2,475,707	18
41	$2,112,438	20
42	$1,666,666	14
43	$2,333,564	18
44	$2,319,278	8
45*	$3,414,136	11
46	$1,890,697	6
47	$2,539,292	6
48	$2,555,790	6
49	$2,726,780	4
50	$2,802,807	11
51*	$1,005,426	1
52	$2,714,125	9

*Two potential outliers may have been reported. For the instances when 45 train cars had been derailed (n=11), there was one incident resulting in $6.3 million in property damage and one incident resulting in $4.9 million, which increased the average property damage for this category by $0.5 million. For the instance when 51 train cars had been derailed, there was only one record of $1.0 million, which is substantially lower the expected value of property damage for that category. The research team did not believe these were outliers and decided to keep them in the dataset for this analysis.

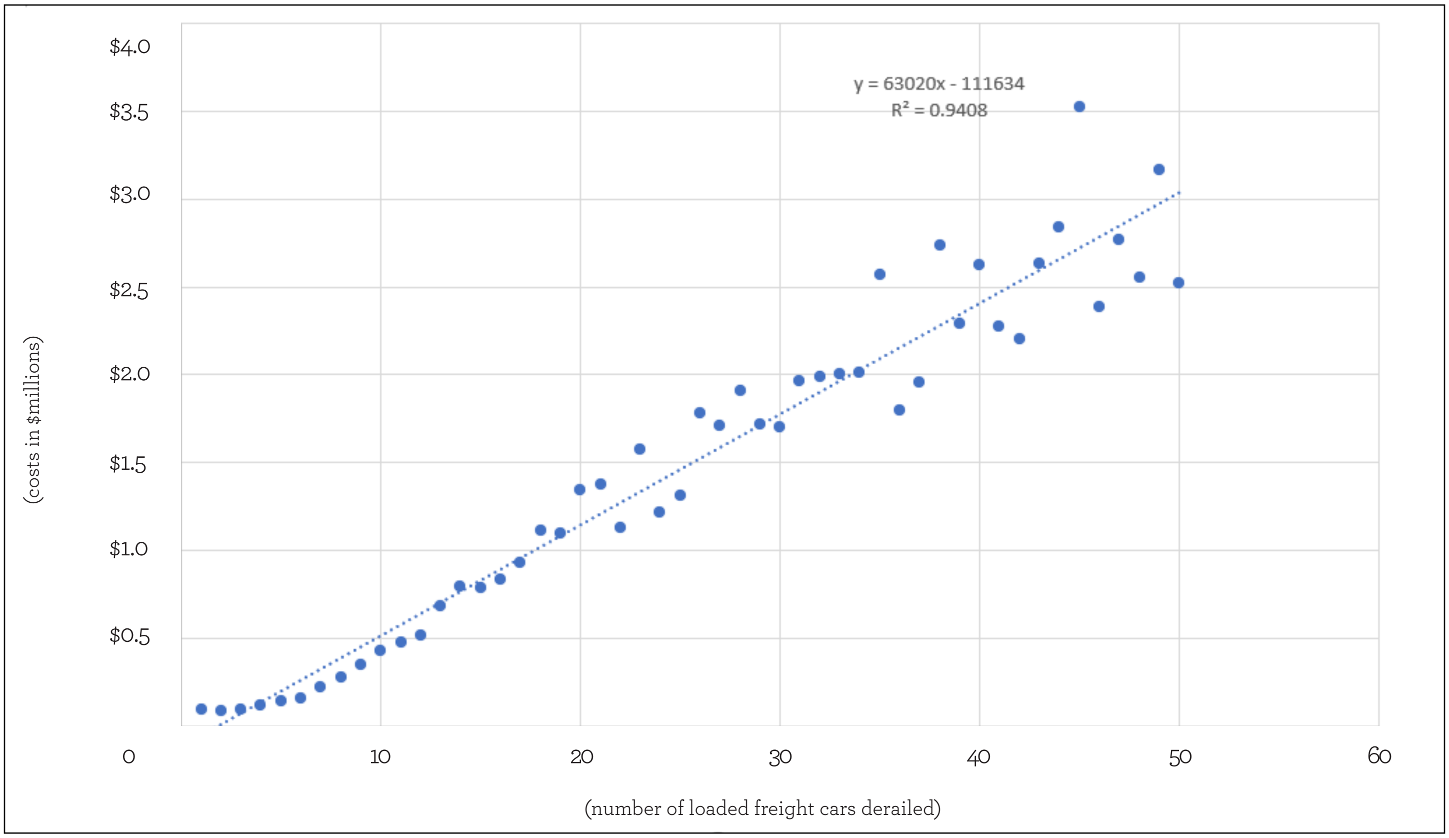
Figure 46: Average Incident Cost per Locomotive Unit Derailed



No. of Cars	Ave. Property Damage	Observations
0	$125,783.72	87,950
1	$142,878.65	5,804
2	$373,938.84	2,430
3	$670,901.48	714
4	$1,007,393.67	208
5	$1,099,348.16	68
6	$701,529.71	29

If a locomotive unit is derailed, it is projected to result in an event with substantial property damage costs. For example, if one locomotive unit is derailed, it is estimated that that the event will cost a total of approximately $283,566 (y = $152,630 x (1) + $130,936). Each additional locomotive unit that is derailed will add $152,630 to the total event cost.

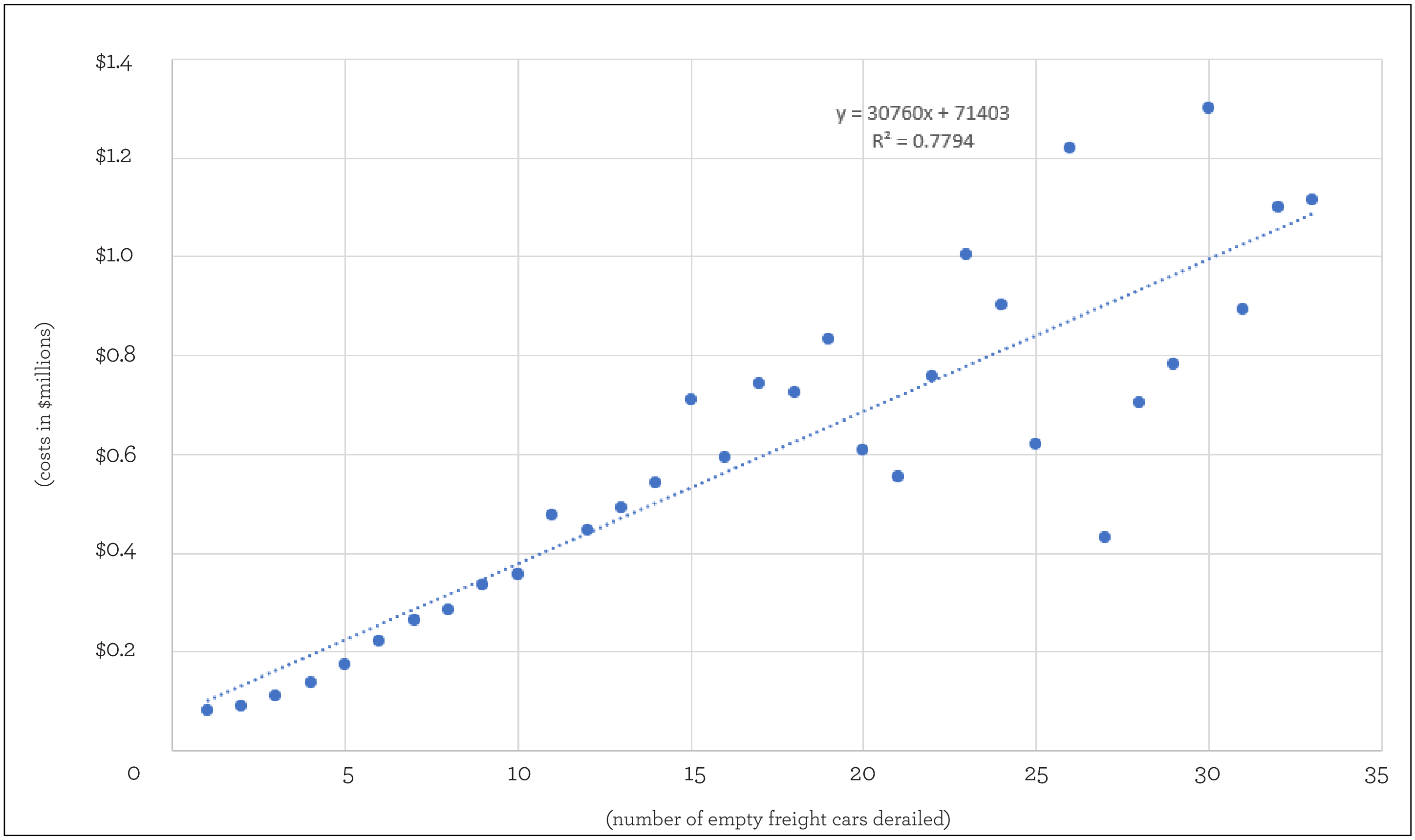
Figure 47: Average Incident Cost per Loaded Freight Car Derailed



If freight cars are derailed, it is projected to result in an event with notable property damage costs. For example, if ten freight cars derail, it is estimated that that the event will cost a total of approximately $518,566 (y = $63,020 x (10) + $111,634). Each additional freight car that is derailed will add $63,020 to the total event cost.

No. of Cars	Ave. Property Damage	Observations
0	$91,309	53767
1	$96,032	11075
2	$84,004	7182
3	$96,617	5811
4	$118,834	4895
5	$139,488	3725
6	$161,896	2555
7	$219,020	1892
8	$276,948	1286
9	$346,139	886
10	$430,399	693
11	$476,362	519
12	$514,803	392
13	$681,156	356
14	$795,434	284
15	$788,746	199
16	$834,104	185
17	$931,090	158
18	$1,112,730	130
19	$1,094,037	123
20	$1,342,187	115
21	$1,377,113	87
22	$1,128,764	86
23	$1,573,688	81
24	$1,219,479	66
25	$1,308,450	73
26	$1,777,926	60
27	$1,707,737	61
28	$1,911,467	47
29	$1,716,056	47
30	$1,700,467	31
31	$1,962,561	50
32	$1,987,595	35
33	$2,003,511	30
34	$2,014,677	16
35	$2,567,089	19
36	$1,795,488	24
37	$1,958,612	17
38	$2,737,382	16
39	$2,293,295	19
40	$2,625,259	12
41	$1,219,479	66
42	$1,308,450	73
43	$1,777,926	60
44	$1,707,737	61
45	$1,911,467	47
46	$1,716,056	47
47	$1,700,467	31
48	$1,962,561	50
49	$1,987,595	35
50	$2,003,511	30

Figure 48: Average Incident Cost per Empty Freight Car Derailed



If empty freight cars are derailed, it is projected to result in an event with notable property damage costs. For example, if 10 freight cars derail, it is estimated that that the event will cost a total of approximately $379,003 (y = $30,760 x (10) + $71,403). Each additional empty freight car that is derailed, will add $30,760 to the total event cost.

No. of Cars	Ave. Property Damage	Observations
0	$137,386	70,003
1	$81,453.54	9,505
2	$89,973.90	5,880
3	$111,152.80	3,517
4	$137,531.60	2,292
5	$173,276.48	1,499
6	$220,852.46	1,005
7	$265,273.66	761
8	$286,561.70	585
9	$335,548.20	406
10	$357,652.34	334
11	$477,862.27	232
12	$447,203.56	207
13	$491,027.52	167
14	$542,121.61	135
15	$709,451.71	100
16	$594,369.12	76
17	$744,628.04	72
18	$725,619.90	58
19	$832,329.57	52
20	$607,461.76	48
21	$553,436.64	38
22	$757,301.65	33
23	$1,002,853.87	29
24	$901,399.51	20
25	$621,233.14	18
26	$1,221,173.52	16
27	$430,860.55	9
28	$704,007.08	15
29	$781,841.65	14
30	$1,301,193.76	4
31	$891,827.70	10
32	$1,098,504.08	10
33	$1,115,828.63	12

Appendices

Literature Review

2020

Literature Review

COMPREHENSIVE COST OF RAIL INCIDENTS IN NORTH CAROINA

RESEARCH PROJECT: 2020-44

Comprehensive Cost of Rail Incidents in North Carolina: Literature Review

A combination of 82 journal articles, industry papers, reports, research syntheses, online documentation, and other sources were reviewed to provide context for evaluating the comprehensive cost of rail incidents in North Carolina. The literature was reviewed to gather information that may assist in the identification, qualification, and quantification of the various types of railroad incidents and their associated costs. Resources reviewed provided context and background of crash events, as well as information pertaining to events yielding property damage, injuries and fatalities, and delay costs.

The literature review was undertaken to gather information that will assist in developing a methodology for estimating and forecasting the comprehensive cost of rail incidents, help illuminate the social and economic impacts to North Carolina, and to provide support for countermeasures and expanded safety training. This project will establish a methodology and produce a tool for estimating the direct, indirect and intangible costs associated with rail incidents, as well as secondary costs associated with supply chain and business disruption. To the greatest extent possible, the research team will use North Carolina specific data to develop the methodology and tool. When NC-specific information is unavailable, the research team will use nationally recognized datasets and monetization factors.

Contents

Rail Incidents Context and Background

Comparison of External Costs of Rail and Truck Freight Transportation

David J. Forkenbrock
Public Policy Center, the University of Iowa
4 October 1999

This report estimates three types of external costs, including accidents, emissions, and noise, for four general types of freight trains. These external costs are compared to those of freight trucking which were estimated in a previous study. By reviewing data regarding external costs values of rail freight transportation, the size of external costs and the degree to which current operating costs would increase in the case of full social cost pricing is estimated.

In order to assess and compare the effects of external costs of rail and truck freight transportation, the social costs, operating costs, and non-market costs of both truck and rail freight transportation are taken into account and are, ultimately, used to compare the overall external costs of both modes.

Finally, the writer concludes that, based on per-ton-miles, the external costs produced by trucking was over three times that generated by any of the four types of freight trains analyzed. It is stated that, despite the use of conservative external cost values, the costs are substantial enough to warrant concern due to the effects that external costs have on the overall well-being of society. The article demonstrates the need for consideration of external costs in the formulation of transportation policy and aims to provide estimates for the amounts by which truck and rail transportation costs should be increased to include external costs.

Rail Passenger Equipment Accidents and the Evaluation of Crashworthiness Strategies

David C. Tyrell
Volpe National Transportation Systems Center, United States Department of Transportation
2 May 2001

This article aims to review relevant railroad accident data to identify possible design modifications to improve passenger survivability and to collect data surrounding accidents that can be used to evaluate the effectiveness of these changes using analytic tools and computer simulations of scenarios.

In order to determine possible structural flaws and the adequacy of design changes, a process is followed in which collision conditions, such as collision or derailment speed, train conditions and the involvement of other objects, and track conditions, are first determined by reviewing relevant accidents and statistically analyzing accident data. Information is then gathered on existing design features and possible design modification options were developed. Next, simulations and analytical tests were conducted to measure and compare crashworthiness of both the existing and redesigned models. The research discussed in this paper focuses on determining collision conditions for accidents grouped into three categories, which include train-to-train collision, collisions with objects, and derailments and other single train events, and seeks to develop possible modifications to improve crashworthiness.

It is noted that current research into rail equipment crashworthiness extends from field investigations of accidents to include full-scale testing of existing and modified designs under conditions intended to mirror accident conditions. While these full-scale tests are not included in the research considered in this article the information gathered provides possible design modifications that will be tested using full-scale accident simulations.

Railroad Derailment Factors Affecting Hazardous Materials Transportation Risk

Christopher P. L. Barkan, C. Tyler Dick, Robert Anderson
Newmark Civil Engineering Laboratory, University of Illinois at Urbana-Champaign
Undated

Due to the lack of available information regarding accidents involving hazardous materials, it is argued that a new, risk-based approach is needed to better comprehend the risk of transporting hazardous materials on different track classes as well as to understand predictive factors for conditions that may affect the release of hazardous materials. This article intends to establish proxy variables that may be used to measure these risk factors and may be incorporated in the risk-based approach.

Abundant data gathered from the Federal Railroad Administration is provided and thoroughly explained in the report. Accident parameters were thoroughly analyzed surrounding derailments of hazardous materials mainly in the case of mainline accidents. This focus is due to the higher risk of hazardous material release in mainline derailments compared to yard derailments as suggested by the overall higher average speeds of mainline railroads. Factors such as train speed and the number of cars derailed were identified as possible proxy variables and investigated to determine their connection with the probability of hazardous material release in the case of an accident.

In conclusion, the article states that the train speed and number of cars derailed considerably related to the probability of hazardous material release. It is noted that, seeing as these variables are commonly recorded in most incidents, they seem to be sufficient candidates as proxy variables to measure performance and evaluate accident prevention options.

Incorporating Accident Risk and Distribution in Economic Models of Public Transport

Andrew W. Evans, Alan D. Morrison
University College London
May 1997

This paper was intended to address the economic effects of recent safety policies as well as measures to reduce disruption or non-scheduled delay applied to rail systems in Great Britain by exploring the consequences and of safety funding sources, namely increased fares, increased subsidy, and reductions in aspects of service provision.

The report first outlines a conventional economic model for a public transport system and examines how it may be adapted to incorporate the new policy variables followed by the discussion of a hypothetical railway system which is applied to the model. Furthermore, the available data and functions are considered for the cost of reducing risk for passengers and nonpassengers as well as reducing non-scheduled delay. Finally, this article evaluates the results of the model when all of the elements are gathered and reviews the setting of the policy variables so as to maximize economic benefit and makes note of various constraints such as the benefits of subsidy, the sensitivity of the results to the valuations of statistical life, and the effects of misperception of risk by passengers.

Railroad Accident Rates for Use in Transportation Risk Analysis

Robert T. Anderson, Christopher P. L. Barkan
Newmark Civil Engineering Laboratory, University of Illinois at Urbana-Champaign
2004

While annual statistics published include accident counts for an array of categories such as railroad, accident type, cause, track type and class, train length, and speed, it is explained that more detailed accident rate statistics are required for hazardous materials transportation risk analysis. This paper analyzes accident data to develop better estimates of accident rates pertaining to risk analysis. Accident rates were calculated for a 10-year period that differentiate main-line and yard track operations, Class I and non-Class I railroads and different FRA track classes.

Raw data tables and graphs give detailed insight into various types of information including derailment rates for Class I and non-Class I railroads, derailment rate calculations, estimated accident rates by track class, transportation risk of hazardous materials calculation, and hazardous materials derailment and release statistics. In addition to this data, the article effectively summarizes the information gathered and uses it to address the overall concern of gathering more detailed accident rate statistics that are more helpful in risk analysis of hazardous material transportation.

Quantitative Analysis of Factors Affecting Railroad Accident Probability and Severity

Robert T. Anderson
University of Illinois at Urbana-Champaign
2005

This paper addresses the effects of train length, train speed, track class, accident cause, and car position on the risk of derailment of freight trains and freight cars and seeks to present methodologies to determine the probability and severity of derailments. The research begins by presenting statistics allowing for a more accurate calculation of the probability of accidents for Class I and non-Class I railroad freight trains. These statistics take into account the multiple orders of magnitude difference in derailment rates between track classes as well as factors used by the Federal Railroad Administration, which include railroad, accident type, accident cause, track type and class, train length, and speed.

Based on this data it was concluded that derailment severity is affected mostly by train speed, the number of cars following the point of derailment, and the accident cause while probability of derailment is more closely affected by train length, train speed, and positioning of cars. Using these conclusions and the updated geometric model, the overall derailment risk was able to be estimated and can be used to further quantify the benefits of changes in railroad operating and safety practices.

Managing Risk on the Railway Infrastructure

Allan M. Zarembski, Joseph W. Palese
Zeta Technologies Inc.
Undated

As a result of the increase in the use of risk management to improve safety and reduce the risk of accidents and derailments in recent years, a new set of track safety management tools was developed to quantify and examine the risk associated with key track failure modes. In this paper, three specific models that directly correlated with track safety and key track failure areas are discussed. These models are the broken rail risk model, which quantifies the risk of occurrence of a broken rail and subsequent broken rail derailment; the track buckling risk model, which identifies areas of high potential buckling risk and directs railway engineers to prioritized locations; and the vehicle/track geometry risk model, which locates and prioritizes areas of high potential for vehicle/track geometry related derailments.

It is noted that all of the models were designed for large-scale applications and are able to identify probable failure sites across entire routes, divisions, or railway systems. By virtue of the models' extensive areas of operation the reduction in the risk of derailments was immense. This report concludes that the use of new risk based assessment techniques is a valid and potentially superior method to identifying locations with high potential failure.

Role of Human Factors in Rail Incidents

Grady C. Cothen Jr.
United States Department of Transportation
16 March 2007

In this written statement, the Federal Railroad Administration's National Rail Safety Action Plan is discussed in relation to human factors and specific accidents that occurred as well as the necessity for enactment of provisions in the new FRA rail safety bill. Based on the railroad industry's safety record, human factors and track causes were the two leading causes in accidents. The focus of this statement is to discuss four main initiatives of the Action Plan which are reducing human factor accidents, addressing fatigue, enhancing hazardous materials safety and emergency preparedness, and improving highway-rail grade crossing safety.

This testimony addresses a number of strategies that may be implemented to assist in reducing accidents caused by human error. Development of rulemaking to address the most common human factors that lead to accidents, the implementation of a "Close Call" pilot research project, the addition of new technologies and redundant safety systems, and safety training for employees were all proposed procedures.

The Cost and Risk Impacts of Rerouting Railroad Shipments of Hazardous Materials

Theodore S. Glickman, Erhan Erkut, Mark S. Zschocke
George Washington University, Bilkent University, University of Waterloo
18 January 2007

This report seeks to utilize quantitative data regarding rail transport risk and to apply a weighted combination of economic cost and risk to develop alternative routes that may reduce the probability of an accident at only a slight cost increase. Route length was used to measure transportation cost and surrounding populations in a given radius from accidents sites were used to quantify transportation risk. It is also argued in this article that, due to the possible effects of a railroad accident involving hazardous materials, risk should play a role in determining the most efficient routes.

In order to compare cost and risk, a computer model was used to develop train movement simulations allowing different routes to be determined based on practical routing factors, such as distance and track quality or the proposed reduced risk routing factors which include a combination of ordinary operating parameters and safety related parameters. The algorithm used in this model is effectively explained in the paper and a wide array of raw data tables as well as graphs and maps are included and summarized.

The overall verdict of the article states that risk reduction can occur with minimal effects on cost and route length. It is maintained that, while cost is important when determining train routes, risk analysis should be considered, also, as a main factor to ensure the safety of hazardous material transportation.

Risk Estimation for Railways Exposed to Landslides

Christopher M. Bunce
Geotechnical Engineering, Department of Civil and Environmental Engineering, University of Alberta
2008

This paper discusses the reduction of temporal exposure of railways to geotechnical hazards through the use of precipitation measurements to identify the potential for landslides at specific locations. Two methods used to predict the occurrence of landslides are analyzed in this report. The first used the Generalized Extreme Value frequency distribution analysis of varied duration of antecedent precipitation to evaluate probable estimates of the return period of each duration antecedent precipitation. The second correlated landslide records with precipitation conditions to identify conditions that provide reliable prediction of landslide events. Through the use of these methods, the benefits of using precipitation induced landslide warning system were measured and compared with other risk reduction strategies for geotechnical hazards.

The report first considers the relationship between precipitation measurements and landslides and reviews the quantitative risk estimation in geotechnical engineering. Sources of precipitation data are then identified, studies on precipitation induced landslides are reviewed, and types of landslides and climatic regions in North America are discussed. The report also considers a method in which precipitation data may be used to identify conditions that caused a landslide which may then be used to distinguish the reoccurrence of hazardous conditions. It is noted that, based on the risk analysis completed, encountering a landslide is the most likely geotechnical railway scenario to result in a train accident or health loss and the report provides other possible methods to compare the benefits of different mitigation strategies.

Relationship Between Train Length and Accident Causes and Rates

Darwin H. Schafer, Christopher P.L. Barkan
Department of Civil and Environmental Engineering, University of Illinois at Urbana-Champaign
2008

This report seeks to quantitatively analyze accident rates based on car mile and train mile accident causes and to develop a metric to evaluate the classification of accident causes as car mile or train mile related. By statistically analyzing the classifications, their utility may be enhanced and the overall understanding of them may be clarified. The goal of this article is to, also, use the metric to properly classify train accident causes, to develop up-to-date train accident rates based on train length, and to conduct a sensitivity analysis on the model to illustrate how changes in train length may affect accident rate. In this study, Federal Railroad Administration data was used and 11 causes were reclassified from the previous classification. Overall, the comparison of car mile and train mile accident causes resulted in the conclusion that operation of longer trains resulted in a lower system-level accident rate while longer trains were expected to experience more accidents than shorter trains.

Numerous raw data tables and graphs are provided in this report regarding expected accidents from car mile and train mile related cause as a function of train length, accident cause groups and classification of FRA accident causes, percent of car mile and train mile related accidents versus train length, percentage of accidents versus train length, classification, score and rank of accident cause groups, and car and train mainline accident rates using reclassification of accident causes. This data is effectively reviewed and summarized in the report and adequately related to the overall conclusion.

In conclusion, accident rates evaluated in a sensitivity analysis showed that the decision to dispatch the same number of shipments in fewer, longer trains as opposed to more, shorter trains may affect the overall accident likelihood. It is noted that a number of accidents may not be purely train mile or car mile related, but may be a combination of the two. Future work is said to be necessary to further investigate these accidents and possibly determine a function for each cause group based on both car and train miles as well as to evaluate and further refine the accident cause clarification metric.

A Practical Risk Assessment Methodology for Safety-Critical Train Control Systems

Chinnarao Mokkapati, Terry Tse, Alan Rao
United States Department of Transportation
July 2009

The objective of this project was to develop a practical methodology, in coordination with a system to implement this methodology, for the assessment of risks associated with the distribution of new safety-critical train control systems. The general steps of this methodology are presented as follows: 1) define the new system and analyze its intended operation to determine all potential hazards, 2) analyze the risks resulting from the identified hazards, 3) determine the tolerable hazard rates for the system functions, thus arriving at a set of safety design requirements for the system, and 4) refine the risk assessment and show that overall risk of the new system is less than or equal to the pre-defined limit.

The software tool developed by the project, called Practical Risk Assessment Methodology, can perform detailed calculations that can be used to implement the four steps and thus conduct a full risk assessment of a new train control system. This report reviews the risk assessment process steps one-by-one, including system definition, hazard identification, identification of accidents, collective risk estimation, and determination of THRs and discusses how each step is completed as well as making note of safety performance measures. Historical data is used to estimate risk assessment parameters. Two test cases of risk assessment are presented in Appendix 3 and other case studies are considered.

A Quantitative Analysis of Options to Reduce Risk of Hazardous Materials Transportation by Railroad

Anthaphon Kawprasert
Department of Civil and Environmental Engineering, University of Illinois at Urbana-Champaign
2010

In this study, routing, track infrastructure improvement, and speed management are considered as approaches to risk reduction for railroad transportation of hazardous materials. This research uses operations research and quantitative risk assessment methods to analyze the potential benefits for each approach. In addition, parameters in the risk model are considered for improvement in order to enhance the quality of risk estimates and to better understand their sensitivity to various assumptions. It is also noted that, due to the complex nature of route risk analysis, results from quantitative risk assessment can be difficult to interpret and, if interpreted or conveyed incorrectly, unhelpful. A multitude of new techniques are presented in this study to present, interpret, and communicate risk results more effectively.

This report first addresses previous studies and literature related to railroad hazardous materials transportation risk assessment, route analysis, decision support tools for risk analysis, and risk communication. Risk reduction by rationalization of hazardous materials transportation rail route structure as well as the effects of train speed on hazardous materials transportation route risk analysis are introduced and evaluated. Furthermore, this paper suggests strategies to improve route infrastructure for risk reduction and analyzes their cost-effectiveness in addition to developing a mathematical model which can be used to determine locations where train operating speeds should be adjusted to minimize risk and transportation cost. A probabilistic risk model for route risk estimates, route risk comparison techniques and the communication and interpretation of route risk analyses results are also all considered in this report. Possible topics of further research are also mentioned including route rationalization, speed-dependent conditional probability of release, tank infrastructure improvement, train speed management, quantitative framework for selecting multiple risk-reduction options, probabilistic risk modeling, and options for route risk comparison and uncertainty errors of risk parameter estimates.

Analysis of Derailments by Accident Cause: Evaluating Railroad Track Upgrades to Reduce Transportation Risk

Xiang Liu, Christopher P.L. Barakan, M. Rapik Saat
Department of Civil and Environmental Engineering, University of Illinois at Urbana-Champaign
2011

This report aims to develop a more sophisticated approach that may be used to examine the interactions among accident causes that may be differently affected by upgrades to track infrastructure. Derailment statistics from the Federal Railroad Administration accident database are used in combination with other related literature in this paper to analyze numerous critical parameters for predicting train derailment risk. In addition, the article summarizes how the safety benefits of track class upgrade in reducing the risks from certain accident causes were quantitatively evaluated. The writer notes that, while a wide array of research exists on the topic of safety and economic impacts of track class upgrade, very few investigations evaluate how track class upgrade affects the risk pertaining to certain accident causes. Upgrading track class is expected to prevent certain track- related derailments, however, this research takes into account that it may also increase the risks from certain types of equipment failure that are more likely to occur at higher speeds.

An accident cause-specific derailment risk model was developed that simultaneously accounts for the interactions among different accident causes that may be differently affected by track class upgrade. In this article, a general framework for derailment risk analysis is first introduced. Derailment rate, severity and corresponding risks are then analyzed and modeled. Finally, the research estimates accident cause-specific derailment risk by Federal Railroad Administration track class using derailment statistics from the FRA Accident/Incident Reporting System database and relevant literature.

Ultimately, the research determines that, although track-related derailments are more likely to occur on lower track classes than derailments caused by equipment failures, some equipment-related causes tend to have higher derailments rates and corresponding higher risk on higher track classes. In general, upgrading track class will reduce track-related derailment risk but it increases the derailment risks pertaining to certain equipment related causes.

Analysis of Causes of Major Train Derailment and Their Effect on Accident Rates

Xiang Liu, M. Rapik Saat, Christopher P.L. Barkan
Department of Civil and Environmental Engineering, University of Illinois at Urbana-Champaign
2012

The results gathered in this article seek to represent the first step in a systematic process of quantitative risk analysis of railroad freight train safety that, ultimately, maintains the goal of optimizing safety improvement and more cost-effective risk management. Through the analysis of train derailment data from the Federal Railroad Administration rail equipment accident database for each track type and accounting for frequency of occurrence by cause and number of cars derailed, the effects of accident cause, type of track and derailment speed were examined.

Widespread amounts of data gave detailed information regarding accident and derailment frequency and severity by accident type and cause, respectively, number of derailments and cars derailed by accident causes, and percentage reduction in derailment rate versus effectiveness of accident prevention strategies and were effectively outlined in the report. The safety benefits of accident prevention strategies were evaluated so that they may be considered as part of an integrated framework to optimize investment that maximizes safety benefits and minimizes risks.

Prevalence and Treatment of Sleep Apnea in Safety-Critical Railroad Employees

Thomas Raslear
United States Department of Transportation
25 November 2014

This short communication summarizes data gathered from three, two question surveys conducted between 2006 and 2009 regarding the prevalence and treatment of sleep apnea in three groups of safety-critical railroad employees. This report aims to provide an estimate of the magnitude of the problem for the railroad industry.

A total of 949 people were surveyed in three groups labeled the train and engine group, which consists of locomotive engineers and conductors in freight service, dispatchers, and the passenger train and engine group, which includes locomotive engineers and conductors in passenger service. The survey distributed involved two yes-or-no questions: “Do you have sleep apnea?” and “Are you receiving treatment for your condition?” The results are compiled in a table which includes the group surveyed, number of participates, number with sleep apnea, the mean percent with sleep apnea, and the percent receiving treatment.

It is noted that the estimated prevalence of sleep apnea in safety-critical railroad employees provided by this study is mostly likely underestimated since respondent may have sleep apnea but are unaware.

Back on Track: Bringing Rail Safety to the 21st Century

Alliance for Innovation and Infrastructure
6 August 2015

As discussed in this paper, the increase in railway transportation of crude oil due to an increase in oil productivity and lack of available pipelines has created a more prominent focus on railway safety and prevention of accidents involving hazardous materials. The paper makes a number of recommendations to the government, the rail industry, shippers, first responders, and other stake holders to strengthen measures to address track and rail integrity and mitigate the potential effects of human errors. Included in these recommendations are the increased use of commercially available technologies to monitor track, equipment, and roadbed conditions, the conduction of more effective and more frequent track and rail inspections, the implementation of operational and technological improvements to prevent accidents caused by human error, and the creation of public enforcement policies for rail owners and operators who fail to meet the Positive Train Control Requirement.

These recommendations along with others are explained throughout the paper along with the exploration of further opportunities to enhance rail transportation safety. Throughout the paper, data is analyzed and the methods used in the development of the previously mentioned recommendations are analyzed. This paper illustrates how commercially available technologies, in combination with improved safety practices, can be leveraged in order to improve rail safety.

Benefit-Cost Analysis Guidance for Rail Projects

Federal Railroad Administration, United States Department of Transportation
June 2016

This article aims to present a consistent approach for the completing a benefit-cost analysis for passenger and freight rail project proposals. This process is helpful to decision makers in organizing information about, and evaluating trade-offs among, alternative transportation investments. Through the inclusion of factors such as improved safety, air quality, mobility, and transportation system connectivity to determine benefits and capital, operating, and maintenance expenses to evaluate costs, the benefit-cost analyses derived from the proposed process serve as a requirement for the use of federal assistance under federal investment programs in addition to helping to define and specify investment alternatives.

Throughout this report, the basis for the suggested methodology used to prepare benefit-cost analyses for passenger and freight rail projects that is acceptable to the FRA is first described. Furthermore, this paper identifies common data sources, values, and additional reference materials for various benefit-cost analysis inputs and assumptions. Finally, the equations and illustrative calculations necessary to project sponsors in the preparation of many quantitative elements of benefit-cost analyses are also provided. The requirements of benefit-cost analyses are said to be dependent on multiple factors including the type of project proposed, the development stage of the project, and the cost of the project and are discussed.

Is it noted that, for the areas described in this report, which may be useful to consider in benefit-cost analyses, formal guidance on recommended methodologies or parameter values have not yet been developed by the United States Department of Transportation. Future research is briefly discussed and said to include improved coverage of the areas focused on in the report.

Investigative Model of Rail Accident and Incident Causes Using Statistical Modeling Approach

Shamsullarifin Bin Ismail
Faculty of Engineering Technology, University Tun Hussein Onn Malaysia
July 2016

This thesis uses a regression model to present a procedure which may be used for the accident prediction model. Through the use of the root cause analysis and the Ishikawa diagram, the most influencing factor on an accident can be determined. Using data from 1999 to 2014 from the Australian Railways website, ten main factors were shown to influence accidents including conductor mistakes, other human mistakes, weather influence, track problems, train problems, signaling error, maintenance error, communication error, procedure error, and other. These factors were used as parameters in the completion of the prediction model. A number of regression models were tested before the completion of the prediction model. The dispersion test and Vuong test were both applied and the zero-inflated model was shown to be the best fitted model to predict accidents and incidents in the case of collision, derailment, or SPAD.

An in depth literature review is included in this report along with a multitude of figures used to communicate raw data. This paper also makes note of any limitations that were encountered and makes suggestions for future research on the topic. Considerations were taken into account throughout the paper, for example, the writer notes that different countries have different rail systems and geography which may, therefore, influence accidents and incidents differently.

Trespassing Railway Property – Typology of Risk Localities

Pavlina Skladana, Pavel Skladany, Pavel Tucka, Miroslav Bidovsky, Barbora Sulikova
CDV Transport Research Center, Czech Republic
18 April 2016

The focus of the research discussed in this paper is to further explore the typology of locations with high risk of accidents resulting from trespassing. The considered research project aims to develop a better understanding of various forms of trespassing in the Czech Republic in order to develop and improve preventative measures. A discussion of similar research is provided, in which the writer notes that, while most research focused on accidents involving trespassers, the research considered in this report focuses on trespassing itself and localities where such behavior occurs. This research categorized and described trespassing sites in terms of their function, location, layout, users, and frequency of trespassing. In addition, the research also identified and evaluated various mechanisms of accidents, pre-crash behavior, and relevant circumstances in order to better comprehend the relationship between trespassing and accidents.

The methodology is summarized, first, and the development of the main categories used in the report is explained. The categories, created through the combination of the location and main function of trespassing sites, include stops and stations, shortcuts of everyday use apart from stations, touristic paths and recreation localities, level crossings, places of meeting or lodging, and places of interest. The data collection and analysis methods are then discussed which involve statistical data collection, organization of statistical data into an electronic map of train/person collisions, interviews with experts, and field surveys. Finally, the overall typology of risk localities is presented in terms of the main categories as well as recognized subtypes.

Ultimately, this report distinguishes six types of risk localities with occurrence of trespassing based on differences between motives of trespassing and surroundings in which it occurred. Considerations regarding data availability and applicability are made throughout the paper, for example, relevant literature was notably brief about characteristics of places of trespassing, the number of sites subjected to thorough field investigation was small, and the typology defined in this research is reliably applicable to the Czech Republic and should be carefully considered when used elsewhere.

Freight-Train Derailment Rates for Railroad Safety and Risk Analysis

Xiang Liu, M. Rapik Saat, Christopher P.L. Barkan
University of Illinois at Urbana-Champaign
10 September 2016

The research discussed in this report recognizes the need for a derailment rate analysis using multiple factors and presents an evaluation of the effects of method operation and traffic density on derailment rate. With data obtained from the Federal Railroad Administration Rail Equipment Accident database involving the FRA track class, method of operation, and annual traffic density of the recorded accidents a negative binomial regression model was used to analyze freight-train derailment rates on U.S. Class 1 railroad main tracks.

This report first breaks down the data collected and the variables used. Derailment and traffic is summarized and the variables, which include track class, method of operation, and traffic density, are all individually explained. The methodology used is clearly explained and raw data tables as well as necessary calculations, specifically in relation to the negative binomial regression model, were all provided to better present the information.

Overall, clear conclusions were drawn regarding the effect of each variable on the general derailment rate. As noted in the analysis conducted using the negative binomial regression model, all three variables have a substantial effect on train derailment. More specifically, higher FRA track class resulted in lower derailment rate, signal track had a lower derailment rate than non-signaled track, and high traffic density correlated with a lower derailment rate. While derailment severity was found to be unaffected by method of operation or traffic density, the research result showed a strong correlation between derailment severity and track class, which is consistent with previous studies conducted on the topic.

The information gathered in this research may be used to improve the accuracy of train safety and risk analyses and, in turn, enable a more precise estimation of risk and help in the development of more effective risk reduction strategies.

Northwest Corridor Regional Railroad Safety Improvements

United States Department of Transportation
Undated

This report aims to summarize the benefit-cost analysis of the implementation of quiet zones throughout the Northwest corridor communities. Overall, the format and layout of the benefit-cost analysis, the methodology used to calculate cost and benefits, and the assumptions, limitations, and applications of the results are all considered. The benefit-cost analysis is structured around the quantifiable safety benefits for vehicular passengers through the implementation of SSM standard safety measures at grade crossings and property value benefits in residential property increases attributed to noise reduction caused by train horns at the grade crossings.

Data tables included in this report provide detailed information regarding project costs, evaluation benefits, and benefit-cost ratio as well as construction costs. The methodology used to quantify safety benefits is reviewed including the consideration of the model used and the definition of base statistics and constants included in the model.

This article concludes that at a 7% discount the cost is valued at $16.9 million and the benefits are valued at $34.1 million while the cost is valued at $22 million and benefits are valued at $54.1 million at a 3% discount. In general, this report accurately describes the total costs and benefits that may occur during each year of the project's life cycle and ultimately provides an accurate benefit-cost ratio.

Principal Factors Contributing to Heavy Haul Freight Train Safety Improvements in North America: A Quantitative Analysis

B. Wang, C. Barkan, R. Saat
University of Illinois at Urbana-Champaign
2 September 2017

This report seeks to quantify the most important factors which contribute to the declining trend of heavy haul freight train accidents. Through the use of train accident data from the Federal Railroad Administration, contributing derailment causes were examined and the changes over 10 years between 2006 and 2015 were quantified in order to provide insights to assist decision makers in choosing the most affective approaches to further reduce or eliminate accidents. The research presented focused on identifying which causes of mainline derailments on Class 1 U.S. railroads have the greatest effect on train safety and risk and quantifying and ranking changes in the number and distribution of derailment causes.

The gathered data was first reviewed and the methodology was explained. The data included details for each accident such as date, railroad, weather, and types of track as well as identified 13 types of accidents which were classified by initial cause. The data used in the report includes date, track type, number of cars derailed, and accident cause. Traffic rates were estimated using ton-miles as a metric for traffic exposure.

The train derailment cause analysis was discussed next. It was noted that, for the development of the most effective derailment prevention strategies, the most frequent causes, which include broken rails or welds and track geometry, must be identified. Derailment frequency and severity was analyzed and the inclusion of data tables and figures adequately presented the research findings.

The report concludes that a generally decreasing trend was found in derailment caused by broken rails or welds, track geometry, and most other cause groups excluding obstructions and other break defects which showed a modest increase in frequency and severity.

Hazard Ranking for Railway Transport of Dangerous Goods in Canada

Renato Macciotta, Sean Robitaille, Michael Hendry, C. Derek Martin
Department of Civil and Environmental Engineering, University of Alberta
14 November 2017

Presented in this report is a hazard ranking tool for railway corridors that transport dangerous goods which was developed for the operations, conditions, and characteristics of a Class 1 railway. By providing a ranking of the hazard levels across the analyzed corridors, the research may allow Canadian railways to prioritize resource allocation for hazard mitigation purposes.

The paper first reviews the development of the hazard ranking tool by discussing the conceptual model and considerations that need to be made, the accident causes and factors considered within the model, and the basic equation used to calculate the hazard ranking. The variables included in the equation, which are the relative and conditional derailment likelihood ranking, the ranking of relative frequency of derailment cause and crossing accidents, the relative presence of structures and conditions required for a derailment are further explained individually. Further details are also given on the steps that were followed in order to calibrate the hazard ranking tool to reflect the characteristics of the Canadian network. The hazard ranking input factors are laid out, including train frequency factor for derailment likelihood, track speed factor, track curvature and gradient factor, safety measures factor for derailment likelihood, temperature factor, train frequency factor for derailment cause frequency, rail type and weight factor, and safety measures factor for derailment cause frequency. The explanations of the included variables are included with data tables to ensure that the data is presented accurately and effectively.

Finally, application examples for the presented tool are illustrated with two typical areas of Class 1 railways in Canada. The first is typical of a main line through flat terrain while the second is typical of secondary lines through mountainous terrain. Considerations made throughout the research process are noted at the end of the report, for example variables such as train frequency, speed, gradient, and curvature, while likely not independent variables, were assumed to be independent to allow them to be quantified. Although considerations such as this one were made throughout the study, the calibration against accident occurrences was performed in order to minimize the effect of the assumptions.

FRA Guide for Preparing Accident/Incident Reports

U.S. Department of Transportation, Federal Railroad Administration
Office of Railroad Safety
23 May 2011

This report provides an overview of the update regulations which must be followed when preparing an incident report. These regulations were updated in alignment with OSHA's recordkeeping and recording regulations and involve the reporting of certain suicide data, the reporting of longitude and latitude for trespasser casualties and rail equipment accidents, the addition of necessary definitions, the clarification of ambiguous definitions and regulations, along with other necessary updates. Included in this guide is an explanation of multiple forms including the railroad injury and illness summary, railroad employee injury/illness record, initial rail equipment accident/incident record, employee human factor attachment, notice to railroad employee involved in rail equipment, highway-rail grade crossing accident/incident report, annual railroad report of employee hours and casualties, by state, and the alternative record for illness claimed to be work-related. The general requirements and instructions for properly filling out these forms is included. The appendices include the official forms as well as codes used in data collection.

Analysis of Collision Risk for Freight Trains in the United States

Xiang Liu
Transportation Research Board
January 2016. https://journals.sagepub.com/doi/pdf/10.3141/2546-15

This report goes into detail regarding the quantification of railroad collision risk, defining risk as the product of collision frequency and severity (number of cars derailed). Within the report, data on collision cost and frequency are used to create a negative binomial regression model for the risk of different categories of collision based on type and location.

The conclusions from the models suggest that collision rates have declined over the study period of 2000 to 2014 and that the relationship between collision frequency and traffic exposure varies based on the category of the collision. The paper states that the statistical model for collision risk can be used to determine effectiveness of safety measures, and that the methodology behind developing the model can be repurposed for numerous other areas of interest like risk of transporting hazardous materials and consequences of collisions other than derailment.

Transport Emissions & Social Cost Assessment: Methodology Guide

Su Song
World resources Institute
January 2017. https://www.wri.org/publication/transport-emissions-social-cost-assessment-methodology-guide

This guide elaborates on the procedure behind estimating emissions due to transport and the accompanying social costs in developing countries that currently lack the tools to create emissions inventories and determine social costs. A key point of the guide is that there is a lack of the type of data that could be used to comprehensively determine the emissions and social cost associated with transport, therefore it is important to use different approaches to estimation and cross-reference these.

The guide discusses two methods of obtaining transport-related emissions: the top-down approach, in which the total amount of fuel sold and/or air quality measurements are used to estimate the emissions which can be attributed to transport, and the bottom-up approach, in which information on distance traveled is used in conjunction with information on factors like number of vehicles of certain types and fuel efficiency ratings. These two approaches also apply to estimating social costs.

A large part of the guide relates to the use of the Transport Emissions & Social cost Assessment Tool, which allows users to input the necessary variables and get out estimates of emissions and social cost.

Commercial Truck Safety: Overview

David Randall Peterman
Congressional Research Service
March 2017. https://crsreports.congress.gov/product/pdf/R/R44792

This report provides a comprehensive summary of the safety issues facing the commercial trucking industry and the pertinent legislation. There are over 11 million large trucks in operation in the United States, and the report addresses some of the biggest concerns that contribute to the 400,000 crashes involving a truck every year.

Sleep apnea leading to sleep deprivation, exceptions to truck weight limits, and less stringent training requirements are all provided as factors that increase the risk of crashes in the report. The report also discusses legislation intended to reduce truck-related traffic incidents, some of which has been enacted such as a rule limiting drivers' hours of service and requiring them to log their hours electronically, and some of which has failed to pass such as a rule preventing a truckers from working the maximum time over 5 consecutive days without taking 2 consecutive early mornings off.

The report concludes with information on the Compliance, Safety, and Accountability Program in use by the Federal Motor Carrier Safety Administration since 2010 to assign safety ratings to carriers, but states that the efficacy of the program is limited by a number of factors like lack of high quality data and poor capability of the ratings to successfully predict when carriers are at higher risks for crashes.

Benefit-Cost Analysis Guidance for Rail Projects

Federal Railroad Administration, U.S. Department of Transportation
June 2016. https://www.dot.ny.gov/divisions/operating/opdm/passenger-rail/passenger-rail-repos itory/FRA%20Benefit-Cost%20Analysis%20Guidance%20for%20Rail%20Projects%20(June%2 02016).pdf

This is a thorough guide to constructing benefit-cost analyses (BCAs) for rail projects. The guide opens with information on how BCAs are invaluable tools in making decisions about any type of infrastructure project and provides the basic principles behind conducting any BCA as well as the proper formatting.

The guide goes in depth about the benefits—like time savings and emissions reductions—and costs—like injuries and property damage—associated with rail travel and provides tables of the monetary value of these.

The guide also provides potential benefits of rail projects that are either qualitative or cannot currently be easily quantified.

Rail Project Reports and Piedmont Improvement Program Update

Paul Worley
North Carolina Joint Legislative Transportation Oversight Committee
February 2016. https://connect.ncdot.gov/resources/Rail-Division-Resources/Documents/Rail%20Division%20Joint%20Legislative%20Transportation%20Oversight%20Committee%20Presentation%20-%2002.05.2016.pdf

This presentation provides a summary of the rail projects currently underway in North Carolina. The first slide explains the Transportation Investments Generating Economic Recovery or TIGER program—a USDOT funding program that started in 2009 which is the source of a great deal of funding for North Carolina transportation infrastructure projects.

The presentation reports on the status and purpose of 5 North Carolina railway projects including improvements along the North Carolina and Virginia rail corridor and the Piedmont Improvement Program, which involves improvement of different railway elements across the Piedmont region.

The funding for each of these projects is detailed in the presentation, as well as information on the total funding and spending of money from the American Recovery and Reinvestment Act (ARRA).

Urban Mobility Scorecard

David Schrank, Bill Eisele, Tim Lomax, and Jim Bak
Texas A&M Transportation Institute, College Station and INRIX, Inc.
August 2015. https://static.tti.tamu.edu/tti.tamu.edu/documents/mobility-scorecard-2015.pdf

This 2015 report presents the issue that as the economy has improved since the 2008 recession, traffic congestion has risen to above pre-recession levels, and will continue to grow along with the U.S. economy, and explains that this congestion (at the time) costs around $160 billion due to the waste of fuel, time, and money.

The report uses data on traffic movement from 471 urban areas in the United States, measured every 15 minutes for the entire year of 2014 to create a comprehensive understanding of the amount of delay that occurs in different urban settings, like cities with different populations or different types of roads within those cities.

Overall the report concludes that cities across the United States are unilaterally facing greater congestion problems since the recession and recommends a balanced approach to solving this issue, involving changes to policies and social factors as well as infrastructure.

Statistical Causal Analysis of Freight-Train Derailments in the United States

Xiang Liu
Rutgers, the State University of New Jersey, New Brunswick
November 2016. https://ascelibrary.org/doi/10.1061/JTEPBS.0000014

This paper addresses the lack of knowledge pertaining to the seasonal and regional variations in railroad accidents and statistical models to predict derailment and its cause based on a given set of conditions with the intent of better equipping train companies to manage risks and prevent derailment.

The paper uses accident count data from reports submitted to the Federal Railroad Administration train accident database for a log-linear model to determine a relationship between season, location, and accident type.

According to the model, broken rail and track geometry defects are the most common causes of derailment, with broken-rail defects being much more likely in the fall and winter and track geometry defects being more likely in the spring and summer. The model also found that Western railroads have equal or higher odds of derailment than Eastern railroads.

Two more takeaways from this paper are that the statistical model developed for it could be applied to other factors and causes of derailment and that further research into why derailment likelihood varies would be beneficial.

Measuring the Impacts of Freight Transportation Improvements on the Economy and Competitiveness

Federal Highway Administration, U.S. Department of Transportation
September 2015. https://ops.fhwa.dot.gov/publications/fhwahop15034/fhwahop15034.pdf

This report is part of a FHWA project intended to determine the relationship between freight improvements and economic competitiveness and productivity, reviewing three different methods of analyzing economic impact (benefit-cost analysis, economic impact assessment, and dynamic modelling tools that can assess productivity changes on account of changes in transportation).

The report provides background information on freight transportation, various types of economic impacts, and the various conditions that influence which analytical tools are ideal for a given scenario.

Within the sections pertaining to each analysis method, the report provides the specific modelling tools that can be used for each method and their characteristics. Following the report are four appendices that provide resources for others to conduct research and analyses into the effects of transportation changes on the economy, including areas of knowledge with significant gaps.

A Statistical Estimate of Total Annual Hazardous Material Incidents Costs

Bennett Pierce, Mark Leopfsky, Steven J Naber, Ph.D., and Ronald DiGregorio
Transportation Research Board
March 2006. http://pubsindex.trb.org/view/2006/C/777262

This paper addresses the unreliability of the cost information in the Pipeline and Hazardous Materials Safety Administration's Hazardous Materials Incident Reporting System database with a statistical modelling approach.

The authors used detailed cost information from a sample of 500 hazardous material incidents over a one-year span to perform a stepwise regression analysis and identify variables that are effective at predicting cost.

The statistical model estimated the cost of hazardous material incidents in this span of time to be significantly greater than the reported cost.

Benefit-Cost Analysis Guidance for Discretionary Grant Programs

Office of the Secretary, U.S. Department of Transportation
December 2018. https://cms.dot.gov/sites/dot.gov/files/docs/mission/office-policy/transportation-policy/14091/benefit-cost-analysis-guidance-2018.pdf

This is a thorough guide to conducting benefit-cost analyses specifically for discretionary grant programs that go towards traffic safety. The guide provides information on the terminology and procedure for benefit-cost analyses as well as tables of suggested monetized values for the factors that would be affected by these grants such as emissions, vehicle travel time, and injuries.

The guide provides sample calculations for determining the monetary benefit of various improvements that could be afforded by grants.

Analysis of the Relationship Between Operator Effectiveness Measures and Economic Impacts of Rail Accidents

Steven R. Hursh, Joseph F. Fanzone, and Thomas G. Raslear
Federal Railroad Administration, U.S. Department ofTransportation
May 2011. http://www.fra.dot.gov/Elib/Document/99

This report describes the findings from an analysis of railroad accidents listed in the Federal Railroad Administration's database to determine the link between cost of human factor accidents and the level of fatigue those involved were operating under.

Those involved with the report used the crewmembers' work schedules to create an estimate of when they would likely be sleeping, and used that to create an "effectiveness score" for each of the crewmembers during their shifts. The costs of 350 human factor-related accidents were examined along with the effectiveness scores of the crewmembers working at the time of the accidents to determine that economic risk of human factor-related accidents is greatly increased below a certain threshold, and this threshold was established in terms of effectiveness score.

Implementing Connected Vehicle and Autonomous Vehicle Technologies at Highway-Rail Grade Crossings

Bud Zaouk & Kelly Ozdemir
KEA Technologies, Inc.
August 2017. https://www.fra.dot.gov/conference/2017/rnw/pdf/Presentations/Engineering%20and%20Technologies/Implementing%20Connected%20Vehicle%20and%20Autonomous%20Vehicle%20Technologies%20at%20Highway-Rail%20Grade%20Crossings.pdf

This presentation discusses the promises of using new vehicle technology to prevent grade crossing collisions, which are currently a highly destructive and costly problem.

The presentation discusses connected vehicle (CV) technology first, which would allow warnings about approaching trains to be transmitted directly into cars approaching crossings. The presentation states that CV technology is currently far along in development and that NHTSA estimates an enormous reduction in crashes would result from adopting the technology.

The presentation goes on to discuss autonomous vehicle (AV) technology, which is currently in a fledgling state but should be developed in a way that incorporates CV technology to maximize the safety benefits of taking away the possibility for human error.

Companies Spent a Record $1.5 Trillion on Shipping Costs in 2017

Erica E. Phillips
June 2018. https://www.wsj.com/articles/companies-are-spending-more-on-shipping-and-thats-not-changing-soon-1529413500

This article discusses a report on the sharp increases in the price of logistic services between 2017 and 2018. The article states that the increase in freight rates was catalyzed by the hurricanes in late 2017 which put a great demand on logistics companies to deliver relief, and that they have been driven higher by increasing e-commerce, fuel prices, and interest rates.

The impending import tariffs on China were cited as another factor that would further drive up shipping prices.

Facing a Critical Shortage of Drivers, the Trucking Industry is Changing

Frank Morris
National Public Radio
February 2019. https://www.npr.org/2019/02/11/691673201/facing-a-critical-shortage-of-drivers-the-trucking-industry-is-changing

This segment expounds upon the issue of a shortage of truck drivers currently facing the United States and the efforts that the trucking industry is undertaking to solve this issue.

The trucking industry has started to offer better pay and benefits, undergo changes in culture to be more welcoming for more diverse demographics, and utilize technology that makes trucking safer and more accessible to new drivers. Despite the advantages of working in the trucking industry, the potential for poor treatment by shipping companies, increasing the amount of time spent working without pay, is cited as a major factor in making trucking an unattractive career choice for many.

The segment reports that the number of drivers needed could nearly double within a few years, making the current shortage even more pressing.

The Indirect Costs Assessment of Railway Incidents and Their Relationship to Human Error - The Case of Signals Passed at Danger

Miltos Kyriakidis, Samuel Simanjuntak, Sarbjeet Singh, Arnab Majumdar
January 2019. https://www.sciencedirect.com/science/article/pii/S2210970618300751?via%3Dihub#fig2

Considering the fact that most railway incidents do not result in any serious harm to passengers, operators, or the trains and railways themselves, this report seeks to determine the indirect costs that can be incurred within the context of trains failing to stop at red signals, a specific and common type of incident commonly referred to as Signal Passed At Danger, or SPAD.

The report introduces indirect costs as costs that come about from loss of production and time as well as employee turnover in the event of an incident, being much more difficult to quantify than direct costs because many more parties and factors are involved.

The report utilizes performance shaping factors—factors that contribute to the likelihood of a SPAD such as distraction or visibility—to analyze the relationship between costs of incidents and the status of the drivers involved, concluding that companies involved should take care to address the more significant of the performance shaping factors affecting them in order to prevent SPADs and the resultant indirect costs.

Procedures for Estimating Highway User Costs, Air Pollution, and Noise Effects

David A. Curry and Dudley G. Anderson
Transportation Research Board
1972. http://onlinepubs.trb.org/Onlinepubs/nchrp/nchrp_rpt_133.pdf

This report presents findings on user costs for highways and methodology for analyzing the relationship between these costs and variables pertaining to highways such as highway type and traffic volume.

The report discusses the cost of travel time and how it is affected by delay-inducing factors, the costs of air and noise pollutions on communities surrounding highways, and the cost of accidents. Provided within the report are worksheets used to lay out these costs for a project, and instructions for an iterative process to rank multiple projects using the worksheets.

The report makes suggestions for future research to perform pertaining to many of the factors examined in the report such as noise and air pollution, speed profiles, and traffic collisions.

The Economics of Railway Safety

Andrew W. Evans
Research in Transportation Economics
2013. http://faculty.wcas.northwestern.edu/~ipsavage/104-12.pdf

This report examines railroad incidents and safety measures, looking at trends in multiple polities but primarily focusing on the United States, Great Britain, and the European Union. The report states that accidents are trending downwards in all the polities examined.

The report discusses safety measures that have contributed to the decline in accidents from an economic perspective. Some safety measures, such as Automatic Train Protection, have very low benefit: cost ratios using the valuation of fatalities and injuries, but they are still put in place due to the emphasis on eliminating all preventable accidents in the railroad industry.

The privatization of the railroad industry is brought up as a potential detriment to safety, however, an analysis included in the report of available data on safety performance pre- and post-privatization from Great Britain and Japan shows no evidence of this.

James Foote Keeps the Changes Coming at CSX, with the Intermodal Franchise a Fresh Focus

Jeff Stagl
Progressive Railroading
October 2018. https://www.progressiverailroading.com/csx_transportation/article.aspx?id=55825&source=pr_digital3/22/17

This article discusses the efforts of CSX president and CEO James Foote to continue the gains in efficiency and productivity that
the railroad had been experiencing over the two years prior to the article's writing.

The previous CEO of CSX, E. Hunter Harrison, had implemented an operating plan at CSX called precision scheduled railroading, the principle of which is to shift focus away from moving trains and towards moving individual cars, resulting in greater overall efficiency.

Two areas cited as areas for improvement by Foote are reliability—he wants the company to emulate UPS in its dedication to tracking shipments and ensuring they proceed according to schedule—and intermodal transport, which he intends to improve by redesigning the infrastructure used in intermodal moves.

Property Damage

Analysis of Freight Train Accident Statistics for 1972-74

E.S. Murphy
Battelle, Pacific Northwest Laboratories
May 1978

Available data from the Federal Railroad Administration regarding the location, class and sub-class, cause, and dollar damage of freight train accidents was reviewed to assess the factors that most directly correlate to the frequency and severity of railroad accidents.

The data tables included in the report give detailed information regarding the number of accidents per million freight train miles, accidents as a function of train speed, distribution of collisions by sub-class, and accidents as a function of train speed for various dollar damage categories. This report adequately summarizes this data and effectively communicates its relevance to the final conclusion and overarching purpose to assess factors related to railroad accident frequency and severity.

Unavailable data is noted when necessary, for example, the lack of statistics regarding accidents that resulted in fires as well as measurements of accident forces, both of which can have an impact of the severity of an accident. A compensatory method for the lack of information concerning accident forces is provided, however, through the use of dollar damage statistics. Although dollar damage information can have bounded usefulness in measuring the severity of accidents, the report makes note of the present limitations.

In conclusion, the report notes a positive correlation between train speed and dollar damage and references additional factors related to accident severity including the type of accident, the kind of equipment involved, as well as the geographical environment of the accident.

Semi-Quantitative Risk Assessment of Adjacent Track Accidents on Shared-Use Rail Corridors

C.Y. Lin, C.P.L. Barkan, M.R. Saat
University of Illinois at Urbana-Champaign
2 September 2017

In this paper, a comprehensive approach to identifying and evaluating factors which affect the probability and consequence of adjacent track accidents is considered. Three sequential events, initial derailment, intrusion, and train presence on adjacent tracks, occur in the event of an ATA. Factors affecting the probability component and consequence associated with each event are established and discussed in the report.

The development of the general risk model is reviewed, first. Risk is presented as the multiplication of the probability of an event and the consequence of the event. The report goes on to divide the probability into three components, the probability of an initial derailment on a multiple track section, the conditional probability of intrusion given an initial derailment, and the conditional probability of the presence of a train on adjacent track given an intrusion, and consider the factors which effect each component. Factors affecting the probability of initial derailment include method of operation, track quality, traffic density, type of equipment and rolling stock defect detection technology. Similarly, the conditional probability of intrusion depends on the distance between track centers, track alignment and geometry, elevation differential, adjacent structures, containment, train speed, and point of derailment, while the conditional probability of train presence on adjacent tracks is affected by intrusion detection and warning systems, traffic density, method of operation, train speed, and shunting. The overall probability is evaluated from the product of the three probability levels. Finally, the consequence, including casualties, equipment damage, infrastructure damage, non-railroad property damage, system disturbance and delay, environmental impact, and economic loss, and factors that affect it are discussed. The factors identified to affect ATA accident severity are train speed, equipment strength, containment, and product being transported.

In general, this report defines the levels of probability and consequences and investigates the various factors which affect the initial accident, the intrusion, the presence of trains on adjacent tracks, and consequences.

Development of Railroad Track Degradation Models

Alan J. Bing, Arnold Gross
Undated

This report outlines a method to using quantitative data retrieved from a track geometry measurement car to assist in the effective management of railroad track maintenance. This approach requires the functional requirements of track are defined; track geometry statistics that relate to the ability of a track to meet its functional needs are selected; models are developed that predict the change in track quality as a function of key causal factors, such as traffic, track type, and maintenance; and a methodology is developed for using the track deterioration models to improve safety and maintenance effectiveness.

Reported in this paper is also the progress that was made to date on refining the track degradation models and the related techniques used to collect and condense the data. The report summarizes the uses of track geometry data, measurement of track geometry and calculation of TQI, track degradation causal parameters and track degradation analysis. Shortcomings in the track degradation model and statistics were recognized and further model development was mentioned.

Analysis of Weather Events on U.S. Railroads

Michael A. Rossetti
Volpe National Transportation Systems Center
Undated

This report reviews over 40,000 records from the FRA Railroad Accident and Incident Reporting System database which detail existing hazards and risks on national railroads. The aim of this paper is to explore the true impact of weather as a causal factor in railroad incidents and accidents by filtering and validating the given records to determine which accidents were due to weather related hazards. The results were evaluated through a comparison of initial consequences or type of accident and secondary consequences such as fatalities, injuries, economic damage, and release of hazardous materials. Through this investigation, 861 records were deemed weather-related and adjustments, including the elimination, addition, and regrouping of extraneous fields from the Railroad Accident and Incident Reporting System, were made to allow for a more accurate representation of the effects of weather and environmental conditions on accidents.

This paper adequately analyzes and summarizes the data included in the FRA records and touches on causes, consequences and risk factors affected by the environment as well as how railroads respond to environmental conditions and adverse weather. It is concluded that weather related accidents are responsible for a number of initial and secondary consequences and the potential risk from the environment may be understated by the data in certain cases. Also, current mitigation strategies, better forecasts, or enhanced technology can be helpful in addressing weather-related risks but some will have higher or more immediate payoffs than others.

A Prediction Model for Broken Rails and an Analysis of Their Economic Impact

Darwin H. Schafer, Christopher P.L. Barkan
Department of Civil and Environmental Engineering, University of Illinois at Urbana-Champaign
11 August 2008

This article aims to analyze and discuss the main factors that influence the occurrence of broken rails and develop a model to predict locations where they are likely to occur. Factors such as track and rail characteristics, maintenance activities and frequency, and on-track testing results were all considered. The development of a statistical model for the prediction of broken rail locations through the use of logistical regression techniques as well as the development of an optimal prediction model containing only the top eight factors related to broken rails are all discussed in the report. In addition, this paper also evaluates the economic impact of broken rail events which included the costs associated with broken rail derailments and service failures and the cost of typical prevention measures.

Overall, the report found the most important factors related to service failures to be rail weight, rail type, rail age, annual traffic, weight of car, presence of an ultrasonic defect, presence of a geometric defect, and the presence of a bridge.

In general, the information presented in this report may be helpful in assisting railroads to more effectively distribute resources to prevent broken rails. It is noted that future work may be helpful in the improvement of the service failure prediction model accuracy. Research into factors such as location-specific climate data, flat wheel incidence, and track inspection data may be beneficial.

Effect of Train Length on Railroad Accidents and a Quantitative Analysis of Factors Affecting Broken Rails

Darwin H. Schafer
University of Illinois at Urbana-Champaign
2008

The overall purpose of this research was to better understand the factors related to railroad accidents, specifically in the case of broken rail derailments, and to provide modeling tools that may be helpful in risk analysis and accident prevention. Two topics were examined, the first being accident rates and accident causes based on train length and the second being accident reduction by preventing broken rails.

Within the first topic, the safety implications of railroads running either more trains or longer trains as a result of increased railroad freight traffic are pondered. The Federal Railroad Administration Office of Safety accident database provided accident data and causes that were analyzed. The findings of the study were used in the calculation of new train-length dependent accident rates.

Several modeling techniques are presented for the prediction of broken rail locations and cost associated with broken rails is evaluated within the second topic. The analysis of broken rails were divided into three areas. These areas, first, evaluate previous work and present new predictive modeling techniques, present a predictive model based on recent service failure data, and, finally, summarize the economic impact of broken rail service failures, derailments, and prevention measures on railroads.

A literature review of previous work on the topics presented in the thesis is included in the second chapter which addresses topics such as, accident causes, accident rates, fracture defect growth, factors influencing broken rails, statistical modeling techniques, neural network modeling applications, and railroad economic research. Useful notes for further research were presented at the end of each chapter and adequately address any unavailable data or lack of resources.

Risk Evaluation of Railway Rolling Stock Failures Using FMECA Technique: A Case Study of Passenger Door System

Fateme Dinmohammadi, Babakalli Alkali, Mahmood Shaffiee, Christophe Berenguer, Ashraf Labib
7 October 2016

Through the use of a failure mode, effects and criticality analysis (FMECA) -based approach, the research discussed in this paper identified, analyzed and evaluated the potential risks of unexpected failures occurring in rolling stock. This report also includes a discussion of a case study of the Class 380 train’s door system operating on Scotland’s railway network in order to illustrate the risk evaluation methodology. The results of this study may be used in the performance assessment of current maintenance practices as well as to plan a cost-effective preventative maintenance program for different components of rolling stock.

A brief summary of risk assessment in the railway industry is given first, followed by an illustration of the FMECA methodology for risk evaluation of rolling stock failures. The FMECA technique systematically analyzes all potential failure modes that could occur in various components of a system, identifies the causes of each failure mode and their impact on the operation of the system, calculates a “risk or “criticality” measure for each failure mode based on the rate of occurrence of failure and severity of the possible consequences, and, finally, prioritizes or classifies the failure modes based on level of criticality and proposes some preventative actions that may improve the reliability of the system. The calculation of the criticality level in the FMECA technique is done through the multiplication of the failure mode and the severity of damage caused by the failure, both rated on a scale from 1 to 10. Based on their criticality, the failure modes were classified as very low, low, medium, high, and very high. This report also presents a case study of the passenger train door system and discusses the results. The raw data gathered for the case study is presented and effectively summarized in section 4.

Possibilities for future research are discussed and include the proposition of a multiple criteria FMECA approach for risk evaluation of different rolling stock, the evaluation of the cost effectiveness of preventative maintenance programs, and the development of a more quantitative approach to characterize the likelihood that a rolling stock failure may occur and the impact of likely consequences.

Fault Tree Analysis of Adjacent Track Accidents on Shared-Use Rail Corridors

Chen-Yu Lin, Mohd Rapik Saat, Christopher P.L. Barkan
Department of Civil and Environmental Engineering, University of Illinois at Urbana-Champaign
2016

In this paper, a probabilistic risk assessment methodology is discussed for analyzing adjacent-train accident risk. While derailments without any intrusion may cause equipment and infrastructure damage, passenger casualties, and disturbances to system operations, ATAs can result in all of these in addition to more severe consequences due to the involvement of multiple trains. Through the creation of an event tree and the implementation of a fault tree analysis, basic events that contribute to ATAs were identified. Using the results of the fault tree analysis, the quantitative probability of an ATA was derived using Boolean algebra. The importance and potential application of fault tree analysis in terms of ATA risk analysis was also discussed.

Three sequential events, which are an initial derailment on multiple track territory, an intrusion of the derailed equipment onto an adjacent track, and the presence of another train on that track, combine to result in an ATA. The research presented focuses on two variants of this type of ATA. The first scenario involves an intrusion when a train is on an adjacent track at the same time and location, with the result being and immediate collision, as the derailing equipment strikes the other train. The second scenario consists of an intrusion and a train on an adjacent track approaching the intrusion site resulting in a potential collision with the equipment from the first derailment.

The methodology and calculations used in the research are clearly laid out throughout the report and figures adequately present the event tree as well as the fault tree analysis. It is noted that the fault tree analysis serves as a foundation for further development of quantitative risk assessment and the evaluation of risk mitigation strategies for ATA and subject of possible future research are discussed and said to involve quantitative derivation of probabilities for minimal cut sets and the general probabilistic equation for ATA risk.

Analysis of U.S. Freight-Train Derailment Severity Using Zero-Truncated Negative Binomial Regression and Quantile Regression

Xiang Liu, M. Rapik Saat, Xiao Qin, Christopher P.L. Barkan
Department of Civil and Environmental Engineering, University of Illinois at Urbana-Champaign
29 April 2013

Due to the potentially severe consequences of train derailments, the high priority of derailment analysis and prevention methods in the rail industry and government inspired the research discussed in this report, through which a zero-truncated negative binomial (ZTNB) regression model was developed in addition to a quantile regression (QR) model. The ZTNB regression model was created to estimate the conditional mean of train derailment severity while the QR model is used to estimate derailment severity at different quantities. The intention of this research is to provide insights regarding development of cost-efficient train safety policies. It is noted that understanding the magnitude and variability of derailment severity is as equally important as analyzing the likelihood of a derailment. Derailment severity is measured by number of cars derailed after a train derailment occurs in this paper.

Overall, quantifying the relationship between train derailment severity and associated affecting factors could be helpful to the rail industry and government in the development, evaluation, prioritization, and implementation of cost-effective safety improvement strategies. This paper first includes a general literature review of similar research on the topic as well as an overview of train derailment severity. The data is then broken down and the variables, which include residual train length, derailment speed, distribution of train power, and proportion of loaded cars, are explained. The development of both the ZTNB regression model and the QR model is explained. Finally, the models are discussed and compared. Raw data tables as well as graphs and calculations are included in the report to better illustrate the methodology and summarize the findings.

Analysis of Canadian Train Derailments from 2001 to 2014

Eric Michael Leishman
Department of Civil and Environmental Engineering, University of Alberta
2017

Long term trends in the number of derailments on Canadian railways were investigated and are discussed in this paper. The considered research also aimed to determine the leading causes of derailments and to analyze the frequency and severity of these causes. The four leading derailments causes were subjected to seasonal and spatial analyses to compare their effect throughout the year as well as in different locations across Canada.

The report begins with a brief overview of the research and includes a literature review which summarizes major findings of related studies conducted on Canadian derailments in the 1980s and early 1990s as well as American derailments in the early 1990s to 2010. The sources used in this report are then introduced. Limitations of the available data are also discussed. Finally, the results of the conducted analyses are presented with information regarding long term derailment trends, common causes, frequency, and severity of derailments addressed first, the seasonal and spatial trends of the four most common causes reviewed second, and findings surrounding derailments involving dangerous goods cars discussed third.

Through the use of derailment data obtained from the Railway Occurrence Database System and rail traffic data from the Statistic Canada website, rail, joint bar and rail anchoring followed by track geometry, environmental conditions, and wheel breaks were determined to be the four leading causes of derailments between 2001 and 2014. Conduction of the seasonal and spatial analyses showed that derailments caused by rail and wheel breaks were more common in the winter, while subgrade and track geometry issues caused more derailments in the summer. It was also found that a higher number of derailments occurred in the Cordillera, Interior Plains, and Canadian Shield regions, while few occurred in the St. Lawrence Lowlands and Appalachian regions. Overall, trends were found to be consistent or decreasing in all regions.

In conclusion, recommendations are made for the improvement of the overall quality of the information in the Railway Occurrence Database System in addition to topics of further research. It is suggested that additional research consider additional incident causes to be analyzed for seasonal and spatial trends, the effects of climate change on the occurrence of extreme weather events that may result in increased derailments, and non-main and yard track derailments.

Comparison of Loaded and Empty Unit Train Derailment Characteristics

Weixi Li, Geordie S. Roscoe, Zhipeng Zang, M. Rapik Saat, Christopher P.L. Barkan
Rail Transportation and Engineering Center, University of Illinois at Urbana-Champaign
15 November 2017

The purpose of this report is to examine the effect of train loading condition on derailment occurrence, causes, and severity. The outlined research developed an algorithm which may be used to identify mainline derailments of loaded and empty unit trains in the US Department of Transportation Federal Railroad Administration database. Through the use of this algorithm, a dataset of incidents between 2001 and 2015 was developed. Ultimately the research quantified the number of derailments of loaded and empty trains, the principal causes of these derailments, and their average severity in terms of number of cars derailed.

This report first supplies a brief review of related studies and the context of the research. The research objective is clearly laid out and the steps taken were provided. These steps include developing a methodology in order to identify loaded and empty unit trains from the FRA database, analyzing the resulting dataset to quantify the relationship between train loading condition and derailment frequency and severity, and evaluating the top derailment causes by derailment frequency and average severity. The report also reviews the data resources in addition to the classification method and the algorithm used in the research. Detailed data tables and figures were included such as a classification flowchart for the loading condition database, a table regarding summary statistics of derailments for loaded and empty trains, a bar graph showing the distribution of freight derailment, frequency and severity by year, and a line graph showing derailment frequency versus severity for loaded and empty trains along with various others.

The research concluded that loading condition does influence derailment frequency, severity, and cause. It also showed that broken rails or welds were the most common derailment causes for loaded trains and obstructions were the most common derailment causes for empty trains in terms of both frequency and severity. Finally, areas for future work are suggested. While the fact there were many more loaded trains recorded in the database than empty trains may be indicative of a difference in derailment rate, traffic data for the two loading conditions were not available. Future studies would need to develop this data so that the accurate traffic and derailment rates may be evaluated and compared. It is also suggested that the difference in derailment causes for loaded and unloaded trains should be looked into further to better understand the effects.

Rail Accidents and Property Values in a Production Era of Unconventional Energy

Chuan Tang, Jeffrey Czajkowski, Martin D. Heintzelman, Minghao Li, Marilyn Montgomery
Risk Management and Decision Processing Center, University of Pennsylvania
July 2018

The research discussed in this report seeks to evaluate the implicit costs of railroad accidents, specifically derailments, involving hazardous materials to communities near rail shipments from depreciating the values of nearby residential properties. The findings presented in this report are helpful to policymakers when investigating regulations and alternate transportation modes to improve safe transportation of hazardous materials. Overall, 33 derailment events occurring between 2004 and 2013 in New York State were identified and 373,000 property transactions within five miles of the railroad were used to quantify the effects of derailments on local and regional scales. A polynomial regression model was used to gauge the area which was affected by derailments and the how long the effects last.

The data and data resources are first summarized including rail accident data as well as property transaction data. Railroad accident data was collected from the National Response Center's spill and accident database and the property transaction data was provided by the New York State Office of Real Property Taxation Services. The method used to estimate special and temporal extents of derailment shock are then discussed. An estimated price function is provided and the variables are individually examined. Next, the methodology used for the difference-in-differences model to quantify the local impact is laid out including the research design, model specification, results, and robustness checks and falsification tests. Finally, the extent of derailments' impact is investigated by expanding the models to include properties within five miles of the track.

The writer concludes that, on average, a derailment negatively impacts housing values by 5% to 7%, but that this effect is limited to houses within one mile of the derailment site. Possible reasons for this negative impact are considered and the results are discussed in further detail. Another significant finding of the study is also noted. The impact of derailments on nearby property values is not permanent. It was found that housing prices returned to their pre-accident level 480 days after derailment. The results of this research are relevant in a central debate on rail transportation of hazardous petrochemical materials. Since the main protest to pipeline development is the perceived risks, this report closes with a brief comparison of the results of the study and data regarding the relationship between pipelines and property values nearby.

An Evaluation of Road Safety, Chapter VI Cost Analysis

Office of Technology Assessment, Congress of the United States
May 1978. https://www.princeton.edu/~ota/disk3/1978/7808/780808.PDF

This chapter of the report provides a summary of the types of costs related to railroad accidents and the trend of these costs over the period of 1966-1975. The report analyzes costs that come directly from railway accidents, including injuries, damage to property, and clearing wrecks, and costs that come from safety measures intended to prevent accidents.

The analysis found that, adjusted for inflation, the total cost of accidents over this period rose by around 130 percent, however, the report states that some of the specific cost changes are most likely under- or overstated because of the weighting used in the analytical model.

Regarding preventive costs, the report says that the cost of safety programs cannot be isolated from general costs that go into the railroad or compared across railroads, making it impossible to determine the trend of these costs.

Injury and Fatality

The Economics of Railroad Safety

Ian Savage
Department of Economics and Transportation Center, Northwestern University
1998

Frequency and causes of injuries and fatalities on the railroad are assessed in this book to further explore whether economic regulation of the quality of service by government was in the public interest and to investigate the justification for current railroad safety regulations and the possibility of alternatives. This was accomplished through the use of data collected from a wide array of sources with the main sources being the Association of American Railroads, the Federal Highway Administration, the Federal Railroad Administration, and the National Transportation Safety Board.

The hazards presented by railroads are identified, casualty rates are assessed, and trends in these rates are examined in the report, first. The book then compares the hazards posed by railroads with similar hazards in other industries or elsewhere in society and reflects on the population's reactions to these hazards. Furthermore, the economics of injuries and fatalities are discussed in regards to highway grade crossings, trespassers and occupational injuries before the amount of safety provided as well as five possible market failures, which include market power, imperfect information, customer rationality, railroad myopia, and external harm, are addressed.

Federal Railroad Safety Programs: Selected Issues in Proposed Reauthorization Legislation

David Randall Peterman
CRS Report for Congress
10 August 2007

As is discussed in this report, despite previous improvements in safety measures and, in turn, the number of employee injuries and fatalities, concerns remain surrounding the increase in freight and passenger rail activity and lack of additional efforts to continue safety improvements. Shortcomings involving effectiveness in preventing fatigue among train operating crews as well as time spent on shift after maximum hours have been reached, which also affects fatigue, are discussed in combination with issues surrounding implementation of automated collision-prevention technology in trains, adequacy of track inspections and safety at highway-rail grade crossings.

This report first reviews the Federal Railroad Administration's current policies including their new initiatives to promote safety as well as their National Rail Safety Action Plan. Issues are then discussed broken into categories, such as train operator fatigue, limbo time, positive train control, track inspections, and highway-rail grade crossing safety. Finally, legislative proposals are summarized and issues are brought forward surrounding the Federal Railroad Safety Accountability and Improvement Act, the Federal Railroad Safety Improvement Act of 2007, and the Railroad Safety Enhancement Act of 2007.

Trespassing on the Railroad

Ian Savage
Research in Transportation Economics
2007

The purpose of this report is to provide a statistical analysis of trespassers who sustained fatal injuries on railroads, specifically, their demographic, the activities they were engaged in and the causes of their injuries. This paper does so through the analysis of given data while taking into account cases of documented suicides, the improvement of fatality rates on railroads over history, as well as trespassers' demographics including those who did and did not sustain fatal injuries.

After successfully analyzing the data and effectively determining the most common demographic of trespassers, this paper provides suggestions for safety precautions that may be taken to prevent trespasser fatalities and details regarding trespassers' demographics that may be useful in determining the most effective procedures to follow. In conclusion, this article notes that, while knowledge of the common demographics of trespassers is helpful in taking measures to reduce the causality count, there is still very little research into trespassers and their motivation for being on the railroad. It is stated that there is a great need for a nationwide comprehensive study using FRA data as well as information from sources such as local police reports, coroners, those suffering non-fatal injuries and the families and friends of the deceased.

Opinions on Railway Trespassing of People Living Close to a Railway Line

Anne Silla, Juha Luoma
Safety Science, Vol. 50, pp. 62-67
2011

This research aims to gain information regarding railway trespassing, specifically whether people consider trespassing a serious problem, what countermeasures they assess as effective, the assessment of their own behavior and overall trespassing safety, and their awareness of the legality of trespassing and trespassing fatalities, by conducting a survey among people living close to a railway line. Previous studies on the topic in focus were discussed including a previous attempt in Finland by the writers to address the issue of railway trespassing, during which, a survey directed at engine drivers, trespasser interviews, and an investigation into trespassing behavior at three selected sites with the use of motion detector cameras were all utilized.

The present research presented in the report was conducted to obtain related information to the earlier study by gathering opinions on railway trespassing from people living close to a railway line. Since the previous study only covered a limited number of relevant aspects of the problem, including potential needs for information campaigns, preference of various countermeasures, and new ideas for prevention based on familiarity with local circumstances, the results obtained from the present research are important for designing effective countermeasures.

Along with the data analysis, the method used for the study in regards to the subjects, distribution, and form of the survey as well as the unprocessed data are provided in the report. The overall discussion provides a summary and analysis of the gathered data. Limitations, such as bias within the sample and low response rate, are also noted in the discussion although the results are still considered useful. The report concludes that, generally speaking, the majority of people are aware of trespassing in their neighborhood, have their own experience about trespassing despite considering trespassing dangerous and illegal, and they support countermeasures such as building an underpass or fencing off the tracks.

The Economics of Railway Safety

Andrew W. Evans
Department of Civil and Environmental Engineering, Imperial College London
16 January 2013

The statistics and economics of railway safety in Great Britain, the European Union, and the United States as well as Finland and Japan were reviewed due to the improvement of railway safety in these countries over recent decades. This report discusses a number of factors that affect railroad safety in these countries. First, the railway risk profile, as measured by fatalities and fatality rates, and the medium term trends in the major classes of accidents are reviewed. The appraisal of railway safety measures and the use of cost-benefit analysis are then evaluated followed by the consideration of automatic train protection systems. Finally, level crossings as a major source of railway risk in almost all countries along with evidence of the effect on safety of rail privatization and deregulation are explored.

In conclusion, it is noted that, in the case of automatic train protection systems, strong institutional, legal, and political pressures exists towards adopting this safety measure despite the low benefit: cost ratio. The writer also discusses level crossing safety performance and mentions a lack of cost benefit analysis case-studies in the literature on the subject. Finally, regarding the privatization or economic deregulation of railway systems, it is concluded that, when data on safety performance before and after privatization was available, there was no evidence that safety deteriorated after privatization. The report does note a lack of available data in this area, however, for the United States, Finland, and the European Union.

Comparing the Fatality Risks in United States Transportation Across Modes and Over Time

Ian Savage
Department of Economics and the Transportation Center, Northwestern University
21 January 2013

The research discussed in this report analyzes the transportation fatality risk in the United States and does so by comparing the relative risks over different modes and over time. Fatality data serves as an indicator of overall safety and generally correlates with differences in non-fatal injuries, illnesses, and property damage allowing researchers to gain insight into overall safety measures through the analysis of a limited set of data.

To analyze fatalities by mode, users were divided into private transportation, in which the user is in control of the vehicle or is a passenger in a vehicle, and commercial transportation, in which passengers or freight shippers contract with transportation providers. Private transportation includes walking, bicycles, motorcycles, cars and light trucks, recreational boating, and private flying while commercial transportation encompasses passengers, employees of transportation companies, or bystanders who are fatally injured by debris or hazardous materials release. The case of a collision between a private user and commercial carrier is taken into account with an intersection of the two categories. The results indicate for economists that industrial organization analysis of firms' commercial safety choices and labor economics' examination of workplace safety, two extensive fields of safety research, affect only a small percentage of total fatalities. The report goes on to look into individual modes including highways, mainline railroads, maritime, aviation, rail transit, and pipelines and analyze the passenger and employee fatality risk comparisons across them.

The time-series analysis reviews trends in fatalities and fatality rates between 1975 and 2010. This section also reviews fatality data for various modes such as highways, mainline railroads, maritime, commercial aviation and private aviation.

Limitations in provided data were noted as well as considerations that should be made, for example, imperfections in the correlation between fatality rates and environmental risks, a lack of trucking data between 2009 and 2010 or problems that arise when using fatality data for analytical purposes due to considerable annual fluctuations.

Based on the data evaluated in this report, the writer concludes that, although transportation safety has considerably increased since 1975, specifically for commercial modes such as aviation, railroads, and maritime, the public continues to push for even more improvement. This is partially due to the fact that, despite consistent improvement, transportation incidents continue to be the leading cause of "unintentional injury deaths" in the United States. It is also noteworthy that a considerable amount of press coverage and public discussion concerns commercial transportation safety due to the dramatic and publicized nature of crashes in commercial transportation.

A Model of Suicide and Trespassing Processes to Support the Analysis and Decision Related to Preventing Railway Suicides and Trespassing Accidents at Railways

Jean-Marie Burkhardt, Helena Radbo, Anne Silla, Francoise Paran
Transport Research Arena, Paris
2014

In this report, a model of suicide and trespassing processes on the tracks is discussed and justified with the goal of helping to guide the analysis and selection of suicide and trespassing process prevention measures in railway areas. The model highlights the similarities and differences between the identified processes and associated measures directed to preventing railway suicides and trespassing accidents. Unlike previous literature dedicated to the prevention of railway suicides and trespassing accidents, the proposed model addresses both issues and integrates injury prevention efforts of intentional and unintentional injuries. This collaboration arose from reasons which are laid out in the article. They are 1) several proposed injury prevention measures are suitable for both suicides and trespassing accidents, 2) positive reinforcement may exist between some of these measures, and 3) suicide and trespassing are usually addressed together for infrastructure managers and railway undertakings.

This research, specifically, address the applicability of the 5, previously developed categories used to classify measures to prevent railway suicides to the prevention of railway trespassing. Upon review, additional categories were created and previous categories were modified.

A brief literature review of sources on railway suicide and trespassing prevention is provided as well as a discussion on perspectives beyond the frame of this specific project. Necessary further steps are noted such as assessing the accuracy of the model in relation to reality, in terms of how much the model differs from reality as well as how important those differences are for the use of the model. The writer also touches on a plan to further elaborate on the model which includes refining, extending, and confronting its content against recently collect evidence in addition to conducting field tests to assess the usefulness and usability of the model.

A Systematic Review of the Literature on Safety Measures to Prevent Railway Suicides and Trespassing Accidents

Grigore M. Havarneanu, Jean-Marie Burkhardt, Francoise Paran
International Union of Railways, Security Division, Paris
11 April 2015

The focus of this report is to review and summarize the past and current trends in railway suicide and trespass prevention practice by analyzing the recommended measures both quantitatively and qualitatively. The discussion mainly revolves around the need for a combined approach and the importance of considering the effect mechanism of the measurements in order to develop better interventions. Despite the fundamentally different motivations for suicide and trespassing, the writers maintain that, since both imply partially similar actions, the measures aimed to reduce trespassing actions may also be applicable to suicide and vice versa.

This review first looks at a number of publications which address railway suicide or trespass to gather information on railway suicide and trespass and analyze the proposed counter measures. A descriptive analysis of these publications are provided. Common approaches as well as theoretical approaches are both discussed and compared. While a number of conclusions are presented at the end of the paper, several limitations of the review are also considered. The report also notes that future studies should be performed in order to evaluate the efficiency of safety measures and point out the conditions that make a measure productive or counterproductive.

Railway Accident Prevention and Infrastructure Protection

El Miloudi El Koursi, Jean Luc Bruyelle
Journal of Civil Engineering and Architecture
2016

This paper analyzes the capability of existing techniques used in the preventative measures which target the reduction of railway suicides, trespassing and level crossing user accidents to effectively reduce accidents along with their cost-effectiveness and their integration within the railway transport system as a whole. This report first presents relative statistics regarding railway safety and analyzes the measures put in place to protect railway infrastructure and avoid accidents. This includes the discussion on the RESTRAIL project model, which accounts for trespassing with suicidal intent and trespassing with no intent of casualty. This section also reviews measures specifically aimed at suicide or trespass prevention that may be applicable to the prevention of both as well as measures aimed at one issue that may be counterproductive in the prevention of the other. The case of level crossings is specifically investigated, next, and the measures devoted to them are evaluated.

Overall, this report includes a number of data presentation methods including graphs which effectively present information regarding the number of fatalities per victim category, a comparison of unauthorized person fatalities and suicides, level crossing accidents and casualties, and level crossing types as well as a raw data table which presents the technical and soft families of measures related to trespassing and suicide. The data provided in these figures is adequately evaluated and effectively summarized throughout the paper.

Rail Safety Statistics

Office of Rail and Road
26 September 2017

Summarized in this Annual Statistical Release is data regarding rail safety in Great Britain from 2008 to 2017. The information included in this release addresses train accidents and the number of injuries and fatalities affecting passengers, the workforce, and members of the public. The Rail Safety and Standards Board, London Underground Unlimited, the British Transport Police, and the Office of Rail and Road were all involved in providing the data presented in the release.

Passenger, workforce and public safety were all discussed through the presentation of data regarding fatalities, injuries on the mainline, injuries on the London Underground, and injuries on trams, metros and other non-network rail networks. Train accidents on the mainline, London underground and non-network rail networks were also considered. Overall, there were 15 passenger fatalities and 6,866 passenger injuries, one work force fatality and 6,713 workforce injuries, 309 public fatalities and 142 public injuries, and 687 train accidents reported.

The inclusion of bar graphs comparing the number of fatalities year to year and pie charts depicting the causes of injuries effectively and clearly present the data. Related publications are also included in the report and are noted to include more details surrounding the statistics included in this release.

Annual Railroad Fatalities since 1975—North Carolina

According to this graph, which plots railroad fatalities of seven different categories against time from 1975 to 2016, railroad fatalities in North Carolina have been gradually declining since 1975. Trespassers have historically made up a plurality of railroad fatalities, and in 2016, it appears that about 20 of 32 fatalities were trespassers while the remaining 12 were evenly split between intentional deaths and motor vehicles at crossings. As of 2014, workers, passengers, and non-trespassers no longer make up a portion of deaths, and no intentional deaths are recorded prior to 2010.

2016 Standardized Crash cost Estimates for North Carolina

North Carolina Department of Transportation
2016

This report contains estimates for the cost of crashes based on factors of vehicle types involved, resultant injury severity, and location (urban vs. rural).

The report uses the Value of a Statistical Life (VSL) from the United States Department of Transportation to determine the cost of each type of injury in the estimates of crash costs.

Costs of each crash type when comparing urban and rural crashes were found to be roughly the same except for the average cost, because rural crashes tend to be more severe on average.

Trespassing and Suicide—The Neglected Rail Safety Problem

Kurt Topel
Chicagoland Rail Safety Team
2018

This presentation discusses the persistent issue of trespassing and suicide-related railroad fatalities in the face of declining overall deaths.

Railroad suicides were not a problem until 2010, while trespassing deaths have remained more or less constant since 1975. The author of the presentation posits that not enough attention is being paid to these deaths because the consequences of the deaths to the railroads is not enough to warrant the expense of dealing with the issue.

The presentation also discusses efforts that have been taken to address these deaths; a program that began in 2010 is reported to have contributed to an 18% decline in railway suicides over 2016 and 2017, and the Federal Railway Administration has been required to create a strategy for reducing trespassing deaths.

Delay Costs

Train Delay and Economic Impact of In-Service Failures of Railroad Rolling Stock

Bryan W. Schlake, Christopher P.L. Barkan, J. Riley Edwards
Department of Civil and Environmental Engineering, University of Illinois at Urbana-Champaign
2011

Due to the limited nature of manual, visual inspection, the use of this technique in current railcar inspection practices did not enable preventive maintenance. In turn, automated wayside condition-monitoring technologies were developed to monitor rolling stock condition and facilitate predictive maintenance strategies. Previous analyses have evaluated the cost reduction as a result of a decrease in derailment rates and have justified investments in wayside detection systems. The research discussed in this report analyzed the effect of lean production methods on main-line railway operations in order to determine the potential impact of improved railcar inspection and maintenance practices made possible by new, automated wayside technologies. The magnitude and variability of train delay as a function of traffic level and severity of service outage were both quantified through the use of dispatch simulation software. As a result, the annual cost caused by main-line delay was found to be substantial when compared with the annual cost of track and equipment damages from main-line derailments caused by mechanical causes.

Overall, a large amount of raw data is provided throughout the report and effectively analyzed and summarized. In short, the simulations used to analyze the effect of in-service failure durations and traffic volume on single and double-track versions of a hypothetical route to estimate train delay indicated that both traffic volume and ISF length had a non-linear effect on delay, with traffic having an exponential effect, and that ISFs have a much greater impact on single-track than double-track operations. It is noted that the study presented can and should be used as a framework to assess the potential impact of equipment-related ISFs on railroad main-line efficiency.

Cost and Delay of Railroad Timber and Concrete Crosstie Maintenance and Replacement

Alexander H. Lovett, C. Tyler Dick, Conrad Ruppert Jr., Christopher P.L. Barkan
Department of Civil and Environmental Engineering, University of Illinois at Urbana-Champaign
2015

In this article, a model which can be used to compare the life-cycle economics of concrete and timber cross ties in addition to a sensitivity analysis which shows the various effects of different inputs on the cost comparison between timber and concrete ties are presented. This research aims to present cost analysis data to ensure that optimal decisions regarding infrastructure investment and maintenance strategies can be made.

Life-cycle costs are addressed, first, and the analysis considers the four main categories of renewal, accident, slow order, and other track maintenance. These categories are then further divided into direct, delay, and network costs. It is noted that, although previous literature has considered direct and delay costs, no previous research has included networks costs as a factor. In regards to life-cycle cost, direct costs are discussed first, including renewal costs, accident costs, slow order costs, and other track maintenance costs, followed by an evaluation of delay and network effects.

For the sensitivity analysis, the writer mentions that some of the required inputs may be difficult and expensive to gather for a large number of lines so an understanding of which inputs have the greatest impact on life-cycle costs must be developed. The sensitivity analysis was performed for each case independently using a total of 39 input factors covering almost all of the track, operations, and disruption characteristics. The findings are presented in a data table and are summarized.

Finally, a case study with a network of four lines was conducted that shows how the proposed model handled various situations. The study found concrete ties to be more cost-effective in most cases. Explanations of outliers and discussions surrounding unexpected results are provided.

The article concludes that the consideration of delay and network costs can greatly affect maintenance decisions. The results of the sensitivity analysis were conclusive and can be used to identify locations of where data collection efforts should be concentrated to improve the accuracy of life-cycle costs analysis. The influence of delay and network effects on the comparison between timber and concrete ties were shown in the case study. The case study also demonstrated that, even if a particular alternative has a higher accident risk, the overall costs of the option with the higher accident rate may be higher due to an increased frequency of network disruptions.

Future work is suggested for the improvement of the model's applicability and validity as well as gathering validation data and the refinement of the component-specific accident rate. Data gathered from actual railroad lines would also be helpful to the model in better representing the actual conditions of the railroad and applying to a wider range of scenarios.

Predicting the Cost and Operational Impacts of Slow Orders on Rail Lines in North America

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2017

A new model is presented in this paper that is used to estimate the effects of traffic disruptions, specifically slow orders, on train operations and track maintenance costs. Factors such as cascading delays, relative speed reductions, overlapping slow order areas of influence, and the ability of a route to recover from a disruption are all included in the model. Factors that affect slow order risk are also considered and are comprised of the rate of occurrence, slow order length and duration, the cost of train delay, and potential compounding effects on subsequent trains and adjacent lines. The purpose of the research discussed in this report is to improve upon previous studies surrounding the costs and operational effects of slow orders in order to improve timing and location planning of track maintenance to minimize costs.

This report begins with an explanation of the Webster uniform delay model which is used to simulate the impacts of stopped traffic in order to evaluate the operation impacts of traffic disruptions. The variables and equations used in the model are clearly defined and the process is effectively summarized. Moreover, the research also takes into account the sensitivity of the model to specified parameters through the use of both single- and two-variable sensitivity analyses. The slow order duration, the number of trains processed per hour under normal operations, the time to traverse the route under normal operating conditions, the length of the route, the normal average train speed, the average annual number of slow orders per mile, the slow order length, the slow order speed, the additional time to accelerate and decelerate from and to the slow order speed, and the normal capacity utilization are among the variables tested in the sensitivity analysis. The effects of increasing the given variables were as expected and the results gave insight on the elasticity of each variable. In addition to the consequences of slow orders, the research addressed in this report also considers the likelihood of slow order occurrence through the use of probabilistic models. The methodology of this model was clearly laid out and the appropriate equations and figures were presented and defined.

Necessary considerations were consistently noted in this report as well as encountered limitations. An example of this can be found in section 2 regarding the Webster uniform delay model when it is noted that the applicability of the model may decrease in the case of a route containing large sections with multiple tracks. Limitations such as outdated statistics were noted in regards to the estimation of slow order risk through the use of the probabilistic model. Assumptions, such as uniform development of defect throughout the year, are also noted in regards to the probabilistic model.

Overall, the research presented effectively helps quantify the effects of route operation before, during, and after a disruption in addition to evaluating the relationship between the normal and slow order operating speed. Notes for improvements in track maintenance and safety practices, such as performing maintenance earlier, preventing slow order overlap areas, and increasing line capacity, are included as well as suggestions for future work on the topic, which includes exploring how train delay and defect probability can be incorporated into an optimization model in order to schedule track maintenance over a network as well as expanding overall understanding of slow order applications and that of recovery adjustment factors to increase their applicability.

Delay Performance of Different Train Types Under Combinations of Structured and Flexible Operations on Single-Track Railway Lines in North America

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2017

The research discussed in this paper uses data provided by the Federal Railroad Administration in addition to Rail Traffic Controller simulation software to compare the effects of scheduled and flexible trains, the amount of schedule flexibility, and train priorities on the performance of a single-track rail corridor.

The results of this study can be helpful in planning for operation of different scheduled and flexible train types on the same rail corridor. The results of the study generally show that reducing schedule flexibility in order to reduce delay and increase level-of-service have little impact until operations become highly structured with little flexibility. This study also shows that schedule trains tend to increase their performance when there are fewer flexible trains on that route but flexible trains are relatively unaffected by traffic composition.

The methodology of the conducted research is broken down and the Rail Traffic Controller software along with the establishment of a baseline schedule and introduction of schedule flexibility are reviewed. Previous research on the topic of interest is reviewed in the report and it is noted that, while previous studies have considered heterogeneity in train speed, priority, and vehicle capability, the differing schedule flexibility and level-of-service requirements of multiple train times has not been studied in these investigations. The writer also makes note of potential areas for future work including providing additional understanding of the trade-off between infrastructure investment, traffic volume, schedule flexibility, and initial timetable design through the introduction of different levels of infrastructure, traffic volume and initial timetables. Quantifying the impact of the types of conflicts on the level-of-service is also noted as an additional logical step for future research.

Rail Vulnerability: Impacts of Winter Related Disruption on Network Performance

Deborah Neves
Civil Engineering and Management
August 2017

The objective of the research presented in this paper is to classify and analyze the vulnerability of the Dutch rail network to winter weather based on its infrastructure and the disruption impacts on accessibility. The disruption impacts were analyzed by listing the most critical routes during the winter in order to consider how performance may be reduced by winter weather susceptibility. Provided in this report is a risk map which clearly depicts the level of vulnerability of the connections. This report intends to provide information which may enable better planning of resources for disruption mitigation and maintenance arrangement as well as support the operators when directing investments on technological improvements providing a more efficient recovery system.

Included in this paper is an introduction on the topic and an explanation of the topic’s relevance to modern society and acknowledgment by the industry and academic field. Recent and relevant studies are also reviewed in more detail. The methodology used in the research is then presented, including an explanation of the steps taken in the evaluation of the vulnerability index, which involves a combination of a link component based on infrastructure and a node component based on station potential, as well as a description of the analysis of the data, and the assessment of route criticality.

The research presented aims to relate disruption cause, time, and location to winter weather aspects such as low temperatures, relative humidity levels, or presence of snow or freezing rain. In order to meet this goal the most critical components were analyzed first for inclusion into the regression model. After reviewing the results, switches were selected as the main infrastructure element for the model. The report then establishes the switch probability regression model based on type of winter weather, number of switches on the link, and train frequency. As a result, the probability of disruptions related to switches for each link within the rail network was assessed. Station importance was also estimated based on potential users, traveler ridership, and station connectivity and included in the model. Finally, the research estimated the vulnerability levels per link through the consideration of the number of routes that used the specified link, the sum of the switch vulnerability levels and the weight of the station importance.

Limitations and areas for future research were discussed and include a need for clear orientation and training of personnel responsible for registering winter weather related disruptions, additional information on disruptions, an inclusion of terrain characteristics in data collection, an implementation of new collecting points within the rail area near critical rail sections, a more detailed quantification of data and a potential classification of heavy, medium, and mild weather events. It is concluded that most of the critical links are focused in one specific area which can be seen on the risk map provided. Possibilities for improvements in procedures are also noted in the conclusion of this report.

Prediction of Weather-Related Incidents on the Rail Network: Prototype Data Model for Wind-Related Delays in Great Britain

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19 June 2018

The research discussed in this paper aims to identify independent variables that may be related to the occurrence of weather-related incidents. To fulfill this purpose, a prototype data model with logistic regression analysis is considered. Through the use of data gathered from the Anglia Route of Great Britain’s rail network between 2006 and 2015, which includes data sets regarding climate, geography, and vegetation in order to cover a wide range of potential contributing factors, ways in which the location and timing of wind-related disruptions may be predicted. The presented study builds on a previous report in which an empirical analysis was performed on the available data and the feasibility of applying the data-processing techniques. In this report, an improved methodology along with details surrounding the data and data resources are first presented followed by an explanation of the development of the prototype data model used to identify trends in the data and to allow for more accurate predictions of weather-related incidents. Next, this improved method and new model are used to assess factors contributing to wind-related delays and predict the probability of future delays in the context of a selected area of Great Britain's rail network.

The methodology explanation includes a review of the area covered in the case study as well as a discussion of the data resources used in the study. The three main data resources used in the research are reported weather-related rail incidents, local historical weather observations, and information on the types and extent of lineside vegetation coverage.

Weather data, vegetation data, weather-related incident data, and railway codification data from the Great Britain railway network along with data gathered from OpenStreetMap are all described in detail. The data cleaning and integration performed before using the data and the data modeling techniques used are also described. A variety of data tables, graphs and figures are used to better present the gathered data and research findings. Also, a number of considerations are noted throughout the report such as causes for outliers or assumptions made which may affect the results.

The report concludes that, according to the initial results from the prototype data model, the performance was good in terms of both sensitivity and specificity of the delay predictions. The model also identified wind direction, relative humidity, and temperature variations as causal factors contributing to wind-related incidents and found that lineside vegetation did not contribute to the prediction of delays. Limitations and considerations that may be problematic are noted to include issues surrounding the timeliness of the vegetation data and assumptions that the vegetation did not change significantly during the period of interest. Areas for future work are also discussed. For example, it is mentioned that, while the model can be adapted to categories of weather-related events besides wind, further variables outside of the considered data set may need to be considered for the model to accurately evaluate those cases. Further research is needed to generalize the prototype used in this study to a larger scale and wider context. Further work may also include the development of interoperable data links to enable location data to be accessible from the diverse set of coding systems currently used on the Great Britain rail network, continued development of the process used to define and determine incident and non-incident periods so that it may be used across different domains, and continued improvements in the modeling techniques.

Valuation of Travel Time Reliability in Freight Transportation: A Review and Meta-analysis of Stated Preference Studies

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August 2017. https://doi.org/10.1016/j.tra.2016.08.001

This report provides a very thorough overview of the studies that have been conducted thus far on value of reliability (VOR) in freight transportation, defining travel time reliability as a measurement of "the unexpected deviation from the expected duration of travel, which travelers develop through their travel experiences or from external sources (i.e. online sources)." The report goes into great detail about the experimental designs and statistical models that have been used in VOR studies and provides tables that summarize the methodology and results of these studies, showing significant variation in both the estimated values for VOR and the methodology used in the studies.

The main finding of this paper is that VOR is such a complex concept that it is very difficult to quantify and that inconsistency in methodology between existing studies makes it impossible to draw any meaningful conclusions from the available data. The report concludes that establishing a consistent definition of VOR as well as guidelines for conducting future studies would be highly conducive towards understanding how travel time reliability is valued in the freight industry.

Monetizing Truck Freight and the Cost of Delay for Major Truck Routes in Georgia

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December 2011. https://smartech.gatech.edu/bitstream/handle/1853/42907/gillett_jessica_c_201 112_mast.pdf

The purpose of this report is to place a monetary value on truck freight in order to understand how the increased volume of truck traffic into the future and resultant increases in congestion will affect the economy of Georgia. The thesis used data from numerous sources including the Federal Highway Administration's Freight Analysis Framework, Georgia Department of Transportation, and American Transportation Research Institute on freight truck movement along I-75 from Macon to the Georgia-Florida border in order to determine the cost of travel and delays for freight trucks.

The author provides a very thorough description of the process behind calculating the value of truck freight, involving groupings by truck type and time sensitivity of goods carried, and takes into account projections about future increases in freight value as well as volume.

The thesis concludes that the expected pace of freight volume increase will exceed the capacity of highways to efficiently accommodate freight traffic unless certain critical links are dealt with. The applicability of this thesis to other highways may be limited considering it only examines one corridor along I-75, but the author acknowledges this limitation and states that the findings of the report could provide guidance for other states' endeavors to determine the needs of their highway networks through delay calculations.

Analysis of Travel Time Reliability for Freight Corridors Connecting the Pacific Northwest

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November 2012. https://pdxscholar.library.pdx.edu/cgi/viewcontent.cgi?referer=https://www.google.com/&httpsredir=1&article=1098&context=cengin_fac

This report pertains to the estimation of variability in travel time along freight corridors in the Pacific Northwest and the consequent economic and environmental costs of the congestion that can negatively impact travel time reliability.

Data on freight truck travel time used in this report were collected from loop sensors within roads, specific incident reports, and GPS data from the trucks themselves. The report goes into detail regarding the issues with these sources and how they were dealt with to maintain the integrity of the data. Also used in this report are previous studies on greenhouse gas and other harmful emissions from freight trucks under different conditions, resulting in a comprehensive picture of the environmental damage that can result from highway congestion.

The report concludes that increased variability in travel time can significantly increase costs for carriers, making urban areas particularly costly for operation of freight trucks, and suggests that the research presented in the report can be used to estimate the benefits of making improvements to roadways that serve to reduce congestion.

The Impact of Freight Delay to Economic Productivity

Florida Department of Transportation
April 2014. https://tampabayfreight.com/wp-content/uploads/The-Impact-of-Freight-Delay-to-Economic-Productivity.pdf

This white paper addresses the critical issue of the effect of freight delays as it relates to the Tampa Bay regional economy. The paper reports that the freight industry provides around 240,000 jobs and the total value of all shipments into and out of the Tampa area is somewhere upwards of $100 billion, therefore it is crucial to determine the true value of delays in order to better understand the economic impacts of congestion along freight corridors.

The paper presents the findings from a number of different sources pertaining to the actual per mile costs of freight, the value that freight drivers personally assign to delays, and the value of travel time reliability. The paper also addressed the economic impacts that extend beyond those shipping and receiving freight.

One key section of the paper relates to a project by the Strategic Highway Research Program of the Transportation Research Board that produced a model of the economic benefits of improved reliability by isolating the variables involved in freight delays, and another deals with ongoing research into value of travel time reliability and benefit-cost analyses pertaining to infrastructure investments. The paper concludes that the impact of freight delays is currently highly uncertain and future research into the topic would be highly beneficial.

As Trains Move Oil Bonanza, Delays Mount for Other Goods and Passengers

Ron Nixon
New York Times
October, 2014. https://www.nytimes.com/2014/10/09/us/as-trains-move-oil-bonanza-delays-mount-for-other-goods-and-passengers.html

This article discusses the influx of oil production that occurred in 2014 and the consequent spike in freight traffic on railroads. The article points out that the traffic increase imposed significant delays on passenger trains as well as trains delivering consumer and industrial goods besides oil.

The article frames aging infrastructure and insufficient train cars as contributors to these delays and discusses proposed improvements like reconfiguring railways and junctions in Chicago and expanding the rail system in North Dakota.

The article discusses factors likely to cause a worsening of the problem such as increasing coal exports and record agricultural output.

Shippers Worry They Will face Increasing Delays as Shutdown Drags On

Erica E. Phillips
Wall Street Journal
January 2019. https://www.wsj.com/articles/shippers-worry-they-will-face-increasing-delays-as-shutdown-drags-on-11547591053

This article discusses the impact of the 2019 government shutdown on the transportation of goods and the concerns that faced many involved in the shipping industry regarding the effects of a prolonged shutdown.

Numerous agencies, like the Transportation Security Administration, Customs and Border Protection, and Environmental Protection Agency, play a role in overseeing shipments into the United States, and the shutdown caused these agencies to be extremely short-staffed, resulting in a growing backlog of issues with shipments.

The article reports that some foreign businesses were affected further by the lack of trade data from the Commerce department, which they use to make decisions on production.

Evaluation of Rail Trespassing Delay Impacts on Railroad Operations

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This report details the impacts of rail trespassing incidents, summarizing the 43 such incidents that happened over a 14-month time period from the end of 2015 to the beginning of 2017.

31 deaths and 8 injuries resulted from these incidents, the average delay per train was found to be 101 minutes, and the average cost of the delay from a trespassing incident was estimated at $7,500, using a figure from a 2015 study on the cost of freight train delays.

Rail Component Repair and Replacement Costs

AAR Price Matrix | January 2020

FID	Applied Job Code	Condtion Code	Fixed Labor Time Standard	Variable Labor Time Standard	Job Code Description	Material Price	Credit	Fixed Labor	Variable Labor	Total Cost
1	1116	7	0	3.888	ADDITIONAL BRAKE CLEANING - ACCOUNT SUBMERGED	$0.00	$0.00	$0.00	$549.14	$549.14
2	1128	0	0	0	INSPECTION ASSOCIATED WITH EHMS LORF-AHS ALERT	$0.00	$0.00	$0.00	$0.00	$0.00
3	1130	7	0	0.072	ADD'L SERVICE STABILITY TEST - EHMS LORF-NCF ALERT	$0.00	$0.00	$0.00	$10.17	$10.17
4	1132	7	0	0.07	ADDITIONAL VENT VALVE TEST - EHMS LORF-NCF ALERT	$0.00	$0.00	$0.00	$9.89	$9.89
5	1139	7	0	2.63	SCT USE MANUAL DEVICE, 1 SET, PER MA-63 OR EW 5171	$0.40	$0.00	$0.00	$371.46	$371.86
6	1140	7	0	2.885	SCT USE AUTO TEST DEVICE, 1 SET, PER MA-63 EW 5171	$0.40	$0.00	$0.00	$407.48	$407.88
7	1142	7	0	2.302	4-PRESSURE SCT W/ AUTO TEST DEV, MA-63 OR EW 5171	$0.40	$0.00	$0.00	$325.13	$325.53
8	1144	7	0	0.87	4-PRESSURE SCT USE AN AUTOMATIC SCT DEVICE, 1 SET	$0.40	$0.00	$0.00	$122.88	$123.28
9	1145	7	0	1.198	SCT USE A MANUAL SCT DEVICE, 1 SET	$0.40	$0.00	$0.00	$169.21	$169.61
10	1146	7	0	1.453	SCT USE AN AUTOMATIC SCT DEVICE, 1 SET	$0.40	$0.00	$0.00	$205.22	$205.62
11	1147	7	0	0.312	BRAKE CYLINDER LEAKAGE TEST, 1 SET	$0.00	$0.00	$0.00	$44.07	$44.07
12	1150	0	0	0.387	GROUP A - PISTON TRAVEL ADJUSTMENT	$0.00	$0.00	$0.00	$54.66	$54.66
13	1151	0	0	0.341	GROUP B - PISTON TRAVEL ADJUSTMENT	$0.00	$0.00	$0.00	$48.16	$48.16
14	1152	0	0	0.437	GROUP C - PISTON TRAVEL ADJUSTMENT	$0.00	$0.00	$0.00	$61.72	$61.72
15	1153	0	0	0.205	BODY MOUNTED BRAKES-TRUCK LEVER ADJUSTMENT	$0.13	$0.00	$0.00	$28.95	$29.08
16	1155	7	0	0.069	SLACK ADJUSTER TEST	$0.00	$0.00	$0.00	$9.75	$9.75
17	1157	7	0	0.078	RETAINING VALVE TEST	$0.00	$0.00	$0.00	$11.02	$11.02
18	1159	7	0	0.155	EMPTY/LOAD VALVE TEST	$0.00	$0.00	$0.00	$21.89	$21.89
19	1160	1	0	0.253	ANGLE COCK, BALL TYPE	$38.20	$0.33	$0.00	$35.73	$73.93
20	1160	2	0	0.253	ANGLE COCK, BALL TYPE	$32.20	$0.00	$0.00	$35.73	$67.93
21	1160	3	0	0.253	ANGLE COCK, BALL TYPE	$34.01	$0.00	$0.00	$35.73	$69.74
22	1161	1	0	0.1	ANGLE COCK / END COCK HANDLE	$19.69	$0.11	$0.00	$14.12	$33.81
23	1162	1	0	0.24	END COCK 1 1/4"	$69.97	$0.33	$0.00	$33.90	$103.87
24	1162	2	0	0.24	END COCK 1 1/4"	$21.39	$0.00	$0.00	$33.90	$55.29
25	1162	3	0	0.24	END COCK 1 1/4"	$34.42	$0.00	$0.00	$33.90	$68.32
26	1163	1	0	0.228	ANGLE COCK / END COCK HANDLE AND TOP CAP ASSEMBLY	$15.03	$0.11	$0.00	$32.20	$47.23
27	1165	1	0	0.114	AIR HOSE SUPPORT COMPLETE - NON-METALLIC	$3.32	$0.00	$0.00	$16.10	$19.42
28	1165	2	0	0.114	AIR HOSE SUPPORT COMPLETE - NON-METALLIC	$1.66	$0.00	$0.00	$16.10	$17.76
29	1165	9	0	0.079	AIR HOSE SUPPORT COMPLETE - NON-METALLIC	$0.00	$0.00	$0.00	$11.16	$11.16
30	1167	1	0	0.114	AIR HOSE SUPPORT COMPLETE - METALLIC	$3.58	$0.00	$0.00	$16.10	$19.68
31	1167	2	0	0.114	AIR HOSE SUPPORT COMPLETE - METALLIC	$1.79	$0.00	$0.00	$16.10	$17.89
32	1167	9	0	0.079	AIR HOSE SUPPORT COMPLETE - METALLIC	$0.00	$0.00	$0.00	$11.16	$11.16
33	1172	1	0	0.25	FLEXIBLE BRANCH PIPE HOSE	$68.43	$0.00	$0.00	$35.31	$103.74
34	1180	1	0	0.255	FLEXIBLE BRAKE PIPE HOSE, UNDER 59 INCHES	$39.86	$0.00	$0.00	$36.02	$75.88
35	1184	1	0	0.272	FLEXIBLE BRAKE PIPE HOSE 59 INCHES OR OVER	$56.14	$0.00	$0.00	$38.42	$94.56
36	1186	1	0	0.272	FLEXIBLE HOSE, 3/4 INCH OR SMALLER	$15.08	$0.00	$0.00	$38.42	$53.50
37	1188	1	0	0	PIPE, 3/4 INCHES OR SMALLER	$1.81	$0.00	$0.00	$0.00	$1.81
38	1188	2	0	0	PIPE, 3/4 INCHES OR SMALLER	$0.90	$0.00	$0.00	$0.00	$0.90
39	1192	1	0	0	PIPE, 1 OR 1-1/4 INCHES	$3.38	$0.33	$0.00	$0.00	$3.38
40	1192	2	0	0	PIPE, 1 OR 1-1/4 INCHES	$1.69	$0.33	$0.00	$0.00	$1.69
41	1194	0	0	0.3	BRAKE PIPE, ANY SIZE - BENDING	$0.00	$0.00	$0.00	$42.37	$42.37
42	1196	0	0	0.15	THREADING PIPE, ANY SIZE, PER END	$0.00	$0.00	$0.00	$21.19	$21.19
43	1197	0	0.123	0.009	PIPE, 3/4 INCH OR LESS-STRAIGHTEN OFF CAR W/ HEAT	$0.00	$0.00	$17.37	$1.27	$1.27
44	1198	0	0.123	0.027	PIPE, 1 OR 1-1/4 INCH-STRAIGHTEN OFF CAR WITH HEAT	$0.00	$0.00	$17.37	$3.81	$3.81
45	1200	1	0	0.1	PIPE NIPPLE, S.W. 1-1/4 INCHES	$4.48	$0.00	$0.00	$14.12	$18.60
46	1200	2	0	0.1	PIPE NIPPLE, S.W. 1-1/4 INCHES	$2.24	$0.00	$0.00	$14.12	$16.36
47	1204	1	0	0.1	PIPE FITTING, E.H. 3/4 INCHES OR LESS	$3.95	$0.00	$0.00	$14.12	$18.07
48	1204	2	0	0.1	PIPE FITTING, E.H. 3/4 INCHES OR LESS	$1.98	$0.00	$0.00	$14.12	$16.10
49	1208	1	0	0.1	PIPE FITTING, E.H. 1 OR 1-1/4 INCHES	$9.69	$0.00	$0.00	$14.12	$23.81
50	1208	2	0	0.1	PIPE FITTING, E.H. 1 OR 1-1/4 INCHES	$4.84	$0.00	$0.00	$14.12	$18.96
51	1210	0	0	0.092	AIR HOSE EXTENSION COUPLING	$0.00	$0.00	$0.00	$12.99	$12.99
52	1210	1	0	0.101	AIR HOSE EXTENSION COUPLING	$5.37	$0.00	$0.00	$14.27	$19.64
53	1210	2	0	0.101	AIR HOSE EXTENSION COUPLING	$2.69	$0.00	$0.00	$14.27	$16.96
54	1212	1	0	0.3	PIPE UNION OR TEE, E.H. 3/4 INCHES OR LESS	$5.68	$0.00	$0.00	$42.37	$48.05
55	1212	2	0	0.3	PIPE UNION OR TEE, E.H. 3/4 INCHES OR LESS	$2.84	$0.00	$0.00	$42.37	$45.21
56	1216	1	0	0.3	PIPE UNION OR TEE, E.H. 1 OR 1-1/4 INCHES	$8.14	$0.00	$0.00	$42.37	$50.51
57	1216	2	0	0.3	PIPE UNION OR TEE, E.H. 1 OR 1-1/4 INCHES	$4.07	$0.00	$0.00	$42.37	$46.44
58	1227	1	0	0.603	PIPE FITTING RFP WELDED 3/4 INCHES OR LESS	$9.19	$0.00	$0.00	$85.17	$94.36
59	1228	1	0	1.239	PIPE FITTING, RFP, WELDED 1 OR 1-1/4 INCHES	$11.96	$0.00	$0.00	$175.00	$186.96
60	1238	1	0.25	0.078	LOK-RING REPAIR COUPLING, 3/8 INCH	$88.79	$0.00	$35.31	$11.02	$99.81
61	1239	1	0.25	0.078	LOK-RING REPAIR COUPLING, 3/4 INCH	$85.62	$0.00	$35.31	$11.02	$96.64
62	1240	1	0.25	0.078	LOK-RING REPAIR COUPLING, 1 INCH	$96.19	$0.00	$35.31	$11.02	$107.21
63	1241	1	0.25	0.078	LOKRING REPAIR COUPLING, 1.25 INCHES	$170.35	$0.00	$35.31	$11.02	$181.37

FID	Applied Job Code	Condtion Code	Fixed Labor Time Standard	Variable Labor Time Standard	Job Code Description	Material Price	Credit	Fixed Labor	Variable Labor	Total Cost
64	1244	1	0	0.233	PIPE FITTING GASKET - OR SEAL - SEPARATELY	$1.93	$0.00	$0.00	$32.91	$34.84
65	1246	1	0.25	0.097	LOK-RING FLANGE FITTING, 3/8 INCH	$71.96	$0.00	$35.31	$13.70	$85.66
66	1247	1	0.25	0.097	LOK-RING FLANGE FITTING, 3/4 INCH	$92.02	$0.00	$35.31	$13.70	$105.72
67	1248	1	0.25	0.097	LOK-RING FLANGE FITTING, 1 INCH	$84.36	$0.00	$35.31	$13.70	$98.06
68	1249	1	0.25	0.097	LOK-RING FLANGE FITTING, 1.25 INCHES	$95.09	$0.00	$35.31	$13.70	$108.79
69	1260	1	0	0.105	CAP SCREW, AIR BRAKE PART, RENEWED	$0.50	$0.00	$0.00	$14.83	$15.33
70	1260	2	0	0.105	CAP SCREW, AIR BRAKE PART, RENEWED	$0.25	$0.00	$0.00	$14.83	$15.08
71	1264	1	0	0.17	BRANCH PIPE TEE BODY	$20.47	$0.55	$0.00	$24.01	$44.48
72	1264	2	0	0.17	BRANCH PIPE TEE BODY	$10.24	$0.55	$0.00	$24.01	$34.25
73	1268	1	0	0.267	CUT-OUT COCK, ANY SIZE, COMPLETE	$87.40	$0.33	$0.00	$37.71	$125.11
74	1268	2	0	0.267	CUT-OUT COCK, ANY SIZE, COMPLETE	$66.47	$0.00	$0.00	$37.71	$104.18
75	1268	3	0	0.267	CUT-OUT COCK, ANY SIZE, COMPLETE	$78.13	$0.00	$0.00	$37.71	$115.84
76	1270	1	0	0.267	DIRT COLLECTOR, COMPLETE	$100.35	$0.00	$0.00	$37.71	$138.06
77	1270	2	0	0.267	DIRT COLLECTOR, COMPLETE	$21.16	$0.00	$0.00	$37.71	$58.87
78	1270	3	0	0.267	DIRT COLLECTOR, COMPLETE	$31.42	$0.00	$0.00	$37.71	$69.13
79	1272	1	0	0.266	COMBINATION DIRT COLL & CUT-OUT COCK, COMPLETE	$48.36	$0.33	$0.00	$37.57	$85.93
80	1272	2	0	0.266	COMBINATION DIRT COLL & CUT-OUT COCK, COMPLETE	$30.23	$0.00	$0.00	$37.57	$67.80
81	1272	3	0	0.266	COMBINATION DIRT COLL & CUT-OUT COCK, COMPLETE	$42.12	$0.00	$0.00	$37.57	$79.69
82	1276	1	0	0.067	DIRT COLLECTOR CHAMBER, COMPLETE, SEPARATELY	$16.42	$0.33	$0.00	$9.46	$25.88
83	1276	2	0	0.067	DIRT COLLECTOR CHAMBER, COMPLETE, SEPARATELY	$8.22	$0.00	$0.00	$9.46	$17.68
84	1277	1	0	0.586	ABDX EMERGENCY PORTION	$755.42	$4.40	$0.00	$82.77	$838.19
85	1277	3	0	0.586	ABDX EMERGENCY PORTION	$113.72	$0.00	$0.00	$82.77	$196.49
86	1279	3	0	0.586	ABDXR EMERGENCY PORTION	$113.72	$0.00	$0.00	$82.77	$196.49
87	1279	U	0	0.586	ABDXR EMERGENCY PORTION	$473.33	$0.00	$0.00	$82.77	$556.10
88	1281	1	0	0.586	DB-20 EMERGENCY PORTION	$691.42	$4.40	$0.00	$82.77	$774.19
89	1281	3	0	0.586	DB-20 EMERGENCY PORTION	$131.55	$0.00	$0.00	$82.77	$214.32
90	1283	1	0	0.586	ABDX-L EMERGENCY PORTION	$904.40	$4.40	$0.00	$82.77	$987.17
91	1283	3	0	0.586	ABDX-L EMERGENCY PORTION	$114.98	$0.00	$0.00	$82.77	$197.75
92	1285	3	0	0.586	ABDXR-L EMERGENCY PORTION	$114.98	$0.00	$0.00	$82.77	$197.75
93	1285	U	0	0.586	ABDXR-L EMERGENCY PORTION	$409.40	$0.00	$0.00	$82.77	$492.17
94	1287	1	0	0.586	DB-20-L EMERGENCY PORTION	$760.70	$4.40	$0.00	$82.77	$843.47
95	1287	3	0	0.586	DB-20-L EMERGENCY PORTION	$130.63	$0.00	$0.00	$82.77	$213.40
96	1289	1	0	0.591	ABDX SERVICE PORTION	$834.63	$4.40	$0.00	$83.47	$918.10
97	1289	3	0	0.591	ABDX SERVICE PORTION	$135.35	$0.00	$0.00	$83.47	$218.82
98	1291	3	0	0.591	ABDXR SERVICE PORTION	$135.35	$0.00	$0.00	$83.47	$218.82
99	1291	U	0	0.591	ABDXR SERVICE PORTION	$470.55	$0.00	$0.00	$83.47	$554.02
100	1293	1	0	0.591	DB-10 SERVICE PORTION	$731.90	$4.40	$0.00	$83.47	$815.37
101	1293	3	0	0.591	DB-10 SERVICE PORTION	$169.82	$0.00	$0.00	$83.47	$253.29
102	1295	1	0	0.591	DB-10C SERVICE PORTION	$798.19	$4.40	$0.00	$83.47	$881.66
103	1295	3	0	0.591	DB-10C SERVICE PORTION	$201.27	$0.00	$0.00	$83.47	$284.74
104	1298	3	0	0.586	ABD EMERGENCY PORTION	$119.18	$0.00	$0.00	$82.77	$201.95
105	1301	3	0	0.586	ABDW EMERGENCY PORTION	$137.33	$0.00	$0.00	$82.77	$220.10
106	1303	1	0	0.232	EMERGENCY PORTION BODY GASKET	$3.46	$0.00	$0.00	$32.77	$36.23
107	1311	3	0	0.591	ABD SERVICE PORTION	$139.19	$0.00	$0.00	$83.47	$222.66
108	1313	1	0	0.266	SERVICE PORTION BODY GASKET	$3.94	$0.00	$0.00	$37.57	$41.51
109	1316	1	0	1.5	AB PIPE BRACKET PORTION, DOUBLE-SIDED	$363.87	$7.48	$0.00	$211.86	$575.73
110	1316	2	0	1.5	AB PIPE BRACKET PORTION, DOUBLE-SIDED	$186.84	$7.48	$0.00	$211.86	$398.70
111	1316	9	0	1.433	AB PIPE BRACKET PORTION, DOUBLE-SIDED	$9.80	$0.00	$0.00	$202.40	$212.20
112	1318	1	0	1.5	AB PIPE BRACKET PORTION, SINGLE SIDED	$552.00	$7.48	$0.00	$211.86	$763.86
113	1318	2	0	1.5	AB PIPE BRACKET PORTION, SINGLE SIDED	$280.90	$7.48	$0.00	$211.86	$492.76
114	1318	9	0	1.433	AB PIPE BRACKET PORTION, SINGLE SIDED	$9.80	$0.00	$0.00	$202.40	$212.20
115	1320	1	0	1.14	AB PIPE BRACKET REPAIRS - BROKEN CAP SCREW	$3.42	$0.00	$0.00	$161.01	$164.43
116	1320	2	0	1.14	AB PIPE BRACKET REPAIRS - BROKEN CAP SCREW	$3.17	$0.00	$0.00	$161.01	$164.18
117	1321	3	0	0.591	ABDT SERVICE PORTION	$143.28	$0.00	$0.00	$83.47	$226.75
118	1323	3	0	0.586	ABDS EMERGENCY PORTION	$145.61	$0.00	$0.00	$82.77	$228.38
119	1325	3	0	0.586	ABDWS OR ABDW-2 EMERG PORTION	$142.21	$0.00	$0.00	$82.77	$224.98
120	1328	1	0	0.634	ASCTD 4-PRESSURE ACCESS PLATE FOR DB-60	$265.02	$111.73	$0.00	$89.55	$354.57
121	1328	3	0	0.634	ASCTD 4-PRESSURE ACCESS PLATE FOR DB-60	$198.77	$111.73	$0.00	$89.55	$288.32
122	1328	9	0	0.086	ASCTD 4-PRESSURE ACCESS PLATE FOR DB-60	$0.00	$0.00	$0.00	$12.15	$12.15
123	1330	1	0	0.634	ASCTD 4-PRESSURE ACCESS PLATE	$222.63	$111.73	$0.00	$89.55	$312.18
124	1330	3	0	0.634	ASCTD 4-PRESSURE ACCESS PLATE	$166.97	$111.73	$0.00	$89.55	$256.52
125	1330	9	0	0.086	ASCTD 4-PRESSURE ACCESS PLATE	$0.00	$0.00	$0.00	$12.15	$12.15
126	1332	1	0	0.139	ASCTD 4-PRESSURE RECEIVER ASSEMBLY W/O BCRD	$111.73	$0.55	$0.00	$19.63	$131.36

FID	Applied Job Code	Condtion Code	Fixed Labor Time Standard	Variable Labor Time Standard	Job Code Description	Material Price	Credit	Fixed Labor	Variable Labor	Total Cost
127	1332	3	0	0.139	ASCTD 4-PRESSURE RECEIVER ASSEMBLY W/O BCRD	$83.80	$0.55	$0.00	$19.63	$103.43
128	1332	9	0	0.055	ASCTD 4-PRESSURE RECEIVER ASSEMBLY W/O BCRD	$0.00	$0.00	$0.00	$7.77	$7.77
129	1334	1	0	0.139	ASCTD 4-PRESSURE RECEIVER ASSEMBLY WITH BCRD	$135.87	$0.55	$0.00	$19.63	$155.50
130	1334	3	0	0.139	ASCTD 4-PRESSURE RECEIVER ASSEMBLY WITH BCRD	$101.90	$0.55	$0.00	$19.63	$121.53
131	1334	9	0	0.055	ASCTD 4-PRESSURE RECEIVER ASSEMBLY WITH BCRD	$0.00	$0.00	$0.00	$7.77	$7.77
132	1340	1	0	0.096	AB VALVE VENT PROTECTOR	$3.03	$0.00	$0.00	$13.56	$16.59
133	1340	2	0	0.096	AB VALVE VENT PROTECTOR	$1.52	$0.00	$0.00	$13.56	$15.08
134	1356	1	0	0.05	RELEASE VALVE HANDLE COMPLETE, ANY TYPE	$5.05	$0.00	$0.00	$7.06	$12.11
135	1356	2	0	0.05	RELEASE VALVE HANDLE COMPLETE, ANY TYPE	$3.02	$0.00	$0.00	$7.06	$10.08
136	1360	1	0	0.07	RELEASE VALVE ROD COMPLETE, ANY TYPE	$10.26	$0.33	$0.00	$9.89	$20.15
137	1360	2	0	0.07	RELEASE VALVE ROD COMPLETE, ANY TYPE	$5.21	$0.33	$0.00	$9.89	$15.10
138	1386	1	0	0.1	B1 QUICK SERVICE VENT PROTECTOR	$7.94	$0.00	$0.00	$14.12	$22.06
139	1386	2	0	0.1	B1 QUICK SERVICE VENT PROTECTOR	$3.97	$0.00	$0.00	$14.12	$18.09
140	1388	1	0	0.267	QUICK SERVICE VALVE	$748.26	$0.33	$0.00	$37.71	$785.97
141	1388	3	0	0.267	QUICK SERVICE VALVE	$561.20	$0.00	$0.00	$37.71	$598.91
142	1388	7	0	1.1	QUICK SERVICE VALVE	$16.34	$0.00	$0.00	$155.36	$171.70
143	1392	1	0	0.738	REDUCTION RELAY PIPE BRACKET PORTION	$402.25	$2.42	$0.00	$104.24	$506.49
144	1392	2	0	0.738	REDUCTION RELAY PIPE BRACKET PORTION	$202.22	$2.42	$0.00	$104.24	$306.46
145	1392	9	0	0.738	REDUCTION RELAY PIPE BRACKET PORTION	$2.19	$0.00	$0.00	$104.24	$106.43
146	1400	1	0	0.264	NO. 8 VENT VALVE	$206.64	$0.33	$0.00	$37.29	$243.93
147	1400	3	0	0.264	NO. 8 VENT VALVE	$55.53	$0.00	$0.00	$37.29	$92.82
148	1401	1	0	0.107	EMPTY LOAD SENSOR VALVE MNTING GASKET (GROUP 1)	$7.43	$0.00	$0.00	$15.11	$22.54
149	1402	1	0	0.248	KM2 OR VX VENT VALVE	$274.24	$0.33	$0.00	$35.03	$309.27
150	1402	3	0	0.248	KM2 OR VX VENT VALVE	$108.25	$0.00	$0.00	$35.03	$143.28
151	1404	1	0	0.14	VENT VALVE VENT PROTECTOR	$10.95	$0.33	$0.00	$19.77	$30.72
152	1404	2	0	0.14	VENT VALVE VENT PROTECTOR	$5.48	$0.00	$0.00	$19.77	$25.25
153	1406	1	0	0.186	EMPTY LOAD SENSOR VALVE (GROUP 1)	$646.85	$0.55	$0.00	$26.27	$673.12
154	1406	3	0	0.186	EMPTY LOAD SENSOR VALVE (GROUP 1)	$487.00	$0.00	$0.00	$26.27	$513.27
155	1406	9	0	0.107	EMPTY LOAD SENSOR VALVE (GROUP 1)	$7.43	$0.00	$0.00	$15.11	$22.54
156	1408	1	0	0.448	EMPTY LOAD PROPORTIONAL VALVE (GROUP 1)	$415.27	$0.55	$0.00	$63.28	$478.55
157	1408	3	0	0.448	EMPTY LOAD PROPORTIONAL VALVE (GROUP 1)	$314.90	$0.00	$0.00	$63.28	$378.18
158	1408	9	0	0.369	EMPTY LOAD PROPORTIONAL VALVE (GROUP 1)	$13.80	$0.00	$0.00	$52.12	$65.92
159	1411	1	0	0.44	EMPTY LOAD RESERVOIR (GROUPS 1 & 2)	$232.89	$0.55	$0.00	$62.15	$295.04
160	1411	3	0	0.44	EMPTY LOAD RESERVOIR (GROUPS 1 & 2)	$176.53	$0.00	$0.00	$62.15	$238.68
161	1411	9	0	0.371	EMPTY LOAD RESERVOIR (GROUPS 1 & 2)	$7.43	$0.00	$0.00	$52.40	$59.83
162	1413	1	0	0.186	UNITIZED EMPTY LOAD VALVE, TRUCK SENSOR (GROUP 2)	$640.51	$0.55	$0.00	$26.27	$666.78
163	1413	3	0	0.186	UNITIZED EMPTY LOAD VALVE, TRUCK SENSOR (GROUP 2)	$482.24	$0.00	$0.00	$26.27	$508.51
164	1413	9	0	0.107	UNITIZED EMPTY LOAD VALVE, TRUCK SENSOR (GROUP 2)	$7.43	$0.00	$0.00	$15.11	$22.54
165	1414	1	0	0.517	EMPTY LOAD SENSOR VALVE PIPE BRACKET (GROUP 1)	$53.83	$0.55	$0.00	$73.02	$126.85
166	1414	3	0	0.517	EMPTY LOAD SENSOR VALVE PIPE BRACKET (GROUP 1)	$40.37	$0.00	$0.00	$73.02	$113.39
167	1414	9	0	0.449	EMPTY LOAD SENSOR VALVE PIPE BRACKET (GROUP 1)	$0.00	$0.00	$0.00	$63.42	$63.42
168	1415	1	0	0.35	UNITIZED E/ L VALVE, SLOPE SHEET MNT (GROUP 3)	$674.60	$0.55	$0.00	$49.43	$724.03
169	1415	3	0	0.35	UNITIZED E/ L VALVE, SLOPE SHEET MNT (GROUP 3)	$507.81	$0.00	$0.00	$49.43	$557.24
170	1415	9	0	0.298	UNITIZED E/ L VALVE, SLOPE SHEET MNT (GROUP 3)	$7.43	$0.00	$0.00	$42.09	$49.52
171	1416	1	0	0.53	E/L PROPORTIONAL VALVE PIPE BRACKET (GROUPS 1 & 2)	$64.59	$0.55	$0.00	$74.86	$139.45
172	1416	3	0	0.53	E/L PROPORTIONAL VALVE PIPE BRACKET (GROUPS 1 & 2)	$48.44	$0.00	$0.00	$74.86	$123.30
173	1416	9	0	0.461	E/L PROPORTIONAL VALVE PIPE BRACKET (GROUPS 1 & 2)	$0.00	$0.00	$0.00	$65.11	$65.11
174	1417	1	0	0.107	UNIT E/L VALVE, TRK SENSOR MNTING GASK (GROUP 2)	$3.35	$0.00	$0.00	$15.11	$18.46
175	1419	1	0	0.202	UNIT E/L VALVE, SLOPE SHEET MNTING GASK (GROUP 3)	$2.07	$0.00	$0.00	$28.53	$30.60
176	1420	1	0	0.253	PROPORTIONING VALVE, SLOPE SHEET MOUNT (GROUP 3)	$530.57	$0.00	$0.00	$35.73	$566.30
177	1420	3	0	0.253	PROPORTIONING VALVE, SLOPE SHEET MOUNT (GROUP 3)	$196.97	$0.00	$0.00	$35.73	$232.70
178	1420	9	0	0.202	PROPORTIONING VALVE, SLOPE SHEET MOUNT (GROUP 3)	$1.46	$0.00	$0.00	$28.53	$29.99
179	1424	1	0	0.643	AIR BRAKE CYL, COMPLETE 10 INCH DIAMETER OR LESS	$362.94	$5.50	$0.00	$90.82	$453.76
180	1424	3	0	0.643	AIR BRAKE CYL, COMPLETE 10 INCH DIAMETER OR LESS	$147.75	$5.50	$0.00	$90.82	$238.57
181	1424	9	0	0.643	AIR BRAKE CYL, COMPLETE 10 INCH DIAMETER OR LESS	$4.38	$0.00	$0.00	$90.82	$95.20
182	1428	1	0	1.733	AIR BRAKE CYLINDER BODY, ANY SIZE	$235.65	$9.57	$0.00	$244.77	$480.42
183	1428	2	0	1.733	AIR BRAKE CYLINDER BODY, ANY SIZE	$120.19	$9.57	$0.00	$244.77	$364.96
184	1440	1	0	0	AB CYLINDER NON-PRESSURE HEAD	$38.10	$1.43	$0.00	$0.00	$38.10
185	1440	2	0	0	AB CYLINDER NON-PRESSURE HEAD	$19.05	$1.43	$0.00	$0.00	$19.05
186	1444	1	0	0	AB CYLINDER PISTON AND HOLLOW ROD	$139.24	$2.31	$0.00	$0.00	$139.24
187	1444	2	0	0	AB CYLINDER PISTON AND HOLLOW ROD	$72.04	$2.31	$0.00	$0.00	$72.04
188	1448	1	0	0	AB CYLINDER RELEASE SPRING	$23.23	$0.77	$0.00	$0.00	$23.23
189	1448	2	0	0	AB CYLINDER RELEASE SPRING	$11.62	$0.77	$0.00	$0.00	$11.62

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190	1452	1	0	0.1	AB CYLINDER PUSH ROD	$22.46	$2.64	$0.00	$14.12	$36.58
191	1452	2	0	0.1	AB CYLINDER PUSH ROD	$11.23	$2.64	$0.00	$14.12	$25.35
192	1454	1	0	0	AB CYLINDER, NON-PRESSURE HEAD SPRING GUIDE	$12.32	$0.00	$0.00	$0.00	$12.32
193	1456	7	0	1.068	AB CYLINDER CLEANED, SEPARATELY	$18.25	$0.00	$0.00	$150.84	$169.09
194	1460	1	0	0.328	PISTON TRAVEL INDICATOR	$20.08	$0.00	$0.00	$46.33	$66.41
195	1476	1	0	0.698	TRUCK BRAKE CYLINDER BODY	$192.70	$3.30	$0.00	$98.59	$291.29
196	1476	2	0	0.698	TRUCK BRAKE CYLINDER BODY	$96.78	$3.30	$0.00	$98.59	$195.37
197	1476	3	0	0.698	TRUCK BRAKE CYLINDER BODY	$144.74	$3.30	$0.00	$98.59	$243.33
198	1480	1	0	0.698	TRUCK BRAKE CYLINDER PISTON ASSEMBLY	$157.69	$2.20	$0.00	$98.59	$256.28
199	1480	3	0	0.698	TRUCK BRAKE CYLINDER PISTON ASSEMBLY	$121.00	$2.20	$0.00	$98.59	$219.59
200	1484	1	0	0.728	TRUCK BRAKE CYLINDER COMPLETE	$437.74	$5.50	$0.00	$102.82	$540.56
201	1484	3	0	0.728	TRUCK BRAKE CYLINDER COMPLETE	$328.60	$5.50	$0.00	$102.82	$431.42
202	1484	9	0	0.481	TRUCK BRAKE CYLINDER COMPLETE	$1.16	$0.00	$0.00	$67.94	$69.10
203	1488	7	0	0.572	TRK BRK CYL & PISTON ASSEMBLY CLEANED SEPARATELY	$58.87	$0.00	$0.00	$80.79	$139.66
204	1490	7	0	0.45	MATE TRUCK BRAKE CYLINDER & PISTON ASSEMBLY CLEANE	$58.87	$0.00	$0.00	$63.56	$122.43
205	1492	1	0	0.221	TRUCK BRAKE CYLINDER HOSE, COMPLETE	$22.01	$0.00	$0.00	$31.21	$53.22
206	1496	1	0	0.2	TRUCK BRAKE CYLINDER PUSH ROD	$43.41	$1.54	$0.00	$28.25	$71.66
207	1496	2	0	0.2	TRUCK BRAKE CYLINDER PUSH ROD	$21.70	$1.54	$0.00	$28.25	$49.95
208	1498	1	0.086	0.025	TEST FITTING, BRK CYL MEASUREMENT TAP & CAP 1/4 IN	$7.24	$0.00	$12.15	$3.53	$10.77
209	1498	9	0.086	0.025	TEST FITTING, BRK CYL MEASUREMENT TAP & CAP 1/4 IN	$0.00	$0.00	$12.15	$3.53	$3.53
210	1500	1	0	0.271	FLANGE ADAPTER, LESS TEST FITTING	$18.32	$0.00	$0.00	$38.28	$56.60
211	1500	9	0	0.271	FLANGE ADAPTER, LESS TEST FITTING	$0.00	$0.00	$0.00	$38.28	$38.28
212	1502	1	0	0.643	FLANGED SOCKET WELD, LESS TEST FITTING	$18.49	$0.00	$0.00	$90.82	$109.31
213	1505	1	0	0.48	3/4 INCH SADDLE-MOUNT WELD FIT, LESS TEST FIT	$26.48	$0.00	$0.00	$67.80	$94.28
214	1506	1	0	0.206	BRAKE LINE HOSE ASSEMBLY, LESS TEST FITTING	$63.52	$0.00	$0.00	$29.10	$92.62
215	1506	9	0	0.206	BRAKE LINE HOSE ASSEMBLY, LESS TEST FITTING	$0.00	$0.00	$0.00	$29.10	$29.10
216	1520	1	0	0.174	RETAINING VALVE, 1967 3 POSITION	$26.60	$0.00	$0.00	$24.58	$51.18
217	1520	3	0	0.174	RETAINING VALVE, 1967 3 POSITION	$20.19	$0.00	$0.00	$24.58	$44.77
218	1532	1	0	0.21	RETAINING VALVE BRACKET, ANY TYPE	$7.92	$0.00	$0.00	$29.66	$37.58
219	1532	2	0	0.21	RETAINING VALVE BRACKET, ANY TYPE	$4.69	$0.00	$0.00	$29.66	$34.35
220	1532	9	0	0.21	RETAINING VALVE BRACKET, ANY TYPE	$1.46	$0.00	$0.00	$29.66	$31.12
221	1540	1	0	0.178	MODULATING VALVE OPERATING PORTION	$560.54	$0.00	$0.00	$25.14	$585.68
222	1540	3	0	0.178	MODULATING VALVE OPERATING PORTION	$420.41	$0.00	$0.00	$25.14	$445.55
223	1540	7	0	0.488	MODULATING VALVE OPERATING PORTION	$560.54	$0.00	$0.00	$68.93	$629.47
224	1576	1	0	0.74	SLACK ADJUSTER, GROUP E	$307.59	$5.50	$0.00	$104.52	$412.11
225	1576	3	0	0.74	SLACK ADJUSTER, GROUP E	$230.69	$5.50	$0.00	$104.52	$335.21
226	1586	1	0	0.5	SLACK ADJUSTER ACTUATOR/CONTROL ROD	$18.93	$1.10	$0.00	$70.62	$89.55
227	1586	2	0	0.5	SLACK ADJUSTER ACTUATOR/CONTROL ROD	$9.47	$1.10	$0.00	$70.62	$80.09
228	1586	3	0	0.5	SLACK ADJUSTER ACTUATOR/CONTROL ROD	$14.20	$1.10	$0.00	$70.62	$84.82
229	1586	8	0	0.5	SLACK ADJUSTER ACTUATOR/CONTROL ROD	$5.08	$0.00	$0.00	$70.62	$75.70
230	1588	1	0	0.74	SLACK ADJUSTER, GROUP J	$383.11	$5.50	$0.00	$104.52	$487.63
231	1588	3	0	0.74	SLACK ADJUSTER, GROUP J	$287.33	$5.50	$0.00	$104.52	$391.85
232	1592	1	0	0.626	SLACK ADJUSTER, GROUP L	$476.38	$5.50	$0.00	$88.42	$564.80
233	1592	3	0	0.626	SLACK ADJUSTER, GROUP L	$357.29	$5.50	$0.00	$88.42	$445.71
234	1594	1	0	0.626	SLACK ADJUSTER, GROUP M	$528.84	$5.50	$0.00	$88.42	$617.26
235	1594	3	0	0.626	SLACK ADJUSTER, GROUP M	$396.63	$5.50	$0.00	$88.42	$485.05
236	1596	1	0	0.626	SLACK ADJUSTER, GROUP N	$549.54	$5.50	$0.00	$88.42	$637.96
237	1596	3	0	0.626	SLACK ADJUSTER, GROUP N	$412.16	$5.50	$0.00	$88.42	$500.58
238	1598	1	0	0.626	SLACK ADJUSTER, GROUP O	$539.06	$5.50	$0.00	$88.42	$627.48
239	1598	3	0	0.626	SLACK ADJUSTER, GROUP O	$404.30	$5.50	$0.00	$88.42	$492.72
240	1600	1	0	0.626	SLACK ADJUSTER, GROUP P	$644.04	$5.50	$0.00	$88.42	$732.46
241	1600	3	0	0.626	SLACK ADJUSTER, GROUP P	$483.03	$5.50	$0.00	$88.42	$571.45
242	1601	1	0	0.626	SLACK ADJUSTER, GROUP Q	$661.32	$5.50	$0.00	$88.42	$749.74
243	1601	3	0	0.626	SLACK ADJUSTER, GROUP Q	$495.99	$5.50	$0.00	$88.42	$584.41
244	1603	1	0	0.74	SLACK ADJUSTER, WATER RESISTANT, GROUP R	$362.69	$5.50	$0.00	$104.52	$467.21
245	1603	3	0	0.74	SLACK ADJUSTER, WATER RESISTANT, GROUP R	$272.02	$5.50	$0.00	$104.52	$376.54
246	1612	1	0	0.622	AB RESERVOIR COMPLETE	$309.55	$29.15	$0.00	$87.85	$397.40
247	1612	3	0	0.622	AB RESERVOIR COMPLETE	$140.92	$29.15	$0.00	$87.85	$228.77
248	1612	9	0	0.622	AB RESERVOIR COMPLETE	$6.81	$0.00	$0.00	$87.85	$94.66
249	1626	1	0	0.138	EOT AIR BRAKE HOSE-AAR APPROVED STANDARD COUPLING	$106.62	$0.00	$0.00	$19.49	$126.11
250	1628	1	0	0.138	AIR BRAKE HOSE-AAR APPROVED STANDARD COUPLING	$20.00	$0.00	$0.00	$19.49	$39.49
251	1629	1	0	0.138	AIR BRAKE HOSE-AAR APPRVD, STRAIGHT SHANK COUPLING	$21.44	$0.00	$0.00	$19.49	$40.93
252	1630	1	0	0.138	AIR BRAKE HOSE 33" OR OVER	$26.53	$0.00	$0.00	$19.49	$46.02

FID	Applied Job Code	Condtion Code	Fixed Labor Time Standard	Variable Labor Time Standard	Job Code Description	Material Price	Credit	Fixed Labor	Variable Labor	Total Cost
253	1632	1	0	0.55	COUPLER ATTACHED BRACKET	$177.44	$3.30	$0.00	$77.68	$255.12
254	1632	2	0	0.55	COUPLER ATTACHED BRACKET	$88.72	$3.30	$0.00	$77.68	$166.40
255	1632	9	0	0.506	COUPLER ATTACHED BRACKET	$0.00	$0.00	$0.00	$71.47	$71.47
256	1650	1	0	1.446	BRK BEAM HGR TYP-18, COMPOSITION	$183.61	$10.89	$0.00	$204.23	$387.84
257	1650	3	0	1.446	BRK BEAM HGR TYP-18, COMPOSITION	$161.58	$10.89	$0.00	$204.23	$365.81
258	1652	1	0	1.418	BRK BEAM UNIT TYP-18, CAST IRON	$86.74	$11.00	$0.00	$200.28	$287.02
259	1652	3	0	1.418	BRK BEAM UNIT TYP-18, CAST IRON	$76.33	$11.00	$0.00	$200.28	$276.61
260	1654	1	0	1.418	BRK BEAM UNIT TYP-18, COMPOSITION	$86.74	$10.89	$0.00	$200.28	$287.02
261	1654	3	0	1.418	BRK BEAM UNIT TYP-18, COMPOSITION	$76.33	$10.89	$0.00	$200.28	$276.61
262	1658	1	0	1.446	BRK BEAM HGR TYP-24, COMPOSITION	$87.81	$14.96	$0.00	$204.23	$292.04
263	1658	3	0	1.446	BRK BEAM HGR TYP-24, COMPOSITION	$77.27	$14.96	$0.00	$204.23	$281.50
264	1660	1	0	1.418	BRK BEAM UNIT TYP-24, CAST IRON	$87.81	$13.53	$0.00	$200.28	$288.09
265	1660	3	0	1.418	BRK BEAM UNIT TYP-24, CAST IRON	$77.27	$13.53	$0.00	$200.28	$277.55
266	1662	1	0	1.418	BRK BEAM UNIT TYP-24 COMPOSITION	$87.81	$14.96	$0.00	$200.28	$288.09
267	1662	3	0	1.418	BRK BEAM UNIT TYP-24 COMPOSITION	$77.27	$14.96	$0.00	$200.28	$277.55
268	1670	1	0	1.635	BRAKE BEAM - UNIT TYPE - TMX / UBX BRAKE SYSTEM	$357.44	$20.35	$0.00	$230.93	$588.37
269	1670	2	0	1.635	BRAKE BEAM - UNIT TYPE - TMX / UBX BRAKE SYSTEM	$178.72	$20.35	$0.00	$230.93	$409.65
270	1670	3	0	1.635	BRAKE BEAM - UNIT TYPE - TMX / UBX BRAKE SYSTEM	$178.72	$20.35	$0.00	$230.93	$409.65
271	1672	1	0	1.635	BRAKE BEAM, MOUNTED CYLINDER TYPE	$640.81	$20.35	$0.00	$230.93	$871.74
272	1672	2	0	1.635	BRAKE BEAM, MOUNTED CYLINDER TYPE	$320.41	$20.35	$0.00	$230.93	$551.34
273	1672	3	0	1.635	BRAKE BEAM, MOUNTED CYLINDER TYPE	$320.41	$20.35	$0.00	$230.93	$551.34
274	1680	1	0	0.297	REPLACEABLE FIXED BRAKE HEAD	$44.77	$0.96	$0.00	$41.95	$86.72
275	1696	1	0.103	0.029	METALLIC BRAKE BEAM WEAR LINER	$6.02	$0.00	$14.55	$4.10	$10.12
276	1697	1	0.103	0.029	NON-METALLIC BRAKE BEAM WEAR LINER	$7.18	$0.00	$14.55	$4.10	$11.28
277	1698	0	0	1.922	MODIFY BRAKE BEAM HEADS	$0.00	$0.00	$0.00	$271.46	$271.46
278	1742	1	0	0.133	BRAKE CONNECTION PIN	$3.37	$0.11	$0.00	$18.79	$22.16
279	1742	2	0	0.133	BRAKE CONNECTION PIN	$1.12	$0.11	$0.00	$18.79	$19.91
280	1768	1	0	0.05	BOTTOM ROD SAFETY SUPPORT, AAR APPROVED	$6.79	$0.00	$0.00	$7.06	$13.85
281	1768	2	0	0.05	BOTTOM ROD SAFETY SUPPORT, AAR APPROVED	$4.03	$0.00	$0.00	$7.06	$11.09
282	1770	1	0	0.054	BRAKE PIN LOCKING DEVICE	$1.46	$0.06	$0.00	$7.63	$9.09
283	1792	1	0	0.2	BOTTOM ROD	$53.01	$3.96	$0.00	$28.25	$81.26
284	1792	2	0	0.2	BOTTOM ROD	$26.58	$3.96	$0.00	$28.25	$54.83
285	1792	8	0	0.2	BOTTOM ROD	$45.87	$0.00	$0.00	$28.25	$74.12
286	1794	1	0.085	0.048	BOTTOM ROD-TRUCK MOUNTED	$191.93	$3.96	$12.01	$6.78	$198.71
287	1794	2	0.085	0.048	BOTTOM ROD-TRUCK MOUNTED	$95.97	$3.96	$12.01	$6.78	$102.75
288	1794	8	0.085	0.048	BOTTOM ROD-TRUCK MOUNTED	$45.72	$0.00	$12.01	$6.78	$52.50
289	1796	1	0.162	0	TOP ROD, ANY SIZE DIAMETER	$5.25	$0.22	$22.88	$0.00	$5.25
290	1796	2	0.162	0	TOP ROD, ANY SIZE DIAMETER	$2.63	$0.22	$22.88	$0.00	$2.63
291	1796	8	0.123	0	TOP ROD, ANY SIZE DIAMETER	$2.55	$0.00	$17.37	$0.00	$2.55
292	1796	9	0.123	0	TOP ROD, ANY SIZE DIAMETER	$0.00	$0.00	$17.37	$0.00	$0.00
293	1800	1	0.085	0.057	BRAKE LEVER	$35.25	$3.08	$12.01	$8.05	$43.30
294	1800	2	0.085	0.057	BRAKE LEVER	$17.85	$3.08	$12.01	$8.05	$25.90
295	1800	8	0.085	0.057	BRAKE LEVER	$30.68	$0.00	$12.01	$8.05	$38.73
296	1802	1	0.085	0.03	BRAKE LEVER, TRUCK MOUNTED	$115.80	$3.08	$12.01	$4.24	$120.04
297	1802	2	0.085	0.03	BRAKE LEVER, TRUCK MOUNTED	$57.95	$3.08	$12.01	$4.24	$62.19
298	1802	8	0.085	0.03	BRAKE LEVER, TRUCK MOUNTED	$36.01	$0.00	$12.01	$4.24	$40.25
299	1804	1	0	0.237	BRAKE LEVER GUIDE OR CARRIER	$31.79	$0.99	$0.00	$33.47	$65.26
300	1804	2	0	0.237	BRAKE LEVER GUIDE OR CARRIER	$16.63	$0.99	$0.00	$33.47	$50.10
301	1804	8	0	0.237	BRAKE LEVER GUIDE OR CARRIER	$31.79	$0.99	$0.00	$33.47	$65.26
302	1808	1	0	0.25	BRAKE DEAD LEVER GUIDE	$33.25	$0.99	$0.00	$35.31	$68.56
303	1808	2	0	0.25	BRAKE DEAD LEVER GUIDE	$18.09	$0.99	$0.00	$35.31	$53.40
304	1808	8	0	0.25	BRAKE DEAD LEVER GUIDE	$33.25	$0.99	$0.00	$35.31	$68.56
305	1812	1	0	0.319	DEAD LEVER GUIDE BRACKET	$33.01	$0.99	$0.00	$45.06	$78.07
306	1812	2	0	0.319	DEAD LEVER GUIDE BRACKET	$17.85	$0.99	$0.00	$45.06	$62.91
307	1814	1	0.091	0.097	TOP ROD JAW, WELD REP, ANY SIZE DIAM	$11.64	$0.11	$12.85	$13.70	$25.34
308	1816	1	0.091	0.082	TOP ROD FITTING, WELD REP, ANY SIZE DIAM	$8.96	$0.11	$12.85	$11.58	$20.54
309	1838	1	0	0.121	BRAKE SHOE-COMP. HI-FRCT 1-1/2 IN.	$5.85	$0.00	$0.00	$17.09	$22.94
310	1840	1	0	0.121	BRAKE SHOE-COMP, HI-FRCT 2 IN.	$6.54	$0.00	$0.00	$17.09	$23.63
311	1842	1	0	0.121	BRK SHOE-COMP-HI-FRCT 1 1/2 IRN INS-RED	$18.66	$0.00	$0.00	$17.09	$35.75
312	1843	1	0	0.121	BRK SHOE-COMP-HI-FRCT 2 IRON INS (RED)	$20.17	$0.00	$0.00	$17.09	$37.26
313	1844	1	0	0.121	BRAKE SHOE-COMP, LOW FRICTION (YELLOW)	$13.67	$0.00	$0.00	$17.09	$30.76
314	1845	1	0	0.121	BRK SHOE-HCF-HI-FRCT 1 1/2 -INCH (RED)	$30.65	$0.00	$0.00	$17.09	$47.74
315	1846	1	0	0.121	BRK SHOE-HCF-HI-FRCT 2 -INCH (RED)	$33.00	$0.00	$0.00	$17.09	$50.09

FID	Applied Job Code	Condtion Code	Fixed Labor Time Standard	Variable Labor Time Standard	Job Code Description	Material Price	Credit	Fixed Labor	Variable Labor	Total Cost
316	1852	1	0	0.099	BRAKE SHOE KEY	$1.58	$0.00	$0.00	$13.98	$15.56
317	1864	1	1.182	0	HAND BRAKE HOUSING ASSEMBLY, GROUP C	$793.60	$8.58	$166.95	$0.00	$793.60
318	1864	3	1.182	0	HAND BRAKE HOUSING ASSEMBLY, GROUP C	$556.44	$8.58	$166.95	$0.00	$556.44
319	1898	1	0.473	0	HAND BRAKE HOUSING ASSEMBLY, GROUP N	$290.76	$8.58	$66.81	$0.00	$290.76
320	1898	3	0.473	0	HAND BRAKE HOUSING ASSEMBLY, GROUP N	$204.45	$8.58	$66.81	$0.00	$204.45
321	1900	1	0.473	0	HAND BRAKE HOUSING ASSEMBLY, GROUP O	$328.67	$8.58	$66.81	$0.00	$328.67
322	1900	3	0.473	0	HAND BRAKE HOUSING ASSEMBLY, GROUP O	$230.99	$8.58	$66.81	$0.00	$230.99
323	1902	1	0.473	0	HAND BRAKE HOUSING ASSEMBLY, GROUP P	$881.33	$8.58	$66.81	$0.00	$881.33
324	1902	3	0.473	0	HAND BRAKE HOUSING ASSEMBLY, GROUP P	$617.85	$8.58	$66.81	$0.00	$617.85
325	1904	1	0.473	0	HAND BRAKE HOUSING ASSEMBLY, GROUP Q	$436.03	$8.58	$66.81	$0.00	$436.03
326	1904	3	0.473	0	HAND BRAKE HOUSING ASSEMBLY, GROUP Q	$306.14	$8.58	$66.81	$0.00	$306.14
327	1906	1	0.473	0	HAND BRAKE HOUSING ASSEMBLY, GROUP R	$560.40	$8.58	$66.81	$0.00	$560.40
328	1906	3	0.473	0	HAND BRAKE HOUSING ASSEMBLY, GROUP R	$393.20	$8.58	$66.81	$0.00	$393.20
329	1908	1	0.473	0	HAND BRAKE HOUSING ASSEMBLY, GROUP T	$413.48	$8.58	$66.81	$0.00	$413.48
330	1908	3	0.473	0	HAND BRAKE HOUSING ASSEMBLY, GROUP T	$290.36	$0.00	$66.81	$0.00	$290.36
331	1909	1	0.473	0	HAND BRAKE HOUSING ASSEMBLY, GROUP U	$433.02	$8.58	$66.81	$0.00	$433.02
332	1909	3	0.473	0	HAND BRAKE HOUSING ASSEMBLY, GROUP U	$304.04	$0.00	$66.81	$0.00	$304.04
333	1910	1	0.473	0	HAND BRAKE HOUSING ASSEMBLY, GROUP V	$460.29	$8.58	$66.81	$0.00	$460.29
334	1910	3	0.473	0	HAND BRAKE HOUSING ASSEMBLY, GROUP V	$323.12	$8.58	$66.81	$0.00	$323.12
335	1916	1	0.258	0	BELL CRANK, AAR, 1966 TYPE	$33.10	$1.87	$36.44	$0.00	$33.10
336	1916	2	0.258	0	BELL CRANK, AAR, 1966 TYPE	$17.09	$1.87	$36.44	$0.00	$17.09
337	1916	9	0.258	0	BELL CRANK, AAR, 1966 TYPE	$0.45	$0.00	$36.44	$0.00	$0.45
338	1920	1	0.258	0	BELL CRANK, AAR, PRIOR TO 1966 TYPE	$38.96	$1.65	$36.44	$0.00	$38.96
339	1920	2	0.258	0	BELL CRANK, AAR, PRIOR TO 1966 TYPE	$20.02	$1.65	$36.44	$0.00	$20.02
340	1920	9	0.258	0	BELL CRANK, AAR, PRIOR TO 1966 TYPE	$0.45	$0.00	$36.44	$0.00	$0.45
341	1936	1	0.2	0	BRAKE WHEEL, HORIZ TYPE, GEARED BRAKE	$55.91	$1.43	$28.25	$0.00	$55.91
342	1936	2	0.2	0	BRAKE WHEEL, HORIZ TYPE, GEARED BRAKE	$28.03	$1.43	$28.25	$0.00	$28.03
343	1936	8	0.2	0	BRAKE WHEEL, HORIZ TYPE, GEARED BRAKE	$16.66	$0.00	$28.25	$0.00	$16.66
344	1941	1	0.2	0	BRAKE WHEEL, VERTICAL TYPE STANDARD #1	$43.20	$1.87	$28.25	$0.00	$43.20
345	1941	2	0.2	0	BRAKE WHEEL, VERTICAL TYPE STANDARD #1	$21.68	$1.87	$28.25	$0.00	$21.68
346	1941	8	0.2	0	BRAKE WHEEL, VERTICAL TYPE STANDARD #1	$21.74	$0.00	$28.25	$0.00	$21.74
347	1942	1	0.2	0	BRAKE WHEEL, VERTICAL TYPE STANDARD #2	$30.18	$1.87	$28.25	$0.00	$30.18
348	1942	2	0.2	0	BRAKE WHEEL, VERTICAL TYPE STANDARD #2	$15.17	$1.87	$28.25	$0.00	$15.17
349	1942	8	0.2	0	BRAKE WHEEL, VERTICAL TYPE STANDARD #2	$21.74	$0.00	$28.25	$0.00	$21.74
350	1960	1	0.617	0	BRAKE SHAFT, 5 FEET OR LESS	$97.38	$2.20	$87.15	$0.00	$97.38
351	1960	2	0.617	0	BRAKE SHAFT, 5 FEET OR LESS	$48.76	$2.20	$87.15	$0.00	$48.76
352	1960	8	0.617	0	BRAKE SHAFT, 5 FEET OR LESS	$25.55	$0.00	$87.15	$0.00	$25.55
353	1968	1	0.2	0	BRAKE SHAFT RATCHET WHEEL	$31.65	$0.44	$28.25	$0.00	$31.65
354	1968	2	0.2	0	BRAKE SHAFT RATCHET WHEEL	$15.83	$0.44	$28.25	$0.00	$15.83
355	1984	1	0.589	0	BRAKE CHAIN HORIZONTAL	$51.61	$0.88	$83.19	$0.00	$51.61
356	1984	2	0.589	0	BRAKE CHAIN HORIZONTAL	$26.17	$0.88	$83.19	$0.00	$26.17
357	1986	1	0	0.133	BRAKE CHAIN CLEVIS	$10.97	$0.33	$0.00	$18.79	$29.76
358	1988	1	0	0.088	PULLROD CLEVIS	$38.62	$0.44	$0.00	$12.43	$51.05
359	1988	2	0	0.088	PULLROD CLEVIS	$19.41	$0.44	$0.00	$12.43	$31.84
360	1988	8	0	0.088	PULLROD CLEVIS	$5.38	$0.00	$0.00	$12.43	$17.81
361	1990	1	0	0.088	LEVER FULCRUM BRACKET	$81.87	$0.44	$0.00	$12.43	$94.30
362	1990	2	0	0.088	LEVER FULCRUM BRACKET	$41.20	$0.44	$0.00	$12.43	$53.63
363	1990	8	0	0.088	LEVER FULCRUM BRACKET	$5.38	$0.00	$0.00	$12.43	$17.81
364	1992	1	0	0.095	PAINT HAND BRAKE CHAIN	$0.24	$0.00	$0.00	$13.42	$13.66
365	2009	2	0	1.092	COUPLER BODY, E 60 DC	$199.21	$33.00	$0.00	$154.23	$353.44
366	2009	3	0	1.092	COUPLER BODY, E 60 DC	$301.76	$33.00	$0.00	$154.23	$455.99
367	2009	T	0	0	COUPLER BODY, E 60 DC	$0.00	$0.00	$0.00	$0.00	$0.00
368	2010	2	0	1.092	COUPLER BODY, SBE 60 DC	$271.48	$33.00	$0.00	$154.23	$425.71
369	2010	3	0	1.092	COUPLER BODY, SBE 60 DC	$411.25	$33.00	$0.00	$154.23	$565.48
370	2010	T	0	0	COUPLER BODY, SBE 60 DC	$0.00	$0.00	$0.00	$0.00	$0.00
371	2011	1	0	1.092	COUPLER BODY, SBE 60 DE OR SBE 60 EE	$610.87	$33.00	$0.00	$154.23	$765.10
372	2011	2	0	1.092	COUPLER BODY, SBE 60 DE OR SBE 60 EE	$230.86	$33.00	$0.00	$154.23	$385.09
373	2011	3	0	1.092	COUPLER BODY, SBE 60 DE OR SBE 60 EE	$349.71	$33.00	$0.00	$154.23	$503.94
374	2011	T	0	0	COUPLER BODY, SBE 60 DE OR SBE 60 EE	$0.00	$0.00	$0.00	$0.00	$0.00
375	2012	2	0	1.092	COUPLER BODY, SE 60 DC	$315.58	$33.00	$0.00	$154.23	$469.81
376	2012	3	0	1.092	COUPLER BODY, SE 60 DC	$478.07	$33.00	$0.00	$154.23	$632.30
377	2012	T	0	0	COUPLER BODY, SE 60 DC	$0.00	$0.00	$0.00	$0.00	$0.00
378	2013	1	0	1.092	COUPLER BODY, E 60 DE OR E 60 EE	$550.52	$33.00	$0.00	$154.23	$704.75

FID	Applied Job Code	Condtion Code	Fixed Labor Time Standard	Variable Labor Time Standard	Job Code Description	Material Price	Credit	Fixed Labor	Variable Labor	Total Cost
379	2013	2	0	1.092	COUPLER BODY, E 60 DE OR E 60 EE	$130.47	$33.00	$0.00	$154.23	$284.70
380	2013	3	0	1.092	COUPLER BODY, E 60 DE OR E 60 EE	$197.61	$33.00	$0.00	$154.23	$351.84
381	2013	T	0	0	COUPLER BODY, E 60 DE OR E 60 EE	$0.00	$0.00	$0.00	$0.00	$0.00
382	2017	2	0	1.092	COUPLER BODY, E 60 CHT OR E 60 CC	$197.97	$33.00	$0.00	$154.23	$352.20
383	2017	3	0	1.092	COUPLER BODY, E 60 CHT OR E 60 CC	$299.87	$33.00	$0.00	$154.23	$454.10
384	2017	T	0	0	COUPLER BODY, E 60 CHT OR E 60 CC	$0.00	$0.00	$0.00	$0.00	$0.00
385	2018	2	0	1.092	COUPLER BODY, SBE 60 CC	$334.26	$33.00	$0.00	$154.23	$488.49
386	2018	3	0	1.092	COUPLER BODY, SBE 60 CC	$506.38	$33.00	$0.00	$154.23	$660.61
387	2018	T	0	0	COUPLER BODY, SBE 60 CC	$0.00	$0.00	$0.00	$0.00	$0.00
388	2019	2	0	1.092	COUPLER BODY, SBE 60 CE	$291.11	$33.00	$0.00	$154.23	$445.34
389	2019	3	0	1.092	COUPLER BODY, SBE 60 CE	$441.00	$33.00	$0.00	$154.23	$595.23
390	2019	T	0	0	COUPLER BODY, SBE 60 CE	$0.00	$0.00	$0.00	$0.00	$0.00
391	2021	2	0	0	COUPLER BODY, SE 60 CHT OR SE 60 CC	$292.53	$33.00	$0.00	$0.00	$292.53
392	2021	3	0	0	COUPLER BODY, SE 60 CHT OR SE 60 CC	$443.15	$33.00	$0.00	$0.00	$443.15
393	2021	T	0	0	COUPLER BODY, SE 60 CHT OR SE 60 CC	$0.00	$0.00	$0.00	$0.00	$0.00
394	2022	2	0	1.092	COUPLER BODY, E 60 CHTE OR E 60 CE	$162.00	$33.00	$0.00	$154.23	$316.23
395	2022	3	0	1.092	COUPLER BODY, E 60 CHTE OR E 60 CE	$245.37	$33.00	$0.00	$154.23	$399.60
396	2022	T	0	0	COUPLER BODY, E 60 CHTE OR E 60 CE	$0.00	$0.00	$0.00	$0.00	$0.00
397	2023	2	0	0	COUPLER BODY, SE 60 CHTE OR SE 60 CE	$315.50	$33.00	$0.00	$0.00	$315.50
398	2023	3	0	0	COUPLER BODY, SE 60 CHTE OR SE 60 CE	$477.95	$33.00	$0.00	$0.00	$477.95
399	2023	T	0	0	COUPLER BODY, SE 60 CHTE OR SE 60 CE	$0.00	$0.00	$0.00	$0.00	$0.00
400	2024	1	0	0	COUPLER BODY, SE 60 DE OR SE 60 EE	$613.68	$33.00	$0.00	$0.00	$613.68
401	2024	2	0	0	COUPLER BODY, SE 60 DE OR SE 60 EE	$247.09	$33.00	$0.00	$0.00	$247.09
402	2024	3	0	0	COUPLER BODY, SE 60 DE OR SE 60 EE	$374.41	$33.00	$0.00	$0.00	$374.41
403	2024	T	0	0	COUPLER BODY, SE 60 DE OR SE 60 EE	$0.00	$0.00	$0.00	$0.00	$0.00
404	2037	1	0	1.092	COUPLER BODY, SBE 67 CE OR SBE 67 DE	$616.99	$33.00	$0.00	$154.23	$771.22
405	2037	2	0	1.092	COUPLER BODY, SBE 67 CE OR SBE 67 DE	$193.85	$33.00	$0.00	$154.23	$348.08
406	2037	3	0	1.092	COUPLER BODY, SBE 67 CE OR SBE 67 DE	$293.63	$33.00	$0.00	$154.23	$447.86
407	2037	T	0	0	COUPLER BODY, SBE 67 CE OR SBE 67 DE	$0.00	$0.00	$0.00	$0.00	$0.00
408	2038	2	0	1.092	COUPLER BODY, SBE 67 CC	$200.06	$33.00	$0.00	$154.23	$354.29
409	2038	3	0	1.092	COUPLER BODY, SBE 67 CC	$303.04	$33.00	$0.00	$154.23	$457.27
410	2038	T	0	0	COUPLER BODY, SBE 67 CC	$0.00	$0.00	$0.00	$0.00	$0.00
411	2041	1	0	1.092	COUPLER BODY, E 67 CE OR E 67 DE	$665.93	$33.00	$0.00	$154.23	$820.16
412	2041	2	0	1.092	COUPLER BODY, E 67 CE OR E 67 DE	$200.06	$33.00	$0.00	$154.23	$354.29
413	2041	3	0	1.092	COUPLER BODY, E 67 CE OR E 67 DE	$303.04	$33.00	$0.00	$154.23	$457.27
414	2041	T	0	0	COUPLER BODY, E 67 CE OR E 67 DE	$0.00	$0.00	$0.00	$0.00	$0.00
415	2043	2	0	1.092	COUPLER BODY, SBE 67 BC	$200.06	$33.00	$0.00	$154.23	$354.29
416	2043	3	0	1.092	COUPLER BODY, SBE 67 BC	$303.04	$33.00	$0.00	$154.23	$457.27
417	2043	T	0	0	COUPLER BODY, SBE 67 BC	$0.00	$0.00	$0.00	$0.00	$0.00
418	2044	1	0	1.092	COUPLER BODY, SBE 67 BE	$665.93	$33.00	$0.00	$154.23	$820.16
419	2044	2	0	1.092	COUPLER BODY, SBE 67 BE	$200.06	$33.00	$0.00	$154.23	$354.29
420	2044	3	0	1.092	COUPLER BODY, SBE 67 BE	$303.04	$33.00	$0.00	$154.23	$457.27
421	2044	T	0	0	COUPLER BODY, SBE 67 BE	$0.00	$0.00	$0.00	$0.00	$0.00
422	2047	2	0	1.092	COUPLER BODY, E 67 BHT OR E 67 BC	$200.06	$33.00	$0.00	$154.23	$354.29
423	2047	3	0	1.092	COUPLER BODY, E 67 BHT OR E 67 BC	$303.04	$33.00	$0.00	$154.23	$457.27
424	2047	T	0	0	COUPLER BODY, E 67 BHT OR E 67 BC	$0.00	$0.00	$0.00	$0.00	$0.00
425	2049	1	0	1.092	COUPLER BODY, E 67 BHTE OR E 67 BE	$665.93	$33.00	$0.00	$154.23	$820.16
426	2049	2	0	1.092	COUPLER BODY, E 67 BHTE OR E 67 BE	$200.06	$33.00	$0.00	$154.23	$354.29
427	2049	3	0	1.092	COUPLER BODY, E 67 BHTE OR E 67 BE	$303.04	$33.00	$0.00	$154.23	$457.27
428	2049	T	0	0	COUPLER BODY, E 67 BHTE OR E 67 BE	$0.00	$0.00	$0.00	$0.00	$0.00
429	2054	2	0	0.136	KNUCKLE E50HTE, E50AE, E50ARE OR E50BE	$46.50	$8.69	$0.00	$19.21	$65.71
430	2055	1	0	0.136	COUPLER KNUCKLE, E50AEV OR E50BEV	$131.25	$8.69	$0.00	$19.21	$150.46
431	2055	2	0	0.136	COUPLER KNUCKLE, E50AEV OR E50BEV	$45.94	$8.69	$0.00	$19.21	$65.15
432	2056	2	0	0.148	COUPLER KNUCKLE LOCK, E40HT	$5.89	$1.65	$0.00	$20.90	$26.79
433	2057	2	0	0.148	COUPLER KNUCKLE LOCK, E42HT	$5.89	$1.65	$0.00	$20.90	$26.79
434	2058	1	0	0.148	COUPLER KNUCKLE,LOCK, E 40 HTE OR E 40AE	$28.76	$1.65	$0.00	$20.90	$49.66
435	2058	2	0	0.148	COUPLER KNUCKLE,LOCK, E 40 HTE OR E 40AE	$10.07	$1.65	$0.00	$20.90	$30.97
436	2058	3	0	0.148	COUPLER KNUCKLE,LOCK, E 40 HTE OR E 40AE	$21.57	$1.65	$0.00	$20.90	$42.47
437	2059	1	0	0.148	COUPLER KNUCKLE LOCK, E42HTE, E42AE OR E42BE	$28.76	$1.65	$0.00	$20.90	$49.66
438	2059	2	0	0.148	COUPLER KNUCKLE LOCK, E42HTE, E42AE OR E42BE	$10.07	$1.65	$0.00	$20.90	$30.97
439	2059	3	0	0.148	COUPLER KNUCKLE LOCK, E42HTE, E42AE OR E42BE	$21.57	$1.65	$0.00	$20.90	$42.47
440	2064	1	0	0.075	COUPLER LOCK LIFTER,TOP,TYPE E	$19.85	$0.44	$0.00	$10.59	$30.44
441	2068	1	0	0.206	COUPLER LOCK LIFTER,BOTTOM,TYPE E	$14.80	$0.44	$0.00	$29.10	$43.90

FID	Applied Job Code	Condtion Code	Fixed Labor Time Standard	Variable Labor Time Standard	Job Code Description	Material Price	Credit	Fixed Labor	Variable Labor	Total Cost
442	2072	1	0	0.158	COUPLER KNUCKLE THROWER,TYPE E	$10.38	$0.66	$0.00	$22.32	$32.70
443	2072	2	0	0.158	COUPLER KNUCKLE THROWER,TYPE E	$3.63	$0.66	$0.00	$22.32	$25.95
444	2076	1	0	0.1	COUPLER KNUCKLE PIN, METALLIC	$6.80	$0.00	$0.00	$14.12	$20.92
445	2076	2	0	0.1	COUPLER KNUCKLE PIN, METALLIC	$2.38	$0.00	$0.00	$14.12	$16.50
446	2080	1	0	0.155	COUPLER TOP HOLE CAP, WELDED	$1.31	$0.00	$0.00	$21.89	$23.20
447	2088	1	0	0.216	COUPLER DRAFT KEY	$63.86	$6.05	$0.00	$30.51	$94.37
448	2088	2	0	0.216	COUPLER DRAFT KEY	$32.01	$6.05	$0.00	$30.51	$62.52
449	2088	3	0	0.216	COUPLER DRAFT KEY	$47.93	$6.05	$0.00	$30.51	$78.44
450	2104	1	0	0.092	COUPLER DRAFT KEY RETAINER	$7.13	$0.22	$0.00	$12.99	$20.12
451	2104	2	0	0.092	COUPLER DRAFT KEY RETAINER	$7.13	$0.22	$0.00	$12.99	$20.12
452	2108	1	0	0.12	COUPLER DRAFT KEY RETAINER LOCK	$2.73	$0.22	$0.00	$16.95	$19.68
453	2108	2	0	0.12	COUPLER DRAFT KEY RETAINER LOCK	$1.44	$0.22	$0.00	$16.95	$18.39
454	2116	1	0	0.092	COUPLER DRAFT KEY WASHER	$4.79	$0.00	$0.00	$12.99	$17.78
455	2116	2	0	0.092	COUPLER DRAFT KEY WASHER	$2.47	$0.00	$0.00	$12.99	$15.46
456	2159	1	0	0.171	CARRIER WEAR PLATE/STRIKER SHIM (NON-METALLIC)	$9.77	$0.00	$0.00	$24.15	$33.92
457	2160	1	0	0.191	CARRIER WEAR PLATE/STRIKER SHIM (METALLIC)	$12.22	$0.00	$0.00	$26.98	$39.20
458	2161	1	0	0.171	CARRIER WEAR PLATE/STRIKER SHIM (MANGANESE)	$17.89	$0.00	$0.00	$24.15	$42.04
459	2162	1	0	2.246	COUPLER CARRIER,20" LONG OR LESS	$47.16	$1.98	$0.00	$317.23	$364.39
460	2162	2	0	2.246	COUPLER CARRIER,20" LONG OR LESS	$23.58	$1.98	$0.00	$317.23	$340.81
461	2162	8	0	2.246	COUPLER CARRIER,20" LONG OR LESS	$22.86	$0.00	$0.00	$317.23	$340.09
462	2164	1	0	2.246	COUPLER CARRIER, OVER 20" LONG	$104.80	$4.40	$0.00	$317.23	$422.03
463	2164	2	0	2.246	COUPLER CARRIER, OVER 20" LONG	$52.40	$4.40	$0.00	$317.23	$369.63
464	2164	8	0	2.246	COUPLER CARRIER, OVER 20" LONG	$50.80	$0.00	$0.00	$317.23	$368.03
465	2166	1	0	2.246	COUPLER CARRIER, OVER 28" LONG	$180.78	$7.59	$0.00	$317.23	$498.01
466	2166	2	0	2.246	COUPLER CARRIER, OVER 28" LONG	$90.39	$7.59	$0.00	$317.23	$407.62
467	2166	8	0	2.246	COUPLER CARRIER, OVER 28" LONG	$87.63	$0.00	$0.00	$317.23	$404.86
468	2167	1	0	0.171	CARRIER WEAR PLATE/STRIKER SHIM (NON-METALLIC)	$17.70	$0.00	$0.00	$24.15	$41.85
469	2168	1	0	2.246	COUPLER, CARRIER, 20"/LESS, SPRING TYPE, METALLIC	$47.16	$1.98	$0.00	$317.23	$364.39
470	2168	2	0	2.246	COUPLER, CARRIER, 20"/LESS, SPRING TYPE, METALLIC	$23.58	$1.98	$0.00	$317.23	$340.81
471	2168	8	0	2.246	COUPLER, CARRIER, 20"/LESS, SPRING TYPE, METALLIC	$24.32	$0.00	$0.00	$317.23	$341.55
472	2169	1	0	0.191	CARRIER WEAR PLATE/STRIKER SHIM (METALLIC)	$31.44	$0.00	$0.00	$26.98	$58.42
473	2171	1	0	0.171	CARRIER WEAR PLATE/STRIKER SHIM (MANGANESE)	$48.60	$0.00	$0.00	$24.15	$72.75
474	2174	1	0	1.429	COUPLER BODY EF511* - C, E, AE, BE, CE OR WE	$860.17	$49.72	$0.00	$201.83	$1,062.00
475	2174	2	0	1.429	COUPLER BODY EF511* - C, E, AE, BE, CE OR WE	$434.11	$49.72	$0.00	$201.83	$635.94
476	2174	3	0	1.429	COUPLER BODY EF511* - C, E, AE, BE, CE OR WE	$647.14	$49.72	$0.00	$201.83	$848.97
477	2174	T	0	0	COUPLER BODY EF511* - C, E, AE, BE, CE OR WE	$0.00	$0.00	$0.00	$0.00	$0.00
478	2175	1	0	1.429	COUPLER EF512C, EF512E, EF512AE, EF512BE OR EF512C	$947.50	$49.17	$0.00	$201.83	$1,149.33
479	2175	2	0	1.429	COUPLER EF512C, EF512E, EF512AE, EF512BE OR EF512C	$477.77	$49.17	$0.00	$201.83	$679.60
480	2175	3	0	1.429	COUPLER EF512C, EF512E, EF512AE, EF512BE OR EF512C	$712.64	$49.17	$0.00	$201.83	$914.47
481	2175	T	0	0	COUPLER EF512C, EF512E, EF512AE, EF512BE OR EF512C	$0.00	$0.00	$0.00	$0.00	$0.00
482	2176	1	0	1.429	COUPLER BODY, EF525C, EF525E, EF525AE OR EF525BE	$1,508.94	$49.72	$0.00	$201.83	$1,710.77
483	2176	2	0	1.429	COUPLER BODY, EF525C, EF525E, EF525AE OR EF525BE	$758.49	$49.72	$0.00	$201.83	$960.32
484	2176	3	0	1.429	COUPLER BODY, EF525C, EF525E, EF525AE OR EF525BE	$1,133.72	$49.72	$0.00	$201.83	$1,335.55
485	2176	T	0	0	COUPLER BODY, EF525C, EF525E, EF525AE OR EF525BE	$0.00	$0.00	$0.00	$0.00	$0.00
486	2177	1	0	1.429	COUPLER BODY EF528* - C, E, AE, BE, CE OR WE	$1,322.80	$49.72	$0.00	$201.83	$1,524.63
487	2177	2	0	1.429	COUPLER BODY EF528* - C, E, AE, BE, CE OR WE	$665.42	$49.72	$0.00	$201.83	$867.25
488	2177	3	0	1.429	COUPLER BODY EF528* - C, E, AE, BE, CE OR WE	$994.11	$49.72	$0.00	$201.83	$1,195.94
489	2177	T	0	0	COUPLER BODY EF528* - C, E, AE, BE, CE OR WE	$0.00	$0.00	$0.00	$0.00	$0.00
490	2181	1	0	1.429	COUPLER BODY, E 68 CE OR E 68 DE	$752.02	$52.14	$0.00	$201.83	$953.85
491	2181	2	0	1.429	COUPLER BODY, E 68 CE OR E 68 DE	$380.03	$52.14	$0.00	$201.83	$581.86
492	2181	3	0	1.429	COUPLER BODY, E 68 CE OR E 68 DE	$566.03	$52.14	$0.00	$201.83	$767.86
493	2181	T	0	0	COUPLER BODY, E 68 CE OR E 68 DE	$0.00	$0.00	$0.00	$0.00	$0.00
494	2182	1	0	1.429	COUPLER BODY, SBE 68 CE OR SBE 68 DE	$752.02	$52.14	$0.00	$201.83	$953.85
495	2182	2	0	1.429	COUPLER BODY, SBE 68 CE OR SBE 68 DE	$380.03	$52.14	$0.00	$201.83	$581.86
496	2182	3	0	1.429	COUPLER BODY, SBE 68 CE OR SBE 68 DE	$566.03	$52.14	$0.00	$201.83	$767.86
497	2182	T	0	0	COUPLER BODY, SBE 68 CE OR SBE 68 DE	$0.00	$0.00	$0.00	$0.00	$0.00
498	2183	2	0	1.429	COUPLER BODY, SE68BE	$380.03	$52.14	$0.00	$201.83	$581.86
499	2183	3	0	1.429	COUPLER BODY, SE68BE	$566.03	$52.14	$0.00	$201.83	$767.86
500	2183	T	0	0	COUPLER BODY, SE68BE	$0.00	$0.00	$0.00	$0.00	$0.00
501	2185	2	0	1.429	COUPLER BODY, E 68 BHT OR E 68 BC	$267.70	$52.14	$0.00	$201.83	$469.53
502	2185	3	0	1.429	COUPLER BODY, E 68 BHT OR E 68 BC	$401.47	$52.14	$0.00	$201.83	$603.30
503	2185	T	0	0	COUPLER BODY, E 68 BHT OR E 68 BC	$0.00	$0.00	$0.00	$0.00	$0.00
504	2186	1	0	1.429	COUPLER BODY, E 68 BHTE OR E 68 BE	$752.02	$52.14	$0.00	$201.83	$953.85

FID	Applied Job Code	Condtion Code	Fixed Labor Time Standard	Variable Labor Time Standard	Job Code Description	Material Price	Credit	Fixed Labor	Variable Labor	Total Cost
505	2186	2	0	1.429	COUPLER BODY, E 68 BHTE OR E 68 BE	$380.03	$52.14	$0.00	$201.83	$581.86
506	2186	3	0	1.429	COUPLER BODY, E 68 BHTE OR E 68 BE	$566.03	$52.14	$0.00	$201.83	$767.86
507	2186	T	0	0	COUPLER BODY, E 68 BHTE OR E 68 BE	$0.00	$0.00	$0.00	$0.00	$0.00
508	2189	2	0	1.429	COUPLER BODY, E 69 AHTE OR E 69 AE	$520.67	$52.14	$0.00	$201.83	$722.50
509	2189	3	0	1.429	COUPLER BODY, E 69 AHTE OR E 69 AE	$776.99	$52.14	$0.00	$201.83	$978.82
510	2189	T	0	0	COUPLER BODY, E 69 AHTE OR E 69 AE	$0.00	$0.00	$0.00	$0.00	$0.00
511	2190	1	0	1.429	COUPLER BODY E 69 BE OR E 69 CE	$1,033.30	$52.14	$0.00	$201.83	$1,235.13
512	2190	2	0	1.429	COUPLER BODY E 69 BE OR E 69 CE	$520.67	$52.14	$0.00	$201.83	$722.50
513	2190	3	0	1.429	COUPLER BODY E 69 BE OR E 69 CE	$776.99	$52.14	$0.00	$201.83	$978.82
514	2190	T	0	0	COUPLER BODY E 69 BE OR E 69 CE	$0.00	$0.00	$0.00	$0.00	$0.00
515	2191	1	0	1.429	COUPLER BODY SBE 69 BE OR SBE 69 CE	$1,033.30	$52.14	$0.00	$201.83	$1,235.13
516	2191	2	0	1.429	COUPLER BODY SBE 69 BE OR SBE 69 CE	$520.67	$52.14	$0.00	$201.83	$722.50
517	2191	3	0	1.429	COUPLER BODY SBE 69 BE OR SBE 69 CE	$776.99	$52.14	$0.00	$201.83	$978.82
518	2191	T	0	0	COUPLER BODY SBE 69 BE OR SBE 69 CE	$0.00	$0.00	$0.00	$0.00	$0.00
519	2192	2	0	1.429	COUPLER BODY, SBE 68 BC	$374.41	$52.14	$0.00	$201.83	$576.24
520	2192	3	0	1.429	COUPLER BODY, SBE 68 BC	$563.14	$52.14	$0.00	$201.83	$764.97
521	2192	T	0	0	COUPLER BODY, SBE 68 BC	$0.00	$0.00	$0.00	$0.00	$0.00
522	2193	1	0	1.429	COUPLER BODY, SBE 68 BE	$890.62	$52.14	$0.00	$201.83	$1,092.45
523	2193	2	0	1.429	COUPLER BODY, SBE 68 BE	$449.33	$52.14	$0.00	$201.83	$651.16
524	2193	3	0	1.429	COUPLER BODY, SBE 68 BE	$669.98	$52.14	$0.00	$201.83	$871.81
525	2193	T	0	0	COUPLER BODY, SBE 68 BE	$0.00	$0.00	$0.00	$0.00	$0.00
526	2194	2	0	1.429	COUPLER BODY, SBE 69 AE	$507.73	$52.14	$0.00	$201.83	$709.56
527	2194	3	0	1.429	COUPLER BODY, SBE 69 AE	$757.58	$52.14	$0.00	$201.83	$959.41
528	2194	T	0	0	COUPLER BODY, SBE 69 AE	$0.00	$0.00	$0.00	$0.00	$0.00
529	2196	1	0	1.429	COUPLER BODY, SE 69 AE, SE 69 BE OR SE 69 CE	$1,007.42	$52.14	$0.00	$201.83	$1,209.25
530	2196	2	0	1.429	COUPLER BODY, SE 69 AE, SE 69 BE OR SE 69 CE	$507.73	$52.14	$0.00	$201.83	$709.56
531	2196	3	0	1.429	COUPLER BODY, SE 69 AE, SE 69 BE OR SE 69 CE	$757.58	$52.14	$0.00	$201.83	$959.41
532	2196	T	0	0	COUPLER BODY, SE 69 AE, SE 69 BE OR SE 69 CE	$0.00	$0.00	$0.00	$0.00	$0.00
533	2209	1	0	1.429	COUPLER BODY, F 70 CHT OR F 70 CC	$811.93	$46.86	$0.00	$201.83	$1,013.76
534	2209	2	0	1.429	COUPLER BODY, F 70 CHT OR F 70 CC	$409.99	$46.86	$0.00	$201.83	$611.82
535	2209	3	0	1.429	COUPLER BODY, F 70 CHT OR F 70 CC	$610.96	$46.86	$0.00	$201.83	$812.79
536	2209	T	0	0	COUPLER BODY, F 70 CHT OR F 70 CC	$0.00	$0.00	$0.00	$0.00	$0.00
537	2210	1	0	0	COUPLER BODY, F 70 CHTE OR F 70 CE	$825.54	$46.86	$0.00	$0.00	$825.54
538	2210	2	0	0	COUPLER BODY, F 70 CHTE OR F 70 CE	$416.79	$46.86	$0.00	$0.00	$416.79
539	2210	3	0	0	COUPLER BODY, F 70 CHTE OR F 70 CE	$621.17	$46.86	$0.00	$0.00	$621.17
540	2210	T	0	0	COUPLER BODY, F 70 CHTE OR F 70 CE	$0.00	$0.00	$0.00	$0.00	$0.00
541	2211	1	0	0	COUPLER BODY, SF 70 CHT OR SF 70 CC	$846.81	$46.86	$0.00	$0.00	$846.81
542	2211	2	0	0	COUPLER BODY, SF 70 CHT OR SF 70 CC	$427.43	$46.86	$0.00	$0.00	$427.43
543	2211	3	0	0	COUPLER BODY, SF 70 CHT OR SF 70 CC	$637.12	$46.86	$0.00	$0.00	$637.12
544	2211	T	0	0	COUPLER BODY, SF 70 CHT OR SF 70 CC	$0.00	$0.00	$0.00	$0.00	$0.00
545	2213	1	0	0	COUPLER BODY, SF 70 CHTE OR SF 70 CE	$842.74	$46.86	$0.00	$0.00	$842.74
546	2213	2	0	0	COUPLER BODY, SF 70 CHTE OR SF 70 CE	$425.39	$46.86	$0.00	$0.00	$425.39
547	2213	3	0	0	COUPLER BODY, SF 70 CHTE OR SF 70 CE	$634.07	$46.86	$0.00	$0.00	$634.07
548	2213	T	0	0	COUPLER BODY, SF 70 CHTE OR SF 70 CE	$0.00	$0.00	$0.00	$0.00	$0.00
549	2215	1	0	1.429	COUPLER BODY, F70DE	$825.54	$46.86	$0.00	$201.83	$1,027.37
550	2215	2	0	1.429	COUPLER BODY, F70DE	$416.79	$46.86	$0.00	$201.83	$618.62
551	2215	3	0	1.429	COUPLER BODY, F70DE	$621.17	$46.86	$0.00	$201.83	$823.00
552	2215	T	0	0	COUPLER BODY, F70DE	$0.00	$0.00	$0.00	$0.00	$0.00
553	2216	1	0	1.429	COUPLER BODY, SF70DE	$842.74	$46.86	$0.00	$201.83	$1,044.57
554	2216	2	0	1.429	COUPLER BODY, SF70DE	$425.39	$46.86	$0.00	$201.83	$627.22
555	2216	3	0	1.429	COUPLER BODY, SF70DE	$634.07	$46.86	$0.00	$201.83	$835.90
556	2216	T	0	0	COUPLER BODY, SF70DE	$0.00	$0.00	$0.00	$0.00	$0.00
557	2244	1	0	1.604	COUPLER BODY, F-ROTARY HTE OR AE	$1,322.08	$45.54	$0.00	$226.55	$1,548.63
558	2244	2	0	1.604	COUPLER BODY, F-ROTARY HTE OR AE	$665.06	$45.54	$0.00	$226.55	$891.61
559	2244	3	0	1.604	COUPLER BODY, F-ROTARY HTE OR AE	$993.57	$45.54	$0.00	$226.55	$1,220.12
560	2244	T	0	0	COUPLER BODY, F-ROTARY HTE OR AE	$0.00	$0.00	$0.00	$0.00	$0.00
561	2254	1	0	0.17	COUPLER KNUCKLE, TYPE F51 HTE, OR F51 AE	$134.70	$9.13	$0.00	$24.01	$158.71
562	2254	2	0	0.17	COUPLER KNUCKLE, TYPE F51 HTE, OR F51 AE	$47.24	$9.13	$0.00	$24.01	$71.25
563	2255	1	0	0.17	COUPLER KNUCKLE, F51AEV	$139.42	$9.13	$0.00	$24.01	$163.43
564	2255	2	0	0.17	COUPLER KNUCKLE, F51AEV	$48.89	$9.13	$0.00	$24.01	$72.90
565	2256	1	0	0.183	COUPLER KNUCKLE LOCK, F41 HT, OR F41 AC	$41.79	$0.77	$0.00	$25.85	$67.64
566	2256	2	0	0.183	COUPLER KNUCKLE LOCK, F41 HT, OR F41 AC	$14.63	$0.77	$0.00	$25.85	$40.48
567	2256	3	0	0.183	COUPLER KNUCKLE LOCK, F41 HT, OR F41 AC	$14.63	$0.77	$0.00	$25.85	$40.48

FID	Applied Job Code	Condtion Code	Fixed Labor Time Standard	Variable Labor Time Standard	Job Code Description	Material Price	Credit	Fixed Labor	Variable Labor	Total Cost
568	2258	1	0	0.183	COUPLER KNUCKLE LOCK, F41 HTE, OR F41 AE	$41.79	$0.77	$0.00	$25.85	$67.64
569	2258	2	0	0.183	COUPLER KNUCKLE LOCK, F41 HTE, OR F41 AE	$14.63	$0.77	$0.00	$25.85	$40.48
570	2258	3	0	0.183	COUPLER KNUCKLE LOCK, F41 HTE, OR F41 AE	$14.63	$0.77	$0.00	$25.85	$40.48
571	2259	1	0	0.183	COUPLER KNUCKLE LOCK, ROTARY, FR41AE OR RF41BE	$50.56	$1.65	$0.00	$25.85	$76.41
572	2259	2	0	0.183	COUPLER KNUCKLE LOCK, ROTARY, FR41AE OR RF41BE	$17.70	$1.65	$0.00	$25.85	$43.55
573	2259	3	0	0.183	COUPLER KNUCKLE LOCK, ROTARY, FR41AE OR RF41BE	$17.70	$1.65	$0.00	$25.85	$43.55
574	2260	1	0	0.241	COUPLER ROTARY LOCK-LIFT ASSEMBLY, TYPE F	$16.60	$0.66	$0.00	$34.04	$50.64
575	2264	1	0	0.075	COUPLER LOCK LIFT ROTOR,TYPE F	$9.93	$0.33	$0.00	$10.59	$20.52
576	2268	1	0	0.193	COUPLER KNUCKLE THROWER,TYPE F	$12.13	$0.77	$0.00	$27.26	$39.39
577	2268	2	0	0.193	COUPLER KNUCKLE THROWER,TYPE F	$4.25	$0.77	$0.00	$27.26	$31.51
578	2272	1	0	0.101	COUPLER TO YOKE CONNECTION PIN,TYPE F	$25.50	$1.10	$0.00	$14.27	$39.77
579	2272	2	0	0.101	COUPLER TO YOKE CONNECTION PIN,TYPE F	$8.93	$1.10	$0.00	$14.27	$23.20
580	2272	3	0	0.101	COUPLER TO YOKE CONNECTION PIN,TYPE F	$8.93	$1.10	$0.00	$14.27	$23.20
581	2274	1	0	0.479	F TYPE YOKE CONNECTION PIN CARRIER	$109.18	$4.40	$0.00	$67.65	$176.83
582	2274	2	0	0.479	F TYPE YOKE CONNECTION PIN CARRIER	$56.78	$4.40	$0.00	$67.65	$124.43
583	2276	1	0	0.479	Y47 PIN RETAINER ASSEMBLY	$14.89	$0.00	$0.00	$67.65	$82.54
584	2276	2	0	0.479	Y47 PIN RETAINER ASSEMBLY	$7.45	$0.00	$0.00	$67.65	$75.10
585	2314	1	0	0	COUPLER YOKE, Y40AHT OR Y40AC	$336.68	$22.33	$0.00	$0.00	$336.68
586	2314	2	0	0	COUPLER YOKE, Y40AHT OR Y40AC	$168.34	$22.33	$0.00	$0.00	$168.34
587	2314	3	0	0	COUPLER YOKE, Y40AHT OR Y40AC	$252.51	$22.33	$0.00	$0.00	$252.51
588	2315	1	0	0	YOKE - Y40AHTE,Y40AE,SY40AE,YS93AE OR WMNY40AE	$380.87	$22.33	$0.00	$0.00	$380.87
589	2315	2	0	0	YOKE - Y40AHTE,Y40AE,SY40AE,YS93AE OR WMNY40AE	$190.44	$22.33	$0.00	$0.00	$190.44
590	2315	3	0	0	YOKE - Y40AHTE,Y40AE,SY40AE,YS93AE OR WMNY40AE	$285.65	$22.33	$0.00	$0.00	$285.65
591	2317	1	0	0	COUPLER YOKE, Y41AHT OR Y41AC	$788.07	$28.16	$0.00	$0.00	$788.07
592	2317	2	0	0	COUPLER YOKE, Y41AHT OR Y41AC	$394.04	$28.16	$0.00	$0.00	$394.04
593	2317	3	0	0	COUPLER YOKE, Y41AHT OR Y41AC	$591.05	$28.16	$0.00	$0.00	$591.05
594	2318	1	0	0	COUPLER YOKE, Y41AHTE OR Y41AE	$788.07	$28.16	$0.00	$0.00	$788.07
595	2318	2	0	0	COUPLER YOKE, Y41AHTE OR Y41AE	$394.04	$28.16	$0.00	$0.00	$394.04
596	2318	3	0	0	COUPLER YOKE, Y41AHTE OR Y41AE	$591.05	$28.16	$0.00	$0.00	$591.05
597	2355	1	0	0	COUPLER YOKE, Y45HT, Y45AHT, BY45HT OR Y45AC	$367.78	$35.20	$0.00	$0.00	$367.78
598	2355	2	0	0	COUPLER YOKE, Y45HT, Y45AHT, BY45HT OR Y45AC	$183.89	$35.20	$0.00	$0.00	$183.89
599	2355	3	0	0	COUPLER YOKE, Y45HT, Y45AHT, BY45HT OR Y45AC	$275.84	$35.20	$0.00	$0.00	$275.84
600	2356	1	0	0	COUPLER YOKE, Y45AHTE, Y45AE OR SY294AE	$372.09	$35.20	$0.00	$0.00	$372.09
601	2356	2	0	0	COUPLER YOKE, Y45AHTE, Y45AE OR SY294AE	$186.05	$35.20	$0.00	$0.00	$186.05
602	2356	3	0	0	COUPLER YOKE, Y45AHTE, Y45AE OR SY294AE	$279.07	$35.20	$0.00	$0.00	$279.07
603	2358	2	0	0	COUPLER YOKE, Y 45HTE	$186.42	$35.20	$0.00	$0.00	$186.42
604	2436	1	0	0	DRAFT GEAR,GROUP J	$482.81	$36.52	$0.00	$0.00	$482.81
605	2436	2	0	0	DRAFT GEAR,GROUP J	$241.41	$36.52	$0.00	$0.00	$241.41
606	2436	3	0	0	DRAFT GEAR,GROUP J	$362.11	$36.52	$0.00	$0.00	$362.11
607	2440	1	0	0	DRAFT GEAR, GROUP K	$915.68	$36.52	$0.00	$0.00	$915.68
608	2440	2	0	0	DRAFT GEAR, GROUP K	$457.84	$36.52	$0.00	$0.00	$457.84
609	2440	3	0	0	DRAFT GEAR, GROUP K	$686.76	$36.52	$0.00	$0.00	$686.76
610	2446	1	0	0	DRAFT GEAR,GROUP M	$453.84	$36.52	$0.00	$0.00	$453.84
611	2446	2	0	0	DRAFT GEAR,GROUP M	$226.92	$36.52	$0.00	$0.00	$226.92
612	2446	3	0	0	DRAFT GEAR,GROUP M	$340.38	$36.52	$0.00	$0.00	$340.38
613	2448	1	0	0	DRAFT GEAR,GROUP R	$1,426.63	$36.52	$0.00	$0.00	$1,426.63
614	2448	2	0	0	DRAFT GEAR,GROUP R	$713.32	$36.52	$0.00	$0.00	$713.32
615	2448	3	0	0	DRAFT GEAR,GROUP R	$1,069.97	$36.52	$0.00	$0.00	$1,069.97
616	2453	1	0	0	DRAFT GEAR FOLLOWER PLATE W/ GROOVES OR ALT STMP E	$78.73	$7.15	$0.00	$0.00	$78.73
617	2453	2	0	0	DRAFT GEAR FOLLOWER PLATE W/ GROOVES OR ALT STMP E	$39.37	$7.15	$0.00	$0.00	$39.37
618	2454	1	0	0	D/G FOLLOWER-VERTICAL PIN CONNECT CPLR	$97.65	$8.25	$0.00	$0.00	$97.65
619	2454	2	0	0	D/G FOLLOWER-VERTICAL PIN CONNECT CPLR	$48.83	$8.25	$0.00	$0.00	$48.83
620	2456	1	0	0	DRAFT GEAR FOLLOWER,1/2 IN.OFFSET TYPE	$97.65	$8.25	$0.00	$0.00	$97.65
621	2456	2	0	0	DRAFT GEAR FOLLOWER,1/2 IN.OFFSET TYPE	$48.83	$8.25	$0.00	$0.00	$48.83
622	2468	1	0	0.401	DRAFT GEAR CARRIER	$29.71	$3.08	$0.00	$56.64	$86.35
623	2468	2	0	0.401	DRAFT GEAR CARRIER	$18.88	$3.08	$0.00	$56.64	$75.52
624	2480	1	0	0.252	UNCOUPLING LEVER NON-TELESCOPING	$17.17	$1.76	$0.00	$35.59	$52.76
625	2480	2	0	0.252	UNCOUPLING LEVER NON-TELESCOPING	$8.66	$1.76	$0.00	$35.59	$44.25
626	2480	8	0	0.252	UNCOUPLING LEVER NON-TELESCOPING	$14.78	$0.00	$0.00	$35.59	$50.37
627	2482	1	0	0.242	UNCOUPLING LEVER, TELESCOPING TYPE	$34.26	$3.85	$0.00	$34.18	$68.44
628	2482	2	0	0.242	UNCOUPLING LEVER, TELESCOPING TYPE	$17.86	$3.85	$0.00	$34.18	$52.04
629	2482	8	0	0.242	UNCOUPLING LEVER, TELESCOPING TYPE	$25.91	$0.00	$0.00	$34.18	$60.09
630	2484	1	0	0.084	FILLER, NON-TELESCOPING UNCOUPLING LEVER BRACKET	$0.84	$0.00	$0.00	$11.86	$12.70

FID	Applied Job Code	Condtion Code	Fixed Labor Time Standard	Variable Labor Time Standard	Job Code Description	Material Price	Credit	Fixed Labor	Variable Labor	Total Cost
631	2486	1	0	0.136	UNCOUPLING LEVER SUPPORT PARTS	$12.18	$0.66	$0.00	$19.21	$31.39
632	2486	2	0	0.136	UNCOUPLING LEVER SUPPORT PARTS	$6.82	$0.66	$0.00	$19.21	$26.03
633	2486	8	0	0.136	UNCOUPLING LEVER SUPPORT PARTS	$9.08	$0.00	$0.00	$19.21	$28.29
634	2574	7	0	0.363	INSP. & LUB. HITCH; KNOCK-DOWN TYPE	$1.50	$0.00	$0.00	$51.27	$52.77
635	2576	7	0	0.284	INSP. & LUB. HITCH; STATIONARY TYPE	$1.50	$0.00	$0.00	$40.11	$41.61
636	2577	1	0	0.127	HITCH INOPERABLE, BO ID DEVICE APPLIED	$40.57	$0.00	$0.00	$17.94	$58.51
637	2577	2	0	0.127	HITCH INOPERABLE, BO ID DEVICE APPLIED	$20.29	$0.00	$0.00	$17.94	$38.23
638	2600	0	0	0.932	ASF ARTICULATED CONNECTION - LABOR	$0.00	$0.00	$0.00	$131.64	$131.64
639	2605	0	0	0.932	NACO ARTICULATED CONNECTION - LABOR	$0.00	$0.00	$0.00	$131.64	$131.64
640	2610	0	0	1.181	CARDWELL WESTINGHOUSE SAC-1 ART CONN - LABOR	$0.00	$0.00	$0.00	$166.80	$166.80
641	2620	1	0	0	ASF CONNECTOR PRIMARY PIN	$203.54	$1.32	$0.00	$0.00	$203.54
642	2622	1	0	0.158	ASF RETAINING PIN	$21.21	$0.22	$0.00	$22.32	$43.53
643	2630	1	0	0	NACO CONNECTOR PRIMARY PIN	$1,472.72	$1.32	$0.00	$0.00	$1,472.72
644	2632	1	0	0.158	NACO RETAINING PIN	$12.99	$0.22	$0.00	$22.32	$35.31
645	2650	1	0	0.11	CARDWELL WESTINGHOUSE SAC-1 SHROUD	$46.86	$0.55	$0.00	$15.54	$62.40
646	2652	1	0	0	CARDWELL WESTINGHOUSE SAC-1 LOCKING WEDGE	$51.58	$1.32	$0.00	$0.00	$51.58
647	2814	1	0	0	ROLLER BEARING GROUP B 6 X 11 INCH OR LESS	$0.00	$0.00	$0.00	$0.00	$0.00
648	2814	3	0	0	ROLLER BEARING GROUP B 6 X 11 INCH OR LESS	$0.00	$0.00	$0.00	$0.00	$0.00
649	2816	1	0	0	ROLLER BEARING, GROUP B,6-1/2X12 IN.	$0.00	$0.00	$0.00	$0.00	$0.00
650	2816	3	0	0	ROLLER BEARING, GROUP B,6-1/2X12 IN.	$0.00	$0.00	$0.00	$0.00	$0.00
651	2820	1	0	0	ROLLER BEARING,GROUP B, 7X12 IN.	$0.00	$0.00	$0.00	$0.00	$0.00
652	2820	3	0	0	ROLLER BEARING,GROUP B, 7X12 IN.	$0.00	$0.00	$0.00	$0.00	$0.00
653	2822	1	0	0	ROLLER BEARING, GROUP B1, 6-1/2X12 IN.	$0.00	$0.00	$0.00	$0.00	$0.00
654	2822	3	0	0	ROLLER BEARING, GROUP B1, 6-1/2X12 IN.	$0.00	$0.00	$0.00	$0.00	$0.00
655	2830	1	0	0	ROLLER BEARING, GROUP B3 7 X 12	$0.00	$0.00	$0.00	$0.00	$0.00
656	2830	3	0	0	ROLLER BEARING, GROUP B3 7 X 12	$0.00	$0.00	$0.00	$0.00	$0.00
657	2857	0	0	0	ROLLER BEARING INSPECTION	$0.00	$0.00	$0.00	$0.00	$0.00
658	2861	3	0	0	ROLLER BEARING, GROUP B2 6 X 11 OR LESS	$0.00	$0.00	$0.00	$0.00	$0.00
659	2862	3	0	0	ROLLER BEARING, GROUP B2 6 1/2 X 12	$0.00	$0.00	$0.00	$0.00	$0.00
660	2863	3	0	0	ROLLER BEARING, GROUP B2 7 X 12	$0.00	$0.00	$0.00	$0.00	$0.00
661	2864	1	0	0	ROLLER BEARING, GROUP B4,6-1/2X12 IN.	$0.00	$0.00	$0.00	$0.00	$0.00
662	2864	3	0	0	ROLLER BEARING, GROUP B4,6-1/2X12 IN.	$0.00	$0.00	$0.00	$0.00	$0.00
663	2865	1	0	0	ROLLER BEARING, GROUP B4, 6 X 11 IN.	$0.00	$0.00	$0.00	$0.00	$0.00
664	2865	3	0	0	ROLLER BEARING, GROUP B4, 6 X 11 IN.	$0.00	$0.00	$0.00	$0.00	$0.00
665	2866	1	0	0	ROLLER BEARING, GROUP B3, 6 1/2 X 9 IN	$0.00	$0.00	$0.00	$0.00	$0.00
666	2866	3	0	0	ROLLER BEARING, GROUP B3, 6 1/2 X 9 IN	$0.00	$0.00	$0.00	$0.00	$0.00
667	2867	1	0	0	ROLLER BEARING, GROUP B5, 6 1/2 X 9 IN	$0.00	$0.00	$0.00	$0.00	$0.00
668	2867	3	0	0	ROLLER BEARING, GROUP B5, 6 1/2 X 9 IN	$0.00	$0.00	$0.00	$0.00	$0.00
669	2870	1	0	0.218	PEDESTAL ADAPTER-NARROW-11 IN OR SMALLER	$40.78	$2.75	$0.00	$30.79	$71.57
670	2870	2	0	0.218	PEDESTAL ADAPTER-NARROW-11 IN OR SMALLER	$20.39	$2.75	$0.00	$30.79	$51.18
671	2872	1	0	0.218	PEDESTAL ADAPTER - NARROW - 6 1/2 X 9 IN	$42.14	$2.75	$0.00	$30.79	$72.93
672	2872	2	0	0.218	PEDESTAL ADAPTER - NARROW - 6 1/2 X 9 IN	$21.07	$2.75	$0.00	$30.79	$51.86
673	2874	1	0	0.218	PEDESTAL ADAPTER-6 1/2 X 12 INCH	$41.40	$2.75	$0.00	$30.79	$72.19
674	2874	2	0	0.218	PEDESTAL ADAPTER-6 1/2 X 12 INCH	$20.70	$2.75	$0.00	$30.79	$51.49
675	2876	1	0	0.218	PEDESTAL ADAPTER-7 X 12 INCH	$65.55	$3.63	$0.00	$30.79	$96.34
676	2876	2	0	0.218	PEDESTAL ADAPTER-7 X 12 INCH	$32.78	$3.63	$0.00	$30.79	$63.57
677	2878	1	0	0.218	PEDESTAL ADAPTER-WIDE-11 INCH OR SMALLER	$93.65	$6.05	$0.00	$30.79	$124.44
678	2878	2	0	0.218	PEDESTAL ADAPTER-WIDE-11 INCH OR SMALLER	$46.83	$6.05	$0.00	$30.79	$77.62
679	2880	1	0	0.218	ELASTOMERIC ADAPTER PAD (STANDARD CAR TRUCK)	$79.86	$0.00	$0.00	$30.79	$110.65
680	2882	1	0	0.218	ELASTOMERIC ADAPTER PAD (ASF)	$84.48	$0.00	$0.00	$30.79	$115.27
681	2884	1	0	0.218	PEDESTAL ADAPTER - STANDARD CAR TRUCK S2-86	$30.53	$2.97	$0.00	$30.79	$61.32
682	2884	2	0	0.218	PEDESTAL ADAPTER - STANDARD CAR TRUCK S2-86	$15.27	$2.97	$0.00	$30.79	$46.06
683	2886	1	0	0.218	PEDESTAL ADAPTER - ASF - 6 1/2 X 12 IN	$39.61	$2.97	$0.00	$30.79	$70.40
684	2886	2	0	0.218	PEDESTAL ADAPTER - ASF - 6 1/2 X 12 IN	$19.81	$2.97	$0.00	$30.79	$50.60
685	2887	1	0	0.218	PEDESTAL ADAPTER - ASF - 6 1/2 X 9 IN	$39.61	$2.97	$0.00	$30.79	$70.40
686	2887	2	0	0.218	PEDESTAL ADAPTER - ASF - 6 1/2 X 9 IN	$19.81	$2.97	$0.00	$30.79	$50.60
687	2889	1	0	0.218	PEDESTAL ADAPTER - NSC - 6 1/2 X 9 IN	$28.22	$2.97	$0.00	$30.79	$59.01
688	2889	2	0	0.218	PEDESTAL ADAPTER - NSC - 6 1/2 X 9 IN	$14.11	$2.97	$0.00	$30.79	$44.90
689	2891	1	0	0.218	ELASTOMERIC ADAPTER PADS (NSC) - SET OF TWO	$71.77	$0.00	$0.00	$30.79	$102.56
690	2893	1	0	0.218	ELASTOMERIC ADAPTER PAD - NEVIS	$73.15	$0.00	$0.00	$30.79	$103.94
691	2895	1	0	0.218	PEDESTAL ADAPTER - NEVIS - 6 1/2 X 9 IN	$75.16	$2.97	$0.00	$30.79	$105.95
692	2895	2	0	0.218	PEDESTAL ADAPTER - NEVIS - 6 1/2 X 9 IN	$37.58	$2.97	$0.00	$30.79	$68.37
693	3001	7	0	0	WHEEL 28" 1W HT-CP	$0.00	$0.00	$0.00	$0.00	$0.00

FID	Applied Job Code	Condtion Code	Fixed Labor Time Standard	Variable Labor Time Standard	Job Code Description	Material Price	Credit	Fixed Labor	Variable Labor	Total Cost
694	3002	7	0	0	WHEEL 28" 1W NHT-CP	$0.00	$0.00	$0.00	$0.00	$0.00
695	3004	7	0	0	WHEEL 28" 1W HT-CP, CB-28	$0.00	$0.00	$0.00	$0.00	$0.00
696	3011	7	0	0	WHEEL 28" MW HT-CP	$0.00	$0.00	$0.00	$0.00	$0.00
697	3021	7	0	0	WHEEL 33" 1W HT-CP	$0.00	$0.00	$0.00	$0.00	$0.00
698	3022	7	0	0	WHEEL 33" 1W NHT-CP	$0.00	$0.00	$0.00	$0.00	$0.00
699	3031	7	0	0	WHEEL 33" 2W HT-CP	$0.00	$0.00	$0.00	$0.00	$0.00
700	3032	7	0	0	WHEEL 33" 2W NHT-CP	$0.00	$0.00	$0.00	$0.00	$0.00
701	3041	7	0	0	WHEEL 33" MW HT-CP	$0.00	$0.00	$0.00	$0.00	$0.00
702	3071	7	0	0	WHEEL 36" 1W HT-CP	$0.00	$0.00	$0.00	$0.00	$0.00
703	3072	7	0	0	WHEEL 36" 1W NHT-CP	$0.00	$0.00	$0.00	$0.00	$0.00
704	3081	7	0	0	WHEEL 36" 2W HT-CP	$0.00	$0.00	$0.00	$0.00	$0.00
705	3082	7	0	0	WHEEL 36" 2W NHT-CP	$0.00	$0.00	$0.00	$0.00	$0.00
706	3091	7	0	0	WHEEL 36" MW HT-CP	$0.00	$0.00	$0.00	$0.00	$0.00
707	3101	7	0	0	WHEEL 38" 1W HT-CP	$0.00	$0.00	$0.00	$0.00	$0.00
708	3102	7	0	0	WHEEL 38" 1W NHT-CP	$0.00	$0.00	$0.00	$0.00	$0.00
709	3111	7	0	0	WHEEL 38" 2W HT-CP	$0.00	$0.00	$0.00	$0.00	$0.00
710	3116	7	0	0	WHEEL, 33" 1W HT-CP CLASS D	$0.00	$0.00	$0.00	$0.00	$0.00
711	3121	7	0	0	WHEEL 36" 1W HT-CP CLASS D	$0.00	$0.00	$0.00	$0.00	$0.00
712	3131	7	0	0	WHEEL 36" 2W HT-CP CLASS D	$0.00	$0.00	$0.00	$0.00	$0.00
713	3151	7	0	0	WHEEL 38" 1W HT-CP CLASS D	$0.00	$0.00	$0.00	$0.00	$0.00
714	3274	1	0	0	AXLE-RWS-ROLLER BRG,11 JRNL OR LESS	$0.00	$0.00	$0.00	$0.00	$0.00
715	3274	2	0	0	AXLE-RWS-ROLLER BRG,11 JRNL OR LESS	$0.00	$0.00	$0.00	$0.00	$0.00
716	3274	3	0	0	AXLE-RWS-ROLLER BRG,11 JRNL OR LESS	$0.00	$0.00	$0.00	$0.00	$0.00
717	3276	1	0	0	AXLE-RWS-ROLLER BRG, 6 1/2 X 12 IN JRNL	$0.00	$0.00	$0.00	$0.00	$0.00
718	3276	2	0	0	AXLE-RWS-ROLLER BRG, 6 1/2 X 12 IN JRNL	$0.00	$0.00	$0.00	$0.00	$0.00
719	3276	3	0	0	AXLE-RWS-ROLLER BRG, 6 1/2 X 12 IN JRNL	$0.00	$0.00	$0.00	$0.00	$0.00
720	3278	1	0	0	AXLE-RWS-ROLLER BRG, 7 X 12 IN JRNL	$0.00	$0.00	$0.00	$0.00	$0.00
721	3278	2	0	0	AXLE-RWS-ROLLER BRG, 7 X 12 IN JRNL	$0.00	$0.00	$0.00	$0.00	$0.00
722	3278	3	0	0	AXLE-RWS-ROLLER BRG, 7 X 12 IN JRNL	$0.00	$0.00	$0.00	$0.00	$0.00
723	3280	1	0	0	AXLE-RWS-ROLLER BRG, 6 1/2 X 9 IN JRNL	$0.00	$0.00	$0.00	$0.00	$0.00
724	3280	2	0	0	AXLE-RWS-ROLLER BRG, 6 1/2 X 9 IN JRNL	$0.00	$0.00	$0.00	$0.00	$0.00
725	3280	3	0	0	AXLE-RWS-ROLLER BRG, 6 1/2 X 9 IN JRNL	$0.00	$0.00	$0.00	$0.00	$0.00
726	3328	A	0	0.837	NEW WHEEL SET 28 INCH, 6 X 11 AXLE	$2,314.47	$0.00	$0.00	$118.22	$2,432.69
727	3328	B	0	0.837	NEW WHEEL SET 28 INCH, 6 X 11 AXLE	$1,456.64	$0.00	$0.00	$118.22	$1,574.86
728	3328	C	0	0.837	NEW WHEEL SET 28 INCH, 6 X 11 AXLE	$1,872.47	$0.00	$0.00	$118.22	$1,990.69
729	3328	D	0	0.837	NEW WHEEL SET 28 INCH, 6 X 11 AXLE	$1,898.95	$0.00	$0.00	$118.22	$2,017.17
730	3329	A	0	0.837	TURNED WHEEL SET 28 INCH, 6 X 11 AXLE	$1,334.73	$0.00	$0.00	$118.22	$1,452.95
731	3329	B	0	0.837	TURNED WHEEL SET 28 INCH, 6 X 11 AXLE	$476.90	$0.00	$0.00	$118.22	$595.12
732	3329	C	0	0.837	TURNED WHEEL SET 28 INCH, 6 X 11 AXLE	$892.42	$0.00	$0.00	$118.22	$1,010.64
733	3329	D	0	0.837	TURNED WHEEL SET 28 INCH, 6 X 11 AXLE	$919.21	$0.00	$0.00	$118.22	$1,037.43
734	3329	F	0	0.837	TURNED WHEEL SET 28 INCH, 6 X 11 AXLE	$936.24	$0.00	$0.00	$118.22	$1,054.46
735	3329	G	0	0.837	TURNED WHEEL SET 28 INCH, 6 X 11 AXLE	$1,351.76	$0.00	$0.00	$118.22	$1,469.98
736	3333	A	0	0.837	NEW WHEEL SET 33 INCH, 6 X 11 AXLE	$2,290.54	$0.00	$0.00	$118.22	$2,408.76
737	3333	B	0	0.837	NEW WHEEL SET 33 INCH, 6 X 11 AXLE	$1,432.71	$0.00	$0.00	$118.22	$1,550.93
738	3333	C	0	0.837	NEW WHEEL SET 33 INCH, 6 X 11 AXLE	$1,848.23	$0.00	$0.00	$118.22	$1,966.45
739	3333	D	0	0.837	NEW WHEEL SET 33 INCH, 6 X 11 AXLE	$1,875.02	$0.00	$0.00	$118.22	$1,993.24
740	3334	A	0	0.837	TURNED WHEEL SET 33 INCH, 6 X 11 AXLE	$1,363.54	$0.00	$0.00	$118.22	$1,481.76
741	3334	B	0	0.837	TURNED WHEEL SET 33 INCH, 6 X 11 AXLE	$505.71	$0.00	$0.00	$118.22	$623.93
742	3334	C	0	0.837	TURNED WHEEL SET 33 INCH, 6 X 11 AXLE	$921.23	$0.00	$0.00	$118.22	$1,039.45
743	3334	D	0	0.837	TURNED WHEEL SET 33 INCH, 6 X 11 AXLE	$948.02	$0.00	$0.00	$118.22	$1,066.24
744	3334	F	0	0.837	TURNED WHEEL SET 33 INCH, 6 X 11 AXLE	$905.23	$0.00	$0.00	$118.22	$1,023.45
745	3334	G	0	0.837	TURNED WHEEL SET 33 INCH, 6 X 11 AXLE	$1,320.75	$0.00	$0.00	$118.22	$1,438.97
746	3336	A	0	0.837	NEW WHL SET 36 IN, 1-W 6 1/2 X 12 AXLE	$2,793.49	$0.00	$0.00	$118.22	$2,911.71
747	3336	B	0	0.837	NEW WHL SET 36 IN, 1-W 6 1/2 X 12 AXLE	$1,500.46	$0.00	$0.00	$118.22	$1,618.68
748	3336	C	0	0.837	NEW WHL SET 36 IN, 1-W 6 1/2 X 12 AXLE	$2,007.91	$0.00	$0.00	$118.22	$2,126.13
749	3336	D	0	0.837	NEW WHL SET 36 IN, 1-W 6 1/2 X 12 AXLE	$2,286.04	$0.00	$0.00	$118.22	$2,404.26
750	3337	A	0	0.837	TURNED WHEEL SET 36 IN, 6 1/2 X 12 AXLE	$1,829.77	$0.00	$0.00	$118.22	$1,947.99
751	3337	B	0	0.837	TURNED WHEEL SET 36 IN, 6 1/2 X 12 AXLE	$536.74	$0.00	$0.00	$118.22	$654.96
752	3337	C	0	0.837	TURNED WHEEL SET 36 IN, 6 1/2 X 12 AXLE	$1,044.19	$0.00	$0.00	$118.22	$1,162.41
753	3337	D	0	0.837	TURNED WHEEL SET 36 IN, 6 1/2 X 12 AXLE	$1,322.32	$0.00	$0.00	$118.22	$1,440.54
754	3337	F	0	0.837	TURNED WHEEL SET 36 IN, 6 1/2 X 12 AXLE	$975.94	$0.00	$0.00	$118.22	$1,094.16
755	3337	G	0	0.837	TURNED WHEEL SET 36 IN, 6 1/2 X 12 AXLE	$1,483.39	$0.00	$0.00	$118.22	$1,601.61
756	3338	A	0	0.837	NEW WHEEL SET 38 INCH, 7 X 12 AXLE	$3,518.87	$0.00	$0.00	$118.22	$3,637.09

FID	Applied Job Code	Condtion Code	Fixed Labor Time Standard	Variable Labor Time Standard	Job Code Description	Material Price	Credit	Fixed Labor	Variable Labor	Total Cost
757	3338	B	0	0.837	NEW WHEEL SET 38 INCH, 7 X 12 AXLE	$1,924.00	$0.00	$0.00	$118.22	$2,042.22
758	3338	C	0	0.837	NEW WHEEL SET 38 INCH, 7 X 12 AXLE	$2,566.87	$0.00	$0.00	$118.22	$2,685.09
759	3338	D	0	0.837	NEW WHEEL SET 38 INCH, 7 X 12 AXLE	$2,875.00	$0.00	$0.00	$118.22	$2,993.22
760	3339	A	0	0.837	TURNED WHEEL SET 38 INCH, 7 X 12 AXLE	$2,253.38	$0.00	$0.00	$118.22	$2,371.60
761	3339	B	0	0.837	TURNED WHEEL SET 38 INCH, 7 X 12 AXLE	$659.51	$0.00	$0.00	$118.22	$777.73
762	3339	C	0	0.837	TURNED WHEEL SET 38 INCH, 7 X 12 AXLE	$1,302.38	$0.00	$0.00	$118.22	$1,420.60
763	3339	D	0	0.837	TURNED WHEEL SET 38 INCH, 7 X 12 AXLE	$1,610.51	$0.00	$0.00	$118.22	$1,728.73
764	3339	F	0	0.837	TURNED WHEEL SET 38 INCH, 7 X 12 AXLE	$1,316.28	$0.00	$0.00	$118.22	$1,434.50
765	3339	G	0	0.837	TURNED WHEEL SET 38 INCH, 7 X 12 AXLE	$1,959.15	$0.00	$0.00	$118.22	$2,077.37
766	3340	A	0	0.837	NEW WHL SET 36, 2-W 6 1/2 X 12 AXLE	$2,946.82	$0.00	$0.00	$118.22	$3,065.04
767	3340	B	0	0.837	NEW WHL SET 36, 2-W 6 1/2 X 12 AXLE	$1,653.79	$0.00	$0.00	$118.22	$1,772.01
768	3340	C	0	0.837	NEW WHL SET 36, 2-W 6 1/2 X 12 AXLE	$2,161.24	$0.00	$0.00	$118.22	$2,279.46
769	3340	D	0	0.837	NEW WHL SET 36, 2-W 6 1/2 X 12 AXLE	$2,439.37	$0.00	$0.00	$118.22	$2,557.59
770	3341	A	0	0.837	NEW WHL SET 36 IN, 1-W 6 1/2 X 9 AXLE	$2,696.91	$0.00	$0.00	$118.22	$2,815.13
771	3341	B	0	0.837	NEW WHL SET 36 IN, 1-W 6 1/2 X 9 AXLE	$1,437.26	$0.00	$0.00	$118.22	$1,555.48
772	3341	C	0	0.837	NEW WHL SET 36 IN, 1-W 6 1/2 X 9 AXLE	$1,932.09	$0.00	$0.00	$118.22	$2,050.31
773	3341	D	0	0.837	NEW WHL SET 36 IN, 1-W 6 1/2 X 9 AXLE	$2,202.08	$0.00	$0.00	$118.22	$2,320.30
774	3342	A	0	0.837	TURNED WHL SET 36 IN, 6 1/2 X 9 AXLE	$1,774.68	$0.00	$0.00	$118.22	$1,892.90
775	3342	B	0	0.837	TURNED WHL SET 36 IN, 6 1/2 X 9 AXLE	$515.03	$0.00	$0.00	$118.22	$633.25
776	3342	C	0	0.837	TURNED WHL SET 36 IN, 6 1/2 X 9 AXLE	$1,009.86	$0.00	$0.00	$118.22	$1,128.08
777	3342	D	0	0.837	TURNED WHL SET 36 IN, 6 1/2 X 9 AXLE	$1,279.85	$0.00	$0.00	$118.22	$1,398.07
778	3342	F	0	0.837	TURNED WHL SET 36 IN, 6 1/2 X 9 AXLE	$932.87	$0.00	$0.00	$118.22	$1,051.09
779	3342	G	0	0.837	TURNED WHL SET 36 IN, 6 1/2 X 9 AXLE	$1,427.70	$0.00	$0.00	$118.22	$1,545.92
780	3343	A	0	0.837	NEW WHL SET 36, 2-W 6 1/2 X 9 AXLE	$2,850.24	$0.00	$0.00	$118.22	$2,968.46
781	3343	B	0	0.837	NEW WHL SET 36, 2-W 6 1/2 X 9 AXLE	$1,590.59	$0.00	$0.00	$118.22	$1,708.81
782	3343	C	0	0.837	NEW WHL SET 36, 2-W 6 1/2 X 9 AXLE	$2,085.42	$0.00	$0.00	$118.22	$2,203.64
783	3343	D	0	0.837	NEW WHL SET 36, 2-W 6 1/2 X 9 AXLE	$2,355.41	$0.00	$0.00	$118.22	$2,473.63
784	3344	B	0	0.837	NEW WHL SET 36 IN, 1-W 6 1/2 X 12 AXLE, UBR	$1,579.38	$0.00	$0.00	$118.22	$1,697.60
785	3344	C	0	0.837	NEW WHL SET 36 IN, 1-W 6 1/2 X 12 AXLE, UBR	$2,127.13	$0.00	$0.00	$118.22	$2,245.35
786	3345	B	0	0.837	TURNED WHEEL SET 36 IN, 6 1/2 X 12 AXLE, UBR	$615.66	$0.00	$0.00	$118.22	$733.88
787	3345	C	0	0.837	TURNED WHEEL SET 36 IN, 6 1/2 X 12 AXLE, UBR	$1,163.41	$0.00	$0.00	$118.22	$1,281.63
788	3345	F	0	0.837	TURNED WHEEL SET 36 IN, 6 1/2 X 12 AXLE, UBR	$1,054.86	$0.00	$0.00	$118.22	$1,173.08
789	3345	G	0	0.837	TURNED WHEEL SET 36 IN, 6 1/2 X 12 AXLE, UBR	$1,602.61	$0.00	$0.00	$118.22	$1,720.83
790	3346	B	0	0.837	NEW WHL SET 36, 2-W 6 1/2 X 12 AXLE, UBR	$1,732.71	$0.00	$0.00	$118.22	$1,850.93
791	3346	C	0	0.837	NEW WHL SET 36, 2-W 6 1/2 X 12 AXLE, UBR	$2,280.46	$0.00	$0.00	$118.22	$2,398.68
792	3347	B	0	0.837	NEW WHEEL SET 33 INCH, 1W 6 X 11 AXLE, UBR	$1,514.45	$0.00	$0.00	$118.22	$1,632.67
793	3347	C	0	0.837	NEW WHEEL SET 33 INCH, 1W 6 X 11 AXLE, UBR	$1,957.17	$0.00	$0.00	$118.22	$2,075.39
794	3348	B	0	0.837	TURNED WHEEL SET 33 INCH, 6 X 11 AXLE, UBR	$587.45	$0.00	$0.00	$118.22	$705.67
795	3348	C	0	0.837	TURNED WHEEL SET 33 INCH, 6 X 11 AXLE, UBR	$1,030.17	$0.00	$0.00	$118.22	$1,148.39
796	3348	F	0	0.837	TURNED WHEEL SET 33 INCH, 6 X 11 AXLE, UBR	$986.97	$0.00	$0.00	$118.22	$1,105.19
797	3348	G	0	0.837	TURNED WHEEL SET 33 INCH, 6 X 11 AXLE, UBR	$1,429.69	$0.00	$0.00	$118.22	$1,547.91
798	3349	B	0	0.837	NEW WHEEL SET 28 INCH, 1W 6 X 11 AXLE, UBR	$1,538.38	$0.00	$0.00	$118.22	$1,656.60
799	3349	C	0	0.837	NEW WHEEL SET 28 INCH, 1W 6 X 11 AXLE, UBR	$1,981.10	$0.00	$0.00	$118.22	$2,099.32
800	3350	B	0	0.837	TURNED WHEEL SET 28 INCH, 6 X 11 AXLE, UBR	$558.64	$0.00	$0.00	$118.22	$676.86
801	3350	C	0	0.837	TURNED WHEEL SET 28 INCH, 6 X 11 AXLE, UBR	$1,001.36	$0.00	$0.00	$118.22	$1,119.58
802	3350	F	0	0.837	TURNED WHEEL SET 28 INCH, 6 X 11 AXLE, UBR	$1,017.98	$0.00	$0.00	$118.22	$1,136.20
803	3350	G	0	0.837	TURNED WHEEL SET 28 INCH, 6 X 11 AXLE, UBR	$1,460.70	$0.00	$0.00	$118.22	$1,578.92
804	3352	B	0	0.837	NEW WHL SET 36 IN, 1-W 6 1/2 X 9 AXLE, UBR	$1,516.60	$0.00	$0.00	$118.22	$1,634.82
805	3352	C	0	0.837	NEW WHL SET 36 IN, 1-W 6 1/2 X 9 AXLE, UBR	$2,044.89	$0.00	$0.00	$118.22	$2,163.11
806	3353	B	0	0.837	TURNED WHEEL SET 36 IN, 6 1/2 X 9 AXLE, UBR	$594.37	$0.00	$0.00	$118.22	$712.59
807	3353	C	0	0.837	TURNED WHEEL SET 36 IN, 6 1/2 X 9 AXLE, UBR	$1,122.66	$0.00	$0.00	$118.22	$1,240.88
808	3353	F	0	0.837	TURNED WHEEL SET 36 IN, 6 1/2 X 9 AXLE, UBR	$1,012.21	$0.00	$0.00	$118.22	$1,130.43
809	3353	G	0	0.837	TURNED WHEEL SET 36 IN, 6 1/2 X 9 AXLE, UBR	$1,540.50	$0.00	$0.00	$118.22	$1,658.72
810	3354	B	0	0.837	NEW WHL SET 36, 2-W 6 1/2 X 9 AXLE, UBR	$1,669.93	$0.00	$0.00	$118.22	$1,788.15
811	3354	C	0	0.837	NEW WHL SET 36, 2-W 6 1/2 X 9 AXLE, UBR	$2,198.22	$0.00	$0.00	$118.22	$2,316.44
812	3360	A	0	0.837	NEW WHEEL SET 33 INCH 1-W, 6 X 11 AXLE, CLASS D	$2,593.85	$0.00	$0.00	$118.22	$2,712.07
813	3360	B	0	0.837	NEW WHEEL SET 33 INCH 1-W, 6 X 11 AXLE, CLASS D	$1,736.02	$0.00	$0.00	$118.22	$1,854.24
814	3360	C	0	0.837	NEW WHEEL SET 33 INCH 1-W, 6 X 11 AXLE, CLASS D	$2,151.54	$0.00	$0.00	$118.22	$2,269.76
815	3360	D	0	0.837	NEW WHEEL SET 33 INCH 1-W, 6 X 11 AXLE, CLASS D	$2,178.33	$0.00	$0.00	$118.22	$2,296.55
816	3362	B	0	0.837	NEW WHL SET 33-IN 1-W, 6 X 11 AXLE, CLASS D, UBR	$1,817.76	$0.00	$0.00	$118.22	$1,935.98
817	3362	C	0	0.837	NEW WHL SET 33-IN 1-W, 6 X 11 AXLE, CLASS D, UBR	$2,260.48	$0.00	$0.00	$118.22	$2,378.70
818	3366	A	0	0.837	NEW WHL SET 36 IN, 1-W 6 1/2 X 12 AXLE, CLASS D	$3,082.65	$0.00	$0.00	$118.22	$3,200.87
819	3366	B	0	0.837	NEW WHL SET 36 IN, 1-W 6 1/2 X 12 AXLE, CLASS D	$1,789.62	$0.00	$0.00	$118.22	$1,907.84

FID	Applied Job Code	Condtion Code	Fixed Labor Time Standard	Variable Labor Time Standard	Job Code Description	Material Price	Credit	Fixed Labor	Variable Labor	Total Cost
820	3366	C	0	0.837	NEW WHL SET 36 IN, 1-W 6 1/2 X 12 AXLE, CLASS D	$2,297.07	$0.00	$0.00	$118.22	$2,415.29
821	3366	D	0	0.837	NEW WHL SET 36 IN, 1-W 6 1/2 X 12 AXLE, CLASS D	$2,575.20	$0.00	$0.00	$118.22	$2,693.42
822	3368	A	0	0.837	NEW WHL SET 38 IN, 1-W 7 X 12 AXLE, CLASS D	$3,906.06	$0.00	$0.00	$118.22	$4,024.28
823	3368	B	0	0.837	NEW WHL SET 38 IN, 1-W 7 X 12 AXLE, CLASS D	$2,312.19	$0.00	$0.00	$118.22	$2,430.41
824	3368	C	0	0.837	NEW WHL SET 38 IN, 1-W 7 X 12 AXLE, CLASS D	$2,955.06	$0.00	$0.00	$118.22	$3,073.28
825	3368	D	0	0.837	NEW WHL SET 38 IN, 1-W 7 X 12 AXLE, CLASS D	$3,263.19	$0.00	$0.00	$118.22	$3,381.41
826	3370	A	0	0.837	NEW WHL SET 36 IN, 2-W 6 1/2 X 12 AXLE, CLASS D	$3,255.31	$0.00	$0.00	$118.22	$3,373.53
827	3370	B	0	0.837	NEW WHL SET 36 IN, 2-W 6 1/2 X 12 AXLE, CLASS D	$1,962.28	$0.00	$0.00	$118.22	$2,080.50
828	3370	C	0	0.837	NEW WHL SET 36 IN, 2-W 6 1/2 X 12 AXLE, CLASS D	$2,469.73	$0.00	$0.00	$118.22	$2,587.95
829	3370	D	0	0.837	NEW WHL SET 36 IN, 2-W 6 1/2 X 12 AXLE, CLASS D	$2,747.86	$0.00	$0.00	$118.22	$2,866.08
830	3371	A	0	0.837	NEW WHL SET 36 IN, 1-W 6 1/2 X 9 AXLE, CLASS D	$2,986.07	$0.00	$0.00	$118.22	$3,104.29
831	3371	B	0	0.837	NEW WHL SET 36 IN, 1-W 6 1/2 X 9 AXLE, CLASS D	$1,726.42	$0.00	$0.00	$118.22	$1,844.64
832	3371	C	0	0.837	NEW WHL SET 36 IN, 1-W 6 1/2 X 9 AXLE, CLASS D	$2,221.25	$0.00	$0.00	$118.22	$2,339.47
833	3371	D	0	0.837	NEW WHL SET 36 IN, 1-W 6 1/2 X 9 AXLE, CLASS D	$2,491.24	$0.00	$0.00	$118.22	$2,609.46
834	3373	A	0	0.837	NEW WHL SET 36 IN, 2-W 6 1/2 X 9 AXLE, CLASS D	$3,158.73	$0.00	$0.00	$118.22	$3,276.95
835	3373	B	0	0.837	NEW WHL SET 36 IN, 2-W 6 1/2 X 9 AXLE, CLASS D	$1,899.08	$0.00	$0.00	$118.22	$2,017.30
836	3373	C	0	0.837	NEW WHL SET 36 IN, 2-W 6 1/2 X 9 AXLE, CLASS D	$2,393.91	$0.00	$0.00	$118.22	$2,512.13
837	3373	D	0	0.837	NEW WHL SET 36 IN, 2-W 6 1/2 X 9 AXLE, CLASS D	$2,663.90	$0.00	$0.00	$118.22	$2,782.12
838	3374	B	0	0.837	NEW WHLSET 36 IN 1-W 6 1/2 X 12 AXLE CLASS D UBR	$1,868.54	$0.00	$0.00	$118.22	$1,986.76
839	3374	C	0	0.837	NEW WHLSET 36 IN 1-W 6 1/2 X 12 AXLE CLASS D UBR	$2,416.29	$0.00	$0.00	$118.22	$2,534.51
840	3376	B	0	0.837	NEW WHLSET 36 IN 2-W 6 1/2 X 12 AXLE CLASS D UBR	$2,041.20	$0.00	$0.00	$118.22	$2,159.42
841	3376	C	0	0.837	NEW WHLSET 36 IN 2-W 6 1/2 X 12 AXLE CLASS D UBR	$2,588.95	$0.00	$0.00	$118.22	$2,707.17
842	3377	B	0	0.837	NEW WHLSET 36 IN,1-W 6 1/2 X 9 AXLE CLASS D UBR	$1,805.76	$0.00	$0.00	$118.22	$1,923.98
843	3377	C	0	0.837	NEW WHLSET 36 IN,1-W 6 1/2 X 9 AXLE CLASS D UBR	$2,334.05	$0.00	$0.00	$118.22	$2,452.27
844	3379	B	0	0.837	NEW WHLSET 36 IN 2-W 6 1/2 X 9 AXLE CLASS D UBR	$1,978.42	$0.00	$0.00	$118.22	$2,096.64
845	3379	C	0	0.837	NEW WHLSET 36 IN 2-W 6 1/2 X 9 AXLE CLASS D UBR	$2,506.71	$0.00	$0.00	$118.22	$2,624.93
846	3399	T	0	0	WHEEL SET TRANSFER	$0.00	$0.00	$0.00	$0.00	$0.00
847	3470	1	0	5.04	GROUP COC-1	$3,127.84	$68.53	$0.00	$711.85	$3,839.69
848	3470	3	0	5.04	GROUP COC-1	$2,060.35	$0.00	$0.00	$711.85	$2,772.20
849	3470	9	0	4.583	GROUP COC-1	$45.56	$0.00	$0.00	$647.30	$692.86
850	3472	1	0	5.04	GROUP COC-2	$3,375.35	$68.53	$0.00	$711.85	$4,087.20
851	3472	3	0	5.04	GROUP COC-2	$2,216.78	$0.00	$0.00	$711.85	$2,928.63
852	3472	9	0	4.583	GROUP COC-2	$45.56	$0.00	$0.00	$647.30	$692.86
853	3476	1	0	5.04	GROUP COC-4	$2,108.97	$68.53	$0.00	$711.85	$2,820.82
854	3476	3	0	5.04	GROUP COC-4	$1,134.44	$0.00	$0.00	$711.85	$1,846.29
855	3476	9	0	4.583	GROUP COC-4	$45.56	$0.00	$0.00	$647.30	$692.86
856	3480	1	0	5.04	GROUP COC-6	$2,673.55	$148.50	$0.00	$711.85	$3,385.40
857	3480	3	0	5.04	GROUP COC-6	$1,383.29	$0.00	$0.00	$711.85	$2,095.14
858	3480	9	0	4.583	GROUP COC-6	$45.56	$0.00	$0.00	$647.30	$692.86
859	3520	1	0	1.861	TRUCK BOLSTER-70 TON	$1,444.13	$115.50	$0.00	$262.85	$1,706.98
860	3520	2	0	1.861	TRUCK BOLSTER-70 TON	$530.41	$0.00	$0.00	$262.85	$793.26
861	3520	3	0	1.861	TRUCK BOLSTER-70 TON	$802.89	$0.00	$0.00	$262.85	$1,065.74
862	3520	T	0	0	TRUCK BOLSTER-70 TON	$0.00	$0.00	$0.00	$0.00	$0.00
863	3524	1	0	1.861	TRUCK BOLSTER-100 OR 110 TON	$1,228.67	$137.50	$0.00	$262.85	$1,491.52
864	3524	2	0	1.861	TRUCK BOLSTER-100 OR 110 TON	$529.37	$0.00	$0.00	$262.85	$792.22
865	3524	3	0	1.861	TRUCK BOLSTER-100 OR 110 TON	$801.31	$0.00	$0.00	$262.85	$1,064.16
866	3524	T	0	0	TRUCK BOLSTER-100 OR 110 TON	$0.00	$0.00	$0.00	$0.00	$0.00
867	3528	1	0	1.861	TRUCK BOLSTER-125 TON	$1,639.97	$183.15	$0.00	$262.85	$1,902.82
868	3528	2	0	1.861	TRUCK BOLSTER-125 TON	$812.54	$0.00	$0.00	$262.85	$1,075.39
869	3528	3	0	1.861	TRUCK BOLSTER-125 TON	$1,230.35	$0.00	$0.00	$262.85	$1,493.20
870	3528	T	0	0	TRUCK BOLSTER-125 TON	$0.00	$0.00	$0.00	$0.00	$0.00
871	3560	1	0	0.101	CENTER PIN	$7.13	$1.32	$0.00	$14.27	$21.40
872	3560	2	0	0.101	CENTER PIN	$7.13	$1.32	$0.00	$14.27	$21.40
873	3562	0	0	0	CENTER BOWL HORIZONTAL LINER, NON-METALLIC	$0.00	$0.00	$0.00	$0.00	$0.00
874	3562	1	0	0.144	CENTER BOWL HORIZONTAL LINER, NON-METALLIC	$19.28	$0.00	$0.00	$20.34	$39.62
875	3564	0	0	0	FULL BOWL LINER, NON-METALLIC	$0.00	$0.00	$0.00	$0.00	$0.00
876	3564	1	0	0.144	FULL BOWL LINER, NON-METALLIC	$40.99	$0.00	$0.00	$20.34	$61.33
877	3566	1	0	0.549	VERTICAL WEAR LINER - CARBON STEEL	$41.26	$0.44	$0.00	$77.54	$118.80
878	3566	9	0	0.313	VERTICAL WEAR LINER - CARBON STEEL	$0.00	$0.00	$0.00	$44.21	$44.21
879	3567	1	0	0.549	VERTICAL WEAR LINER - STAINLESS STEEL	$35.55	$0.44	$0.00	$77.54	$113.09
880	3567	9	0	0.313	VERTICAL WEAR LINER - STAINLESS STEEL	$0.00	$0.00	$0.00	$44.21	$44.21
881	3570	0	0	0.144	CENTER BOWL LINER, METALLIC	$0.00	$0.00	$0.00	$20.34	$20.34
882	3570	1	0	0.144	CENTER BOWL LINER, METALLIC	$14.92	$0.00	$0.00	$20.34	$35.26

FID	Applied Job Code	Condtion Code	Fixed Labor Time Standard	Variable Labor Time Standard	Job Code Description	Material Price	Credit	Fixed Labor	Variable Labor	Total Cost
883	3571	0	0	0	FULL BOWL LINER, METALLIC	$0.00	$0.00	$0.00	$0.00	$0.00
884	3571	1	0	0.144	FULL BOWL LINER, METALLIC	$101.31	$0.00	$0.00	$20.34	$121.65
885	3572	1	0	0.076	TRK SIDE BEARING ROLLER OR FRICT BLOCK	$14.18	$1.32	$0.00	$10.73	$24.91
886	3572	2	0	0.076	TRK SIDE BEARING ROLLER OR FRICT BLOCK	$7.09	$1.32	$0.00	$10.73	$17.82
887	3576	1	0	0.448	TRK SIDE BEARING HOUSING	$48.79	$2.09	$0.00	$63.28	$112.07
888	3576	2	0	0.448	TRK SIDE BEARING HOUSING	$26.45	$2.09	$0.00	$63.28	$89.73
889	3580	1	0	0.448	TRK SIDE BEARING ROLLER HOUSING DOUBLE	$46.11	$2.20	$0.00	$63.28	$109.39
890	3580	2	0	0.448	TRK SIDE BEARING ROLLER HOUSING DOUBLE	$25.11	$2.20	$0.00	$63.28	$88.39
891	3582	1	0.082	0.203	FRICTION CASTING - RIDE CONTROL	$41.15	$0.55	$11.58	$28.67	$69.82
892	3582	2	0.082	0.203	FRICTION CASTING - RIDE CONTROL	$20.65	$0.55	$11.58	$28.67	$49.32
893	3583	1	0.082	0.203	FRICTION CASTING - XCR	$96.50	$3.85	$11.58	$28.67	$125.17
894	3583	2	0.082	0.203	FRICTION CASTING - XCR	$48.33	$3.85	$11.58	$28.67	$77.00
895	3584	1	0.078	0.203	FRICTION CASTING - STABILIZED TRUCK	$37.72	$1.21	$11.02	$28.67	$66.39
896	3584	2	0.078	0.203	FRICTION CASTING - STABILIZED TRUCK	$18.94	$1.21	$11.02	$28.67	$47.61
897	3585	1	0.078	0.203	FRICTION CASTING - SWING MOTION TRUCK	$107.88	$2.53	$11.02	$28.67	$136.55
898	3585	2	0.078	0.203	FRICTION CASTING - SWING MOTION TRUCK	$54.02	$2.53	$11.02	$28.67	$82.69
899	3588	0	0.103	0.334	TRUCK SIDE BEARING SHIM	$3.96	$0.00	$14.55	$47.17	$51.13
900	3588	1	0.103	0.334	TRUCK SIDE BEARING SHIM	$14.44	$0.00	$14.55	$47.17	$61.61
901	3720	1	0	1.506	SIDE FRAME-70 TON OR LESS	$477.14	$82.50	$0.00	$212.71	$689.85
902	3720	2	0	1.506	SIDE FRAME-70 TON OR LESS	$285.30	$82.50	$0.00	$212.71	$498.01
903	3720	3	0	1.506	SIDE FRAME-70 TON OR LESS	$430.58	$0.00	$0.00	$212.71	$643.29
904	3720	T	0	0	SIDE FRAME-70 TON OR LESS	$0.00	$0.00	$0.00	$0.00	$0.00
905	3724	1	0	1.506	SIDE FRAME-100 OR 110 TON	$846.84	$99.00	$0.00	$212.71	$1,059.55
906	3724	2	0	1.506	SIDE FRAME-100 OR 110 TON	$409.52	$0.00	$0.00	$212.71	$622.23
907	3724	3	0	1.506	SIDE FRAME-100 OR 110 TON	$618.79	$0.00	$0.00	$212.71	$831.50
908	3724	T	0	0	SIDE FRAME-100 OR 110 TON	$0.00	$0.00	$0.00	$0.00	$0.00
909	3728	1	0	1.506	SIDE FRAME-125 TON	$1,041.22	$117.15	$0.00	$212.71	$1,253.93
910	3728	2	0	1.506	SIDE FRAME-125 TON	$433.42	$0.00	$0.00	$212.71	$646.13
911	3728	3	0	1.506	SIDE FRAME-125 TON	$655.01	$0.00	$0.00	$212.71	$867.72
912	3728	T	0	0	SIDE FRAME-125 TON	$0.00	$0.00	$0.00	$0.00	$0.00
913	3760	1	0	0.466	TRANSOM-MOUNTED INSIDE SIDE FRAME UNDER SPRINGS	$976.27	$26.84	$0.00	$65.82	$1,042.09
914	3760	2	0	0.466	TRANSOM-MOUNTED INSIDE SIDE FRAME UNDER SPRINGS	$491.06	$26.84	$0.00	$65.82	$556.88
915	3760	9	0	0.256	TRANSOM-MOUNTED INSIDE SIDE FRAME UNDER SPRINGS	$2.92	$0.00	$0.00	$36.16	$39.08
916	3762	1	0	0.454	TRANSOM-MOUNTED UNDER SIDEFRAMES	$1,076.80	$20.90	$0.00	$64.12	$1,140.92
917	3762	2	0	0.454	TRANSOM-MOUNTED UNDER SIDEFRAMES	$539.86	$20.90	$0.00	$64.12	$603.98
918	3762	9	0	0.244	TRANSOM-MOUNTED UNDER SIDEFRAMES	$2.92	$0.00	$0.00	$34.46	$37.38
919	3772	1	0.078	0.187	TRK SD FR/BLSTR FRCT CAST WEAR PLT-RD CNTRL OR XCR	$20.96	$0.00	$11.02	$26.41	$47.37
920	3774	1	0.078	0.187	TRK SD FR/BLSTR FRCT CAST WEAR PLT-BARBER/SWNG MTN	$20.96	$0.00	$11.02	$26.41	$47.37
921	3778	1	0	0.247	PEDESTAL ROOF LINER, CLIP ON TYPE	$3.24	$0.22	$0.00	$34.89	$38.13
922	3904	1	0.105	0	TRUCK SPRING, OUTER COIL, D3	$12.71	$2.31	$14.83	$0.00	$12.71
923	3904	2	0.105	0	TRUCK SPRING, OUTER COIL, D3	$6.43	$2.31	$14.83	$0.00	$6.43
924	3904	3	0.105	0	TRUCK SPRING, OUTER COIL, D3	$8.31	$2.31	$14.83	$0.00	$8.31
925	3908	1	0.105	0	TRUCK SPRING, OUTER COIL, D4	$12.66	$2.20	$14.83	$0.00	$12.66
926	3908	2	0.105	0	TRUCK SPRING, OUTER COIL, D4	$6.41	$2.20	$14.83	$0.00	$6.41
927	3908	3	0.105	0	TRUCK SPRING, OUTER COIL, D4	$8.28	$2.20	$14.83	$0.00	$8.28
928	3912	1	0.105	0	TRUCK SPRING, OUTER COIL, D5	$14.82	$2.20	$14.83	$0.00	$14.82
929	3912	2	0.105	0	TRUCK SPRING, OUTER COIL, D5	$7.49	$2.20	$14.83	$0.00	$7.49
930	3912	3	0.105	0	TRUCK SPRING, OUTER COIL, D5	$9.69	$2.20	$14.83	$0.00	$9.69
931	3914	1	0.105	0	TRUCK SPRING,OUTER COIL, D7	$12.10	$2.31	$14.83	$0.00	$12.10
932	3914	2	0.105	0	TRUCK SPRING,OUTER COIL, D7	$6.13	$2.31	$14.83	$0.00	$6.13
933	3914	3	0.105	0	TRUCK SPRING,OUTER COIL, D7	$7.92	$2.31	$14.83	$0.00	$7.92
934	3920	1	0.105	0	TRUCK SPRING, INNER COIL, D3	$5.68	$0.88	$14.83	$0.00	$5.68
935	3920	2	0.105	0	TRUCK SPRING, INNER COIL, D3	$2.92	$0.88	$14.83	$0.00	$2.92
936	3920	3	0.105	0	TRUCK SPRING, INNER COIL, D3	$3.74	$0.88	$14.83	$0.00	$3.74
937	3924	1	0.105	0	TRUCK SPRING, INNER COIL, D4	$5.76	$0.88	$14.83	$0.00	$5.76
938	3924	2	0.105	0	TRUCK SPRING, INNER COIL, D4	$2.96	$0.88	$14.83	$0.00	$2.96
939	3924	3	0.105	0	TRUCK SPRING, INNER COIL, D4	$3.80	$0.88	$14.83	$0.00	$3.80
940	3928	1	0.105	0	TRUCK SPRING, INNER COIL, D5	$6.63	$0.88	$14.83	$0.00	$6.63
941	3928	2	0.105	0	TRUCK SPRING, INNER COIL, D5	$3.39	$0.88	$14.83	$0.00	$3.39
942	3928	3	0.105	0	TRUCK SPRING, INNER COIL, D5	$4.36	$0.88	$14.83	$0.00	$4.36
943	3932	1	0.105	0	TRUCK SPRING, INNER COIL, D6	$5.74	$0.88	$14.83	$0.00	$5.74
944	3932	2	0.105	0	TRUCK SPRING, INNER COIL, D6	$2.95	$0.88	$14.83	$0.00	$2.95
945	3932	3	0.105	0	TRUCK SPRING, INNER COIL, D6	$3.78	$0.88	$14.83	$0.00	$3.78

FID	Applied Job Code	Condtion Code	Fixed Labor Time Standard	Variable Labor Time Standard	Job Code Description	Material Price	Credit	Fixed Labor	Variable Labor	Total Cost
946	3933	1	0.105	0	TRUCK SPRING, INNER COIL, D6A	$3.87	$0.88	$14.83	$0.00	$3.87
947	3933	2	0.105	0	TRUCK SPRING, INNER COIL, D6A	$2.01	$0.88	$14.83	$0.00	$2.01
948	3933	3	0.105	0	TRUCK SPRING, INNER COIL, D6A	$2.57	$0.88	$14.83	$0.00	$2.57
949	3934	1	0.105	0	TRUCK SPRING, INNER COIL, D7	$5.83	$0.88	$14.83	$0.00	$5.83
950	3934	2	0.105	0	TRUCK SPRING, INNER COIL, D7	$2.99	$0.88	$14.83	$0.00	$2.99
951	3934	3	0.105	0	TRUCK SPRING, INNER COIL, D7	$3.84	$0.88	$14.83	$0.00	$3.84
952	3940	1	0.078	0	TRK STABILIZING SPRING-BARBER OR SWING MOTION TRK	$8.02	$0.33	$11.02	$0.00	$8.02
953	3940	2	0.078	0	TRK STABILIZING SPRING-BARBER OR SWING MOTION TRK	$4.09	$0.33	$11.02	$0.00	$4.09
954	3942	1	0.082	0.203	TRUCK STABILIZING SPRING - RIDE CONTROL OR XCR TRK	$8.02	$0.33	$11.58	$28.67	$36.69
955	3942	2	0.082	0.203	TRUCK STABILIZING SPRING - RIDE CONTROL OR XCR TRK	$4.09	$0.33	$11.58	$28.67	$32.76
956	3952	1	0.105	0	TRUCK SPRING FRICTION SNUBBER	$216.55	$4.62	$14.83	$0.00	$216.55
957	3952	2	0.105	0	TRUCK SPRING FRICTION SNUBBER	$108.35	$4.62	$14.83	$0.00	$108.35
958	3954	1	0.105	0	TRUCK SPRING HYDRAULIC SNUBBER	$144.25	$3.85	$14.83	$0.00	$144.25
959	3954	3	0.105	0	TRUCK SPRING HYDRAULIC SNUBBER	$72.13	$3.85	$14.83	$0.00	$72.13
960	4001	1	0.197	0.049	METAL RUNNING BOARD, GRATE TYPE 20 IN WIDE OR LESS	$18.65	$0.88	$27.82	$6.92	$25.57
961	4001	2	0.197	0.049	METAL RUNNING BOARD, GRATE TYPE 20 IN WIDE OR LESS	$9.69	$0.88	$27.82	$6.92	$16.61
962	4001	8	0.197	0.049	METAL RUNNING BOARD, GRATE TYPE 20 IN WIDE OR LESS	$10.89	$0.00	$27.82	$6.92	$17.81
963	4001	9	0.114	0.049	METAL RUNNING BOARD, GRATE TYPE 20 IN WIDE OR LESS	$0.73	$0.00	$16.10	$6.92	$7.65
964	4002	1	0.197	0.049	METAL RUNNING BOARD, GRATE TYPE OVER 20 INCH WIDE	$15.82	$0.88	$27.82	$6.92	$22.74
965	4002	2	0.197	0.049	METAL RUNNING BOARD, GRATE TYPE OVER 20 INCH WIDE	$8.28	$0.88	$27.82	$6.92	$15.20
966	4002	8	0.197	0.049	METAL RUNNING BOARD, GRATE TYPE OVER 20 INCH WIDE	$10.89	$0.00	$27.82	$6.92	$17.81
967	4002	9	0.114	0.049	METAL RUNNING BOARD, GRATE TYPE OVER 20 INCH WIDE	$0.73	$0.00	$16.10	$6.92	$7.65
968	4005	1	0.197	0.049	METAL RUNNING BOARD, PLATE TYPE 20 IN WIDE OR LESS	$12.89	$1.32	$27.82	$6.92	$19.81
969	4005	2	0.197	0.049	METAL RUNNING BOARD, PLATE TYPE 20 IN WIDE OR LESS	$6.81	$1.32	$27.82	$6.92	$13.73
970	4005	8	0.197	0.049	METAL RUNNING BOARD, PLATE TYPE 20 IN WIDE OR LESS	$10.64	$0.00	$27.82	$6.92	$17.56
971	4005	9	0.114	0.049	METAL RUNNING BOARD, PLATE TYPE 20 IN WIDE OR LESS	$0.73	$0.00	$16.10	$6.92	$7.65
972	4006	1	0.197	0.049	METAL RUNNING BOARD, PLATE TYPE OVER 20 INCH WIDE	$15.49	$1.32	$27.82	$6.92	$22.41
973	4006	2	0.197	0.049	METAL RUNNING BOARD, PLATE TYPE OVER 20 INCH WIDE	$8.11	$1.32	$27.82	$6.92	$15.03
974	4006	8	0.197	0.049	METAL RUNNING BOARD, PLATE TYPE OVER 20 INCH WIDE	$13.23	$0.00	$27.82	$6.92	$20.15
975	4006	9	0.114	0.049	METAL RUNNING BOARD, PLATE TYPE OVER 20 INCH WIDE	$0.73	$0.00	$16.10	$6.92	$7.65
976	4008	1	0	0.956	METAL RUNNING BOARD, END	$175.51	$10.23	$0.00	$135.03	$310.54
977	4008	2	0	0.956	METAL RUNNING BOARD, END	$102.62	$10.23	$0.00	$135.03	$237.65
978	4008	8	0	1.837	METAL RUNNING BOARD, END	$35.63	$0.00	$0.00	$259.46	$295.09
979	4008	9	0	0.79	METAL RUNNING BOARD, END	$8.76	$0.00	$0.00	$111.58	$120.34
980	4012	1	0	0.214	METAL RUNNING BOARD, SIDE	$28.11	$1.21	$0.00	$30.23	$58.34
981	4012	2	0	0.214	METAL RUNNING BOARD, SIDE	$14.61	$1.21	$0.00	$30.23	$44.84
982	4012	8	0	0.214	METAL RUNNING BOARD, SIDE	$15.07	$0.00	$0.00	$30.23	$45.30
983	4012	9	0	0.214	METAL RUNNING BOARD, SIDE	$1.10	$0.00	$0.00	$30.23	$31.33
984	4017	1	0	0.423	METAL END CROSSOVER BOARD, 72 INCHES OR LESS	$31.75	$2.09	$0.00	$59.74	$91.49
985	4017	2	0	0.423	METAL END CROSSOVER BOARD, 72 INCHES OR LESS	$18.80	$2.09	$0.00	$59.74	$78.54
986	4017	8	0	0.423	METAL END CROSSOVER BOARD, 72 INCHES OR LESS	$29.25	$0.00	$0.00	$59.74	$88.99
987	4017	9	0	0.319	METAL END CROSSOVER BOARD, 72 INCHES OR LESS	$5.84	$0.00	$0.00	$45.06	$50.90
988	4018	1	0.135	0.581	METAL END CROSSOVER BOARD, OVER 72 INCHES	$56.78	$4.40	$19.07	$82.06	$138.84
989	4018	2	0.135	0.581	METAL END CROSSOVER BOARD, OVER 72 INCHES	$31.31	$4.40	$19.07	$82.06	$113.37
990	4018	8	0.135	0.581	METAL END CROSSOVER BOARD, OVER 72 INCHES	$49.02	$0.00	$19.07	$82.06	$131.08
991	4018	9	0	0.462	METAL END CROSSOVER BOARD, OVER 72 INCHES	$5.84	$0.00	$0.00	$65.25	$71.09
992	4020	1	0	0.472	METAL BRAKE STEP	$22.61	$1.32	$0.00	$66.67	$89.28
993	4020	2	0	0.472	METAL BRAKE STEP	$12.77	$1.32	$0.00	$66.67	$79.44
994	4020	8	0	0.472	METAL BRAKE STEP	$18.16	$0.00	$0.00	$66.67	$84.83
995	4020	9	0	0.472	METAL BRAKE STEP	$2.92	$0.00	$0.00	$66.67	$69.59
996	4024	1	0.197	0.049	FBRGLASS RUN BRD, GRATE OVER 12 UP TO 24 IN WIDE	$31.36	$0.00	$27.82	$6.92	$38.28
997	4024	2	0.197	0.049	FBRGLASS RUN BRD, GRATE OVER 12 UP TO 24 IN WIDE	$16.05	$0.00	$27.82	$6.92	$22.97
998	4024	9	0.114	0.049	FBRGLASS RUN BRD, GRATE OVER 12 UP TO 24 IN WIDE	$0.73	$0.00	$16.10	$6.92	$7.65
999	4026	1	0.197	0.049	FIBERGLASS RUN BRD, GRATE TYPE OVER 24 INCHES WIDE	$46.65	$0.00	$27.82	$6.92	$53.57
1000	4026	2	0.197	0.049	FIBERGLASS RUN BRD, GRATE TYPE OVER 24 INCHES WIDE	$23.69	$0.00	$27.82	$6.92	$30.61
1001	4026	9	0.114	0.049	FIBERGLASS RUN BRD, GRATE TYPE OVER 24 INCHES WIDE	$0.73	$0.00	$16.10	$6.92	$7.65
1002	4070	1	0	1.882	LABOR, EOC CUSHIONING UNIT	$24.12	$0.00	$0.00	$265.81	$289.93
1003	4070	9	0	1.4	LABOR, EOC CUSHIONING UNIT	$24.12	$0.00	$0.00	$197.74	$221.86
1004	4071	1	0	5.04	LABOR, COC CUSHIONING UNIT	$45.56	$0.00	$0.00	$711.85	$757.41
1005	4071	9	0	4.583	LABOR, COC CUSHIONING UNIT	$45.56	$0.00	$0.00	$647.30	$692.86
1006	4074	1	0	0.304	LABOR, REPAIR EOCC RESTORING MECHANISM ON CAR	$5.36	$0.00	$0.00	$42.94	$48.30
1007	4080	1	0.57	0	SEPARABLE BODY CENTER PLATE 14 INCH	$263.13	$10.45	$80.51	$0.00	$263.13
1008	4080	2	0.57	0	SEPARABLE BODY CENTER PLATE 14 INCH	$131.57	$10.45	$80.51	$0.00	$131.57

FID	Applied Job Code	Condtion Code	Fixed Labor Time Standard	Variable Labor Time Standard	Job Code Description	Material Price	Credit	Fixed Labor	Variable Labor	Total Cost
1009	4081	1	0.57	0	SEPARABLE BODY CENTER PLATE 16 INCH	$379.13	$15.40	$80.51	$0.00	$379.13
1010	4081	2	0.57	0	SEPARABLE BODY CENTER PLATE 16 INCH	$189.57	$15.40	$80.51	$0.00	$189.57
1011	4082	1	0.57	0	LOW PROFILE BODY CENTER PLATE ANY SIZE	$220.59	$20.35	$80.51	$0.00	$220.59
1012	4082	2	0.57	0	LOW PROFILE BODY CENTER PLATE ANY SIZE	$110.30	$20.35	$80.51	$0.00	$110.30
1013	4090	1	0.11	0.077	BODY SIDE BEARING	$33.25	$1.65	$15.54	$10.88	$44.13
1014	4090	2	0.11	0.077	BODY SIDE BEARING	$17.36	$1.65	$15.54	$10.88	$28.24
1015	4092	0	0.195	0	BODY SIDE BEARING SHIM	$3.96	$0.00	$27.54	$0.00	$3.96
1016	4092	1	0.195	0	BODY SIDE BEARING SHIM	$14.44	$0.00	$27.54	$0.00	$14.44
1017	4092	2	0.195	0	BODY SIDE BEARING SHIM	$3.96	$0.00	$27.54	$0.00	$3.96
1018	4093	0	0.195	0	BODY SIDE BEARING SHIM-MALE ART. CONNECTOR POS.	$3.96	$0.00	$27.54	$0.00	$3.96
1019	4093	1	0.195	0	BODY SIDE BEARING SHIM-MALE ART. CONNECTOR POS.	$14.44	$0.00	$27.54	$0.00	$14.44
1020	4093	2	0.195	0	BODY SIDE BEARING SHIM-MALE ART. CONNECTOR POS.	$3.96	$0.00	$27.54	$0.00	$3.96
1021	4094	0	0.195	0	BODY SIDE BEARING SHIM-FEMALE ART. CONNECTOR POS.	$3.96	$0.00	$27.54	$0.00	$3.96
1022	4094	1	0.195	0	BODY SIDE BEARING SHIM-FEMALE ART. CONNECTOR POS.	$14.44	$0.00	$27.54	$0.00	$14.44
1023	4094	2	0.195	0	BODY SIDE BEARING SHIM-FEMALE ART. CONNECTOR POS.	$3.96	$0.00	$27.54	$0.00	$3.96
1024	4102	1	0	0.045	ENGINE LUBRICATING OIL	$1.46	$0.00	$0.00	$6.36	$7.82
1025	4110	0	0	0.4	BATTERY SERVICE	$0.00	$0.00	$0.00	$56.50	$56.50
1026	4114	1	0	0.296	ANTI-FREEZE, PERMANENT TYPE	$7.93	$0.00	$0.00	$41.81	$49.74
1027	4128	0	0	1.333	BATTERY RENEWED	$0.00	$0.00	$0.00	$188.27	$188.27
1028	4144	0	0	1	CHECK UNIT FOR CAUSE OF FAILURE	$0.00	$0.00	$0.00	$141.24	$141.24
1029	4148	0	0	0.5	CHECK UNIT AFTER REPAIR	$0.00	$0.00	$0.00	$70.62	$70.62
1030	4150	0	0	1	LABOR, REFRIGERATION SYSTEM	$0.00	$0.00	$0.00	$141.24	$141.24
1031	4160	1	0	0.5	FUEL/OIL FILTER	$5.68	$0.00	$0.00	$70.62	$76.30
1032	4162	0	0	0.3	PURGE AND PRIME ENGINE	$0.00	$0.00	$0.00	$42.37	$42.37
1033	4180	7	0	0.033	NUT OR SCREW TIGHTENED	$0.00	$0.00	$0.00	$4.66	$4.66
1034	4200	1	0	0	CHAIN	$6.36	$0.11	$0.00	$0.00	$6.36
1035	4200	2	0	0	CHAIN	$6.36	$0.11	$0.00	$0.00	$6.36
1036	4202	1	0	0	HIGH STRENGTH LOW ALLOY STEEL	$2.28	$0.11	$0.00	$0.00	$2.28
1037	4202	2	0	0	HIGH STRENGTH LOW ALLOY STEEL	$1.14	$0.11	$0.00	$0.00	$1.14
1038	4204	1	0	0	CARBON STEEL, STRUCTURAL, PRESSED	$2.62	$0.11	$0.00	$0.00	$2.62
1039	4204	2	0	0	CARBON STEEL, STRUCTURAL, PRESSED	$1.31	$0.11	$0.00	$0.00	$1.31
1040	4206	1	0	0	HIGH STRENGTH ALUMINUM, STRUCTURAL, PRESSED	$7.86	$0.31	$0.00	$0.00	$7.86
1041	4206	2	0	0	HIGH STRENGTH ALUMINUM, STRUCTURAL, PRESSED	$3.93	$0.31	$0.00	$0.00	$3.93
1042	4216	1	0	0	FORGINGS	$3.37	$0.11	$0.00	$0.00	$3.37
1043	4216	2	0	0	FORGINGS	$1.69	$0.11	$0.00	$0.00	$1.69
1044	4222	1	0	0	CASTING, STEEL	$1.92	$0.11	$0.00	$0.00	$1.92
1045	4222	2	0	0	CASTING, STEEL	$0.96	$0.11	$0.00	$0.00	$0.96
1046	4236	1	0	0	ALUMINUM CREDIT	$0.00	$0.31	$0.00	$0.00	$0.00
1047	4244	1	0	0	STEEL CREDIT	$0.00	$0.11	$0.00	$0.00	$0.00
1048	4246	1	0	0	STAINLESS STEEL CREDIT	$0.00	$0.29	$0.00	$0.00	$0.00
1049	4320	1	0	0.137	CARD BOARD	$2.75	$0.00	$0.00	$19.35	$22.10
1050	4322	1	0	0.224	CARD BOARD BRACKET	$20.07	$0.22	$0.00	$31.64	$51.71
1051	4324	1	0	0.297	METAL, DOT PLACARD HOLDER	$8.52	$0.00	$0.00	$41.95	$50.47
1052	4328	1	0	0.273	WOOD, DOT PLACARD HOLDER	$8.25	$0.00	$0.00	$38.56	$46.81
1053	4330	1	0	0.224	PLACARD BRACKET	$25.31	$0.44	$0.00	$31.64	$56.95
1054	4342	1	0	0.477	STANDARD TEMPERATURE AEI TAG, AT5118-AAR	$29.40	$0.00	$0.00	$67.37	$96.77
1055	4342	2	0	0.477	STANDARD TEMPERATURE AEI TAG, AT5118-AAR	$15.43	$0.00	$0.00	$67.37	$82.80
1056	4342	8	0	0.417	STANDARD TEMPERATURE AEI TAG, AT5118-AAR	$1.46	$0.00	$0.00	$58.90	$60.36
1057	4342	9	0	0.151	STANDARD TEMPERATURE AEI TAG, AT5118-AAR	$1.46	$0.00	$0.00	$21.33	$22.79
1058	4344	1	0	0.238	EOT AEI TAG, AT5549-AAR	$45.27	$0.00	$0.00	$33.62	$78.89
1059	4344	2	0	0.238	EOT AEI TAG, AT5549-AAR	$23.37	$0.00	$0.00	$33.62	$56.99
1060	4344	8	0	0.238	EOT AEI TAG, AT5549-AAR	$1.46	$0.00	$0.00	$33.62	$35.08
1061	4344	9	0	0.238	EOT AEI TAG, AT5549-AAR	$1.46	$0.00	$0.00	$33.62	$35.08
1062	4350	1	0	0.477	HIGH TEMPERATURE AEI TAG, AT5133-AAR	$33.14	$0.00	$0.00	$67.37	$100.51
1063	4350	2	0	0.477	HIGH TEMPERATURE AEI TAG, AT5133-AAR	$17.30	$0.00	$0.00	$67.37	$84.67
1064	4350	8	0	0.417	HIGH TEMPERATURE AEI TAG, AT5133-AAR	$1.46	$0.00	$0.00	$58.90	$60.36
1065	4350	9	0	0.151	HIGH TEMPERATURE AEI TAG, AT5133-AAR	$1.46	$0.00	$0.00	$21.33	$22.79
1066	4356	1	0	0.397	AEI BRACKET W/MECH. FASTENERS	$4.07	$0.00	$0.00	$56.07	$60.14
1067	4356	2	0	0.397	AEI BRACKET W/MECH. FASTENERS	$2.77	$0.00	$0.00	$56.07	$58.84
1068	4356	9	0	0.397	AEI BRACKET W/MECH. FASTENERS	$1.46	$0.00	$0.00	$56.07	$57.53
1069	4358	1	0	0.493	AEI BRACKET WELDED	$2.61	$0.00	$0.00	$69.63	$72.24
1070	4358	2	0	0.493	AEI BRACKET WELDED	$1.31	$0.00	$0.00	$69.63	$70.94
1071	4358	9	0	0.493	AEI BRACKET WELDED	$0.00	$0.00	$0.00	$69.63	$69.63

FID	Applied Job Code	Condtion Code	Fixed Labor Time Standard	Variable Labor Time Standard	Job Code Description	Material Price	Credit	Fixed Labor	Variable Labor	Total Cost
1072	4360	1	0	0.038	FIBERGLASS HATCH COVER TROUGH, 20" WIDE	$22.79	$0.00	$0.00	$5.37	$28.16
1073	4360	2	0	0.038	FIBERGLASS HATCH COVER TROUGH, 20" WIDE	$11.64	$0.00	$0.00	$5.37	$17.01
1074	4360	9	0	0.038	FIBERGLASS HATCH COVER TROUGH, 20" WIDE	$0.48	$0.00	$0.00	$5.37	$5.85
1075	4362	1	0	0.038	FIBERGLASS HATCH COVER TROUGH, 24" WIDE	$25.46	$0.00	$0.00	$5.37	$30.83
1076	4362	2	0	0.038	FIBERGLASS HATCH COVER TROUGH, 24" WIDE	$12.97	$0.00	$0.00	$5.37	$18.34
1077	4362	9	0	0.038	FIBERGLASS HATCH COVER TROUGH, 24" WIDE	$0.48	$0.00	$0.00	$5.37	$5.85
1078	4364	1	0	0.038	ALUMINUM HATCH COVER TROUGH, 20" WIDE	$24.55	$1.55	$0.00	$5.37	$29.92
1079	4364	2	0	0.038	ALUMINUM HATCH COVER TROUGH, 20" WIDE	$12.52	$1.55	$0.00	$5.37	$17.89
1080	4364	9	0	0.038	ALUMINUM HATCH COVER TROUGH, 20" WIDE	$0.48	$0.00	$0.00	$5.37	$5.85
1081	4366	1	0	0.038	ALUMINUM HATCH COVER TROUGH, 24" WIDE	$36.46	$1.86	$0.00	$5.37	$41.83
1082	4366	2	0	0.038	ALUMINUM HATCH COVER TROUGH, 24" WIDE	$20.68	$1.86	$0.00	$5.37	$26.05
1083	4366	9	0	0.038	ALUMINUM HATCH COVER TROUGH, 24" WIDE	$4.90	$0.00	$0.00	$5.37	$10.27
1084	4400	1	0	0.084	COTTER OR SPLIT KEY	$0.15	$0.00	$0.00	$11.86	$12.01
1085	4404	1	0.086	0.054	BOLT, COMMON STANDARD	$0.37	$0.00	$12.15	$7.63	$8.00
1086	4406	1	0.086	0.054	BOLT,HT,FLT HD. 3/4" DIA. OR OVER	$2.11	$0.00	$12.15	$7.63	$9.74
1087	4410	1	0.086	0.054	BOLT,HT,5/8 IN.DIA.OR LESS UNDER 6" LONG	$0.73	$0.00	$12.15	$7.63	$8.36
1088	4412	1	0.086	0.054	BOLT,HT, 5/8" DIA. OR LESS	$2.45	$0.00	$12.15	$7.63	$10.08
1089	4414	1	0.086	0.054	BOLT,HT,3/4" DIA.OR OVER,UNDER 6" LONG	$1.34	$0.00	$12.15	$7.63	$8.97
1090	4416	1	0.086	0.054	BOLT,HT, 3/4" DIA. OR OVER	$2.27	$0.00	$12.15	$7.63	$9.90
1091	4418	1	0.086	0.054	TWO-PIECE RIVET, NON-COATED LESS THAN 5/8 INCH DIA	$0.63	$0.00	$12.15	$7.63	$8.26
1092	4422	1	0.086	0.054	TWO-PIECE RIVET, NON-COATED 5/8 INCH DIA OR OVER	$1.98	$0.00	$12.15	$7.63	$9.61
1093	4424	1	0.086	0.054	BOLT,COATED, LESS THAN 5/8" DIA	$0.55	$0.00	$12.15	$7.63	$8.18
1094	4426	1	0.086	0.054	BOLT,COATED, 5/8" DIA. OR OVER	$0.42	$0.00	$12.15	$7.63	$8.05
1095	4428	1	0.086	0.054	TWO-PIECE RIVET, COATED LESS THAN 5/8 INCH DIAM	$0.83	$0.00	$12.15	$7.63	$8.46
1096	4430	1	0.086	0.054	TWO-PIECE RIVET, COATED 5/8 INCH DIA OR OVER	$1.42	$0.00	$12.15	$7.63	$9.05
1097	4445	1	0	0.17	NAILS, PER ONE TENTH POUND	$0.08	$0.00	$0.00	$24.01	$24.09
1098	4450	0	0	1	LABOR, FREIGHT CAR	$0.00	$0.00	$0.00	$141.24	$141.24
1099	4452	0	0	0.076	LABOR,CONSTANT CONTACT SIDE BEARING COMPONENTS	$0.00	$0.00	$0.00	$10.73	$10.73
1100	4454	0	0	0.049	MA/EW INSPECTIONS-TO REPORT EW/MA INSPECTIONS	$0.00	$0.00	$0.00	$6.92	$6.92
1101	4455	0	0	0	RULE 88 B2 INSPECTION - LABOR	$0.00	$0.00	$0.00	$0.00	$0.00
1102	4456	0	0	2.743	TRAIN DELAY ALLOWANCE, LINE OF ROAD	$0.00	$0.00	$0.00	$387.42	$387.42
1103	4457	0	0	1.075	SETOUT/PICKUP ALLOWANCE, LINE OF ROAD	$0.00	$0.00	$0.00	$151.83	$151.83
1104	4458	1	0	0.829	LABOR, JACK CAR WITH TRUCK SEPARATION	$0.15	$0.00	$0.00	$117.09	$117.24
1105	4459	1	0	1.724	LABOR, JACK CAR - LINE OF ROAD	$0.00	$0.00	$0.00	$243.50	$243.50
1106	4461	1	0	0.542	LABOR, JACK CAR WITHOUT TRUCK SEPARATION	$0.15	$0.00	$0.00	$76.55	$76.70
1107	4462	9	0	0.882	SOLID DRAW BAR CONNECTION - LABOR	$4.38	$0.00	$0.00	$124.57	$128.95
1108	4465	0	0	0.325	LABOR-ACC TRK SIDE FRM WEAR PLT-RIDE CNTRL OR XCR	$0.00	$0.00	$0.00	$45.90	$45.90
1109	4466	0	0	0.197	LABOR-ACC TRK SIDE FRAME WEAR PLT-BARBER/SWING MTN	$0.00	$0.00	$0.00	$27.82	$27.82
1110	4467	0	0	0.336	LABOR, R&R RIDE CONTROL OR XCR SIDE FRAME	$0.00	$0.00	$0.00	$47.46	$47.46
1111	4469	9	0	0.615	R & R SLACK ADJUSTER, ANY TYPE	$0.45	$0.00	$0.00	$86.86	$87.31
1112	4470	1	0	1.492	LABOR, DRAFT GEAR AND/OR YOKE	$8.04	$0.00	$0.00	$210.73	$218.77
1113	4470	9	0	0.767	LABOR, DRAFT GEAR AND/OR YOKE	$8.04	$0.00	$0.00	$108.33	$116.37
1114	4474	9	0	0.565	R&R COUPLER BODY, E TYPE	$0.15	$0.00	$0.00	$79.80	$79.95
1115	4474	T	0	0	R&R COUPLER BODY, E TYPE	$0.00	$0.00	$0.00	$0.00	$0.00
1116	4478	9	0	0.867	R&R COUPLER BODY, TYPE E/F OR F	$0.15	$0.00	$0.00	$122.46	$122.61
1117	4478	T	0	0	R&R COUPLER BODY, TYPE E/F OR F	$0.00	$0.00	$0.00	$0.00	$0.00
1118	4480	9	0	1	LOAD R&R FOR SAFETY APPL, OPEN TOP CAR	$0.00	$0.00	$0.00	$141.24	$141.24
1119	4482	0	0	0.107	LABOR, FALL PROTECTION	$0.00	$0.00	$0.00	$15.11	$15.11
1120	4486	0	0	32.058	LOADING ALLOWANCE	$0.00	$0.00	$0.00	$4,527.87	$4,527.87
1121	4488	0	0	8.123	UNLOADING ALLOWANCE	$0.00	$0.00	$0.00	$1,147.29	$1,147.29
1122	4489	0	0	1.729	DISMANTLING ALLOWANCE	$0.00	$0.00	$0.00	$244.20	$244.20
1123	4490	8	0	0.009	STRAIGHTEN PART OFF CAR	$0.00	$0.00	$0.00	$1.27	$1.27
1124	4500	1	0	0.2	SEAL HOOK-PIN-WEDGE	$14.04	$0.00	$0.00	$28.25	$42.29
1125	4500	2	0	0.2	SEAL HOOK-PIN-WEDGE	$7.02	$0.00	$0.00	$28.25	$35.27
1126	4506	1	0	0.66	SIDE DOOR LOCK ASSEMBLY	$81.59	$1.43	$0.00	$93.22	$174.81
1127	4506	2	0	0.66	SIDE DOOR LOCK ASSEMBLY	$41.43	$1.43	$0.00	$93.22	$134.65
1128	4508	1	0	0.354	DOOR HASP	$24.71	$0.00	$0.00	$50.00	$74.71
1129	4508	2	0	0.354	DOOR HASP	$12.36	$0.00	$0.00	$50.00	$62.36
1130	4512	1	0	0.472	DOOR HASP FASTENER	$54.89	$0.00	$0.00	$66.67	$121.56
1131	4512	2	0	0.472	DOOR HASP FASTENER	$27.45	$0.00	$0.00	$66.67	$94.12
1132	4528	9	0	0.8	SIDE DOOR, R&R OR R, NON-FLUSH TYPE	$0.00	$0.00	$0.00	$112.99	$112.99
1133	4530	1	0	0	PLUG DOOR ROLLER ASSEMBLY	$82.95	$1.43	$0.00	$0.00	$82.95
1134	4530	2	0	0	PLUG DOOR ROLLER ASSEMBLY	$41.48	$1.43	$0.00	$0.00	$41.48

FID	Applied Job Code	Condtion Code	Fixed Labor Time Standard	Variable Labor Time Standard	Job Code Description	Material Price	Credit	Fixed Labor	Variable Labor	Total Cost
1135	4532	9	0	3	SIDE DOOR, R&R OR R, FLUSH PLUG TYPE	$0.00	$0.00	$0.00	$423.72	$423.72
1136	4534	0	0	1.456	FLUSH PLUG TYPE DOOR REPLACED	$0.00	$0.00	$0.00	$205.65	$205.65
1137	4536	0	0	0.4	NON-FLUSH SIDE DOOR REPLACED	$0.00	$0.00	$0.00	$56.50	$56.50
1138	4538	0	0	0	SIDE DOOR OR END DOOR CLOSED	$0.00	$0.00	$0.00	$0.00	$0.00
1139	4540	0	0	0	BOXCAR DOOR INSPECTION & LUBRICATION	$0.00	$0.00	$0.00	$0.00	$0.00
1140	4550	1	0	0	LUMBER	$2.75	$0.00	$0.00	$0.00	$2.75
1141	4554	1	0	0.01	PLYWOOD, 1/4 INCH THICK	$0.66	$0.00	$0.00	$1.41	$2.07
1142	4558	1	0	0.01	PLYWOOD, 1/2 INCH THICK	$0.88	$0.00	$0.00	$1.41	$2.29
1143	4580	1	0.094	0.1	HAND HOLD OR GRAB IRON 36 INCH OR LESS	$14.94	$0.55	$13.28	$14.12	$29.06
1144	4580	8	0.094	0.1	HAND HOLD OR GRAB IRON 36 INCH OR LESS	$14.94	$0.55	$13.28	$14.12	$29.06
1145	4582	1	0.094	0.1	HAND HOLD OR GRAB IRON OVER 36" LONG -UP TO 72"	$29.15	$0.88	$13.28	$14.12	$43.27
1146	4582	8	0.094	0.1	HAND HOLD OR GRAB IRON OVER 36" LONG -UP TO 72"	$29.15	$0.88	$13.28	$14.12	$43.27
1147	4583	8	0.094	0.1	HAND HOLD OR GRAB IRON OVER 72" LONG	$29.15	$1.65	$13.28	$14.12	$43.27
1148	4584	1	0	0.204	SILL STEP WITHOUT CENTER TREAD	$42.63	$1.32	$0.00	$28.81	$71.44
1149	4584	8	0	0.204	SILL STEP WITHOUT CENTER TREAD	$42.63	$1.32	$0.00	$28.81	$71.44
1150	4588	1	0	0.42	SILL STEP WITH CENTER TREAD	$56.84	$1.76	$0.00	$59.32	$116.16
1151	4588	8	0	0.42	SILL STEP WITH CENTER TREAD	$56.84	$1.76	$0.00	$59.32	$116.16
1152	4592	1	0	0.136	LADDER TREAD	$14.94	$0.44	$0.00	$19.21	$34.15
1153	4592	8	0	0.136	LADDER TREAD	$14.94	$0.44	$0.00	$19.21	$34.15
1154	4593	1	0.094	0.348	LADDER COMPLETE 2, 3, OR 4 TREADS	$64.29	$3.74	$13.28	$49.15	$113.44
1155	4593	8	0.094	0.348	LADDER COMPLETE 2, 3, OR 4 TREADS	$57.79	$0.00	$13.28	$49.15	$106.94
1156	4594	1	0	2.628	LADDER COMPLETE 5, 6, OR 7 TREADS	$120.83	$7.15	$0.00	$371.18	$492.01
1157	4594	8	0	2.628	LADDER COMPLETE 5, 6, OR 7 TREADS	$108.75	$0.00	$0.00	$371.18	$479.93
1158	4595	1	0	3.504	LADDER COMPLETE 8, 9, OR 10 TREADS	$132.64	$9.24	$0.00	$494.91	$627.55
1159	4595	8	0	3.504	LADDER COMPLETE 8, 9, OR 10 TREADS	$118.71	$0.00	$0.00	$494.91	$613.62
1160	4602	1	0	0.014	PAINT, ALKYD OR LATEX	$0.24	$0.00	$0.00	$1.98	$2.22
1161	4606	0	0	0.014	PAINT LABOR	$0.00	$0.00	$0.00	$1.98	$1.98
1162	4608	0	0	0.367	STENCIL REPORTING MARKS- 1 END	$0.00	$0.00	$0.00	$51.84	$51.84
1163	4612	0	0	0.367	STENCIL REPORTING MARKS - 1 SIDE	$0.00	$0.00	$0.00	$51.84	$51.84
1164	4616	0	0	1.467	STENCIL REPORTING MARKS- 2 SIDES & ENDS	$0.00	$0.00	$0.00	$207.20	$207.20
1165	4624	1	0.089	0.03	BUILT STENCIL-PER SIDE	$3.94	$0.00	$12.57	$4.24	$8.18
1166	4626	1	0	0.094	BRAKE CYLINDER PISTON TRAVEL DECAL	$2.26	$0.00	$0.00	$13.28	$15.54
1167	4628	1	0.089	0.023	THIS CAR EXCESS HEIGHT DECAL	$2.89	$0.00	$12.57	$3.25	$6.14
1168	4712	0	0	0.216	BOTTOM OUTLET CAP, THREADED TYPE	$0.00	$0.00	$0.00	$30.51	$30.51
1169	4712	9	0	0.216	BOTTOM OUTLET CAP, THREADED TYPE	$0.00	$0.00	$0.00	$30.51	$30.51
1170	4716	0	0	0.076	BOTTOM OUTLET CAP, CAM-LOCK TYPE	$0.00	$0.00	$0.00	$10.73	$10.73
1171	4716	9	0	0.076	BOTTOM OUTLET CAP, CAM-LOCK TYPE	$0.00	$0.00	$0.00	$10.73	$10.73
1172	4744	1	0	0	WATER FOR TESTING TANK	$0.58	$0.00	$0.00	$0.00	$0.58
1173	4748	1	0	0	PIPE FOR RAILINGS, 1-1/4 INCHES	$3.38	$0.33	$0.00	$0.00	$3.38
1174	4748	2	0	0	PIPE FOR RAILINGS, 1-1/4 INCHES	$1.69	$0.33	$0.00	$0.00	$1.69
1175	4750	0	0	0.15	THREADING PIPE, PER END	$0.00	$0.00	$0.00	$21.19	$21.19
1176	4752	1	0	0.1	PIPE FITTING, COUPLING, ANY TYPE	$9.20	$0.00	$0.00	$14.12	$23.32
1177	4752	2	0	0.1	PIPE FITTING, COUPLING, ANY TYPE	$4.60	$0.00	$0.00	$14.12	$18.72
1178	4754	1	0	0	7/8 INCHES DIAMETER SOLID STEEL ROD	$6.74	$0.22	$0.00	$0.00	$6.74
1179	4754	2	0	0	7/8 INCHES DIAMETER SOLID STEEL ROD	$3.37	$0.22	$0.00	$0.00	$3.37
1180	4756	0	0	0.3	HANDRAILS/PLATFORM RAILS - BENDING	$0.00	$0.00	$0.00	$42.37	$42.37
1181	4758	0	0	0.352	HANDRAILS/PLATFORM RAILS - END FLATTENED	$0.00	$0.00	$0.00	$49.72	$49.72
1182	4760	0	0	2	DISCONNECTION OF TANKTRAIN COUPLING	$0.00	$0.00	$0.00	$282.48	$282.48
1183	4764	0	0	0	TANK CAR END PLTFRM RAIL FIELD REPR-OWNER NOTIFY	$0.00	$0.00	$0.00	$0.00	$0.00
1184	4800	0	0	0.04	TACK OR FILLET WELD	$0.00	$0.00	$0.00	$5.65	$5.65
1185	4804	0	0	0.04	GROOVE JOINT WELD, 1/8 INCH OR LESS	$0.00	$0.00	$0.00	$5.65	$5.65
1186	4808	0	0	0.054	GROOVE JOINT WELD, OVER 1/8 INCH TO 1/2 INCH	$0.00	$0.00	$0.00	$7.63	$7.63
1187	4812	0	0	0.11	GROOVE JOINT WELD, OVER 1/2 INCH TO 1 INCH	$0.00	$0.00	$0.00	$15.54	$15.54
1188	4900	1	0	0.173	CHAIN-TIE DOWN 3/8" ALLOY	$81.16	$1.76	$0.00	$24.43	$105.59
1189	4900	2	0	0.173	CHAIN-TIE DOWN 3/8" ALLOY	$40.58	$1.76	$0.00	$24.43	$65.01
1190	4900	3	0	0.173	CHAIN-TIE DOWN 3/8" ALLOY	$60.87	$1.76	$0.00	$24.43	$85.30
1191	4900	9	0	0.173	CHAIN-TIE DOWN 3/8" ALLOY	$0.00	$0.00	$0.00	$24.43	$24.43
1192	4904	1	0	0.205	WINCH SWIVEL TYPE	$111.88	$3.85	$0.00	$28.95	$140.83
1193	4904	2	0	0.205	WINCH SWIVEL TYPE	$55.94	$3.85	$0.00	$28.95	$84.89
1194	4904	3	0	0.205	WINCH SWIVEL TYPE	$83.91	$3.85	$0.00	$28.95	$112.86
1195	4904	9	0	0.205	WINCH SWIVEL TYPE	$0.00	$0.00	$0.00	$28.95	$28.95
1196	4908	1	0	0.173	CHAIN-TIE DOWN 1/2" ALLOY	$252.05	$3.96	$0.00	$24.43	$276.48
1197	4908	2	0	0.173	CHAIN-TIE DOWN 1/2" ALLOY	$126.03	$3.96	$0.00	$24.43	$150.46

FID	Applied Job Code	Condtion Code	Fixed Labor Time Standard	Variable Labor Time Standard	Job Code Description	Material Price	Credit	Fixed Labor	Variable Labor	Total Cost
1198	4908	3	0	0.173	CHAIN-TIE DOWN 1/2" ALLOY	$189.04	$3.96	$0.00	$24.43	$213.47
1199	4908	9	0	0.173	CHAIN-TIE DOWN 1/2" ALLOY	$0.00	$0.00	$0.00	$24.43	$24.43
1200	4912	1	0	0.082	REPAIR LINK, CHAIN	$15.95	$0.00	$0.00	$11.58	$27.53
1201	4912	9	0	0.082	REPAIR LINK, CHAIN	$0.00	$0.00	$0.00	$11.58	$11.58
1202	4916	1	0	0.205	CHAIN ANCHOR ASSEMBLY	$43.08	$1.54	$0.00	$28.95	$72.03
1203	4916	2	0	0.205	CHAIN ANCHOR ASSEMBLY	$21.54	$1.54	$0.00	$28.95	$50.49
1204	4916	9	0	0.205	CHAIN ANCHOR ASSEMBLY	$0.00	$0.00	$0.00	$28.95	$28.95
1205	4921	1	0	0.359	CONTAINER PEDESTAL WITH AUTO LOW PROFILE LOCK	$133.96	$1.43	$0.00	$50.71	$184.67
1206	4921	2	0	0.359	CONTAINER PEDESTAL WITH AUTO LOW PROFILE LOCK	$66.98	$1.43	$0.00	$50.71	$117.69
1207	4921	9	0	0.359	CONTAINER PEDESTAL WITH AUTO LOW PROFILE LOCK	$0.00	$0.00	$0.00	$50.71	$50.71
1208	4923	1	0	0.203	PEDESTAL LATCH ASSEMBLY TWIST TYPE	$165.65	$1.43	$0.00	$28.67	$194.32
1209	4923	9	0	0.203	PEDESTAL LATCH ASSEMBLY TWIST TYPE	$0.00	$0.00	$0.00	$28.67	$28.67
1210	4924	1	0	0.171	PEDESTAL LATCH ASSEMBLY HOOK TYPE	$43.48	$1.76	$0.00	$24.15	$67.63
1211	4924	9	0	0.171	PEDESTAL LATCH ASSEMBLY HOOK TYPE	$0.00	$0.00	$0.00	$24.15	$24.15
1212	4925	1	0.154	0.586	RATCHET WINCH FOR CABLE TIE DOWN	$88.45	$1.98	$21.75	$82.77	$171.22
1213	4925	9	0.154	0.586	RATCHET WINCH FOR CABLE TIE DOWN	$0.00	$0.00	$21.75	$82.77	$82.77
1214	4926	1	0.154	0.084	CABLE ASSEMBLY, 3/8" X APPROX. 17'	$16.82	$1.98	$21.75	$11.86	$28.68
1215	4926	9	0.062	0.081	CABLE ASSEMBLY, 3/8" X APPROX. 17'	$0.00	$0.00	$8.76	$11.44	$11.44
1216	4928	1	0	0.174	EDGE PROTECTOR, METAL	$9.02	$0.00	$0.00	$24.58	$33.60
1217	4928	2	0	0.174	EDGE PROTECTOR, METAL	$4.51	$0.00	$0.00	$24.58	$29.09
1218	4930	1	0	0.071	EDGE PROTECTOR, PLASTIC	$4.04	$0.00	$0.00	$10.03	$14.07
1219	4930	2	0	0.071	EDGE PROTECTOR, PLASTIC	$2.02	$0.00	$0.00	$10.03	$12.05
1220	5428	1	0	0.467	UPPER VERTICAL STRUT PIVOT PIN	$4.70	$0.00	$0.00	$65.96	$70.66
1221	5428	2	0	0.467	UPPER VERTICAL STRUT PIVOT PIN	$2.35	$0.00	$0.00	$65.96	$68.31
1222	5456	1	0	0.283	LOCK JAW STOP	$39.37	$0.00	$0.00	$39.97	$79.34
1223	5456	2	0	0.283	LOCK JAW STOP	$19.69	$0.00	$0.00	$39.97	$59.66
1224	5500	1	0.11	0.044	REFLECTIVE SHEETING, INITIAL APPLICATION OR RENEW	$1.35	$0.00	$15.54	$6.21	$7.56
1225	5502	1	0.11	0.044	REFLECTIVE SHEETING	$1.35	$0.00	$15.54	$6.21	$7.56
1226	5702	1	0	1.882	GROUP EOC-1D	$2,162.48	$105.93	$0.00	$265.81	$2,428.29
1227	5702	3	0	1.882	GROUP EOC-1D	$1,427.64	$0.00	$0.00	$265.81	$1,693.45
1228	5702	9	0	1.4	GROUP EOC-1D	$24.12	$0.00	$0.00	$197.74	$221.86
1229	5704	1	0	1.882	GROUP EOC-1B	$2,255.05	$105.93	$0.00	$265.81	$2,520.86
1230	5704	3	0	1.882	GROUP EOC-1B	$1,361.22	$0.00	$0.00	$265.81	$1,627.03
1231	5704	9	0	1.4	GROUP EOC-1B	$24.12	$0.00	$0.00	$197.74	$221.86
1232	5708	1	0	1.882	GROUP EOC-2D	$2,136.17	$91.74	$0.00	$265.81	$2,401.98
1233	5708	3	0	1.882	GROUP EOC-2D	$1,463.71	$0.00	$0.00	$265.81	$1,729.52
1234	5708	9	0	1.4	GROUP EOC-2D	$24.12	$0.00	$0.00	$197.74	$221.86
1235	5710	1	0	1.882	GROUP EOC-2B	$2,232.22	$91.74	$0.00	$265.81	$2,498.03
1236	5710	3	0	1.882	GROUP EOC-2B	$1,556.67	$0.00	$0.00	$265.81	$1,822.48
1237	5710	9	0	1.4	GROUP EOC-2B	$24.12	$0.00	$0.00	$197.74	$221.86
1238	5716	1	0	1.882	GROUP EOC-3B	$2,413.54	$55.00	$0.00	$265.81	$2,679.35
1239	5716	3	0	1.882	GROUP EOC-3B	$1,243.46	$0.00	$0.00	$265.81	$1,509.27
1240	5716	9	0	1.4	GROUP EOC-3B	$24.12	$0.00	$0.00	$197.74	$221.86
1241	5722	1	0	1.882	GROUP EOC-4B	$2,835.49	$55.00	$0.00	$265.81	$3,101.30
1242	5722	3	0	1.882	GROUP EOC-4B	$1,344.42	$0.00	$0.00	$265.81	$1,610.23
1243	5722	9	0	1.4	GROUP EOC-4B	$24.12	$0.00	$0.00	$197.74	$221.86
1244	5726	1	0	1.882	GROUP EOC-5D	$2,259.49	$91.74	$0.00	$265.81	$2,525.30
1245	5726	3	0	1.882	GROUP EOC-5D	$1,552.88	$0.00	$0.00	$265.81	$1,818.69
1246	5726	9	0	1.4	GROUP EOC-5D	$24.12	$0.00	$0.00	$197.74	$221.86
1247	5728	1	0	1.882	GROUP EOC-5B	$2,308.99	$91.74	$0.00	$265.81	$2,574.80
1248	5728	3	0	1.882	GROUP EOC-5B	$1,602.90	$0.00	$0.00	$265.81	$1,868.71
1249	5728	9	0	1.4	GROUP EOC-5B	$24.12	$0.00	$0.00	$197.74	$221.86
1250	5732	1	0	1.882	GROUP EOC-6D	$2,251.70	$105.93	$0.00	$265.81	$2,517.51
1251	5732	3	0	1.882	GROUP EOC-6D	$1,438.88	$0.00	$0.00	$265.81	$1,704.69
1252	5732	9	0	1.4	GROUP EOC-6D	$24.12	$0.00	$0.00	$197.74	$221.86
1253	5734	1	0	1.882	GROUP EOC-6B	$2,251.94	$105.93	$0.00	$265.81	$2,517.75
1254	5734	3	0	1.882	GROUP EOC-6B	$1,443.09	$0.00	$0.00	$265.81	$1,708.90
1255	5734	9	0	1.4	GROUP EOC-6B	$24.12	$0.00	$0.00	$197.74	$221.86
1256	5740	1	0	1.882	GROUP EOC-7B	$1,592.53	$91.74	$0.00	$265.81	$1,858.34
1257	5740	3	0	1.882	GROUP EOC-7B	$1,014.89	$0.00	$0.00	$265.81	$1,280.70
1258	5740	9	0	1.4	GROUP EOC-7B	$24.12	$0.00	$0.00	$197.74	$221.86
1259	5746	1	0	1.882	GROUP EOC-8B	$1,726.97	$55.00	$0.00	$265.81	$1,992.78
1260	5746	3	0	1.882	GROUP EOC-8B	$1,143.73	$0.00	$0.00	$265.81	$1,409.54

FID	Applied Job Code	Condtion Code	Fixed Labor Time Standard	Variable Labor Time Standard	Job Code Description	Material Price	Credit	Fixed Labor	Variable Labor	Total Cost
1261	5746	9	0	1.4	GROUP EOC-8B	$24.12	$0.00	$0.00	$197.74	$221.86
1262	5747	1	0	1.882	GROUP EOC-8F	$1,693.84	$55.00	$0.00	$265.81	$1,959.65
1263	5747	3	0	1.882	GROUP EOC-8F	$1,121.25	$0.00	$0.00	$265.81	$1,387.06
1264	5747	9	0	1.4	GROUP EOC-8F	$24.12	$0.00	$0.00	$197.74	$221.86
1265	5750	1	0	1.882	GROUP EOC-9D	$1,569.12	$55.00	$0.00	$265.81	$1,834.93
1266	5750	3	0	1.882	GROUP EOC-9D	$1,079.75	$0.00	$0.00	$265.81	$1,345.56
1267	5750	9	0	1.4	GROUP EOC-9D	$24.12	$0.00	$0.00	$197.74	$221.86
1268	5752	1	0	1.882	GROUP EOC-9B	$1,404.13	$55.00	$0.00	$265.81	$1,669.94
1269	5752	3	0	1.882	GROUP EOC-9B	$1,020.51	$0.00	$0.00	$265.81	$1,286.32
1270	5752	9	0	1.4	GROUP EOC-9B	$24.12	$0.00	$0.00	$197.74	$221.86
1271	5756	1	0	1.882	GROUP EOC-10D	$1,444.67	$60.28	$0.00	$265.81	$1,710.48
1272	5756	3	0	1.882	GROUP EOC-10D	$1,180.43	$0.00	$0.00	$265.81	$1,446.24
1273	5756	9	0	1.4	GROUP EOC-10D	$24.12	$0.00	$0.00	$197.74	$221.86
1274	5758	1	0	1.882	GROUP EOC-10B	$1,627.22	$60.28	$0.00	$265.81	$1,893.03
1275	5758	3	0	1.882	GROUP EOC-10B	$1,138.85	$0.00	$0.00	$265.81	$1,404.66
1276	5758	9	0	1.4	GROUP EOC-10B	$24.12	$0.00	$0.00	$197.74	$221.86
1277	5759	1	0	1.882	GROUP EOC-10F	$1,493.84	$60.28	$0.00	$265.81	$1,759.65
1278	5759	3	0	1.882	GROUP EOC-10F	$1,150.70	$0.00	$0.00	$265.81	$1,416.51
1279	5759	9	0	1.4	GROUP EOC-10F	$24.12	$0.00	$0.00	$197.74	$221.86
1280	5762	1	0	1.882	GROUP EOC-11D	$2,236.45	$114.73	$0.00	$265.81	$2,502.26
1281	5762	3	0	1.882	GROUP EOC-11D	$1,601.55	$0.00	$0.00	$265.81	$1,867.36
1282	5762	9	0	1.4	GROUP EOC-11D	$24.12	$0.00	$0.00	$197.74	$221.86
1283	5764	1	0	1.882	GROUP EOC-11B	$1,964.65	$114.73	$0.00	$265.81	$2,230.46
1284	5764	3	0	1.882	GROUP EOC-11B	$1,731.80	$0.00	$0.00	$265.81	$1,997.61
1285	5764	9	0	1.4	GROUP EOC-11B	$24.12	$0.00	$0.00	$197.74	$221.86
1286	5768	1	0	1.882	GROUP EOC-12D	$2,294.99	$124.19	$0.00	$265.81	$2,560.80
1287	5768	3	0	1.882	GROUP EOC-12D	$1,797.87	$0.00	$0.00	$265.81	$2,063.68
1288	5768	9	0	1.4	GROUP EOC-12D	$24.12	$0.00	$0.00	$197.74	$221.86
1289	5770	1	0	1.882	GROUP EOC-12B	$2,285.49	$124.19	$0.00	$265.81	$2,551.30
1290	5770	3	0	1.882	GROUP EOC-12B	$1,757.85	$0.00	$0.00	$265.81	$2,023.66
1291	5770	9	0	1.4	GROUP EOC-12B	$24.12	$0.00	$0.00	$197.74	$221.86
1292	5776	1	0	1.882	GROUP EOC-13B	$1,691.48	$93.50	$0.00	$265.81	$1,957.29
1293	5776	3	0	1.882	GROUP EOC-13B	$1,360.77	$0.00	$0.00	$265.81	$1,626.58
1294	5776	9	0	1.4	GROUP EOC-13B	$24.12	$0.00	$0.00	$197.74	$221.86
1295	5782	1	0	1.882	GROUP EOC-14B	$2,233.61	$93.50	$0.00	$265.81	$2,499.42
1296	5782	3	0	1.882	GROUP EOC-14B	$1,666.63	$0.00	$0.00	$265.81	$1,932.44
1297	5782	9	0	1.4	GROUP EOC-14B	$24.12	$0.00	$0.00	$197.74	$221.86
1298	5786	1	0	1.882	GROUP EOC-15D	$1,689.35	$142.12	$0.00	$265.81	$1,955.16
1299	5786	3	0	1.882	GROUP EOC-15D	$1,667.02	$0.00	$0.00	$265.81	$1,932.83
1300	5786	9	0	1.4	GROUP EOC-15D	$24.12	$0.00	$0.00	$197.74	$221.86
1301	5788	1	0	1.882	GROUP EOC-15B	$2,057.12	$142.12	$0.00	$265.81	$2,322.93
1302	5788	3	0	1.882	GROUP EOC-15B	$1,669.18	$0.00	$0.00	$265.81	$1,934.99
1303	5788	9	0	1.4	GROUP EOC-15B	$24.12	$0.00	$0.00	$197.74	$221.86
1304	5792	1	0	1.882	GROUP EOC-16D	$2,071.32	$119.46	$0.00	$265.81	$2,337.13
1305	5792	3	0	1.882	GROUP EOC-16D	$1,527.87	$0.00	$0.00	$265.81	$1,793.68
1306	5792	9	0	1.4	GROUP EOC-16D	$24.12	$0.00	$0.00	$197.74	$221.86
1307	5794	1	0	1.882	GROUP EOC-16B	$2,160.58	$92.40	$0.00	$265.81	$2,426.39
1308	5794	3	0	1.882	GROUP EOC-16B	$1,434.96	$0.00	$0.00	$265.81	$1,700.77
1309	5794	9	0	1.4	GROUP EOC-16B	$24.12	$0.00	$0.00	$197.74	$221.86
1310	5842	1	0	1.882	GROUP EOC-24B	$1,986.19	$93.50	$0.00	$265.81	$2,252.00
1311	5842	3	0	1.882	GROUP EOC-24B	$1,746.70	$0.00	$0.00	$265.81	$2,012.51
1312	5842	9	0	1.4	GROUP EOC-24B	$24.12	$0.00	$0.00	$197.74	$221.86
1313	5843	1	0	1.882	GROUP EOC-25E	$1,478.89	$93.50	$0.00	$265.81	$1,744.70
1314	5843	3	0	1.882	GROUP EOC-25E	$1,230.33	$0.00	$0.00	$265.81	$1,496.14
1315	5843	9	0	1.4	GROUP EOC-25E	$24.12	$0.00	$0.00	$197.74	$221.86
1316	5846	1	0	1.882	GROUP EOC-26B	$1,855.75	$93.50	$0.00	$265.81	$2,121.56
1317	5846	3	0	1.882	GROUP EOC-26B	$1,067.16	$0.00	$0.00	$265.81	$1,332.97
1318	5846	9	0	1.4	GROUP EOC-26B	$24.12	$0.00	$0.00	$197.74	$221.86
1319	5847	1	0	1.882	GROUP EOC-26F	$2,303.12	$93.50	$0.00	$265.81	$2,568.93
1320	5847	3	0	1.882	GROUP EOC-26F	$1,658.28	$0.00	$0.00	$265.81	$1,924.09
1321	5847	9	0	1.4	GROUP EOC-26F	$24.12	$0.00	$0.00	$197.74	$221.86
1322	5850	1	0	1.882	GROUP EOC-27D	$1,245.24	$93.50	$0.00	$265.81	$1,511.05
1323	5850	3	0	1.882	GROUP EOC-27D	$1,170.42	$0.00	$0.00	$265.81	$1,436.23

FID	Applied Job Code	Condtion Code	Fixed Labor Time Standard	Variable Labor Time Standard	Job Code Description	Material Price	Credit	Fixed Labor	Variable Labor	Total Cost
1324	5850	9	0	1.4	GROUP EOC-27D	$24.12	$0.00	$0.00	$197.74	$221.86
1325	5880	1	0	0	E-TYPE CUSHION UNIT FLOATING YOKE	$909.63	$44.00	$0.00	$0.00	$909.63
1326	5880	3	0	0	E-TYPE CUSHION UNIT FLOATING YOKE	$682.22	$44.00	$0.00	$0.00	$682.22
1327	5884	1	0	0	F-TYPE CUSHION UNIT FLOATING YOKE	$904.69	$34.32	$0.00	$0.00	$904.69
1328	5884	3	0	0	F-TYPE CUSHION UNIT FLOATING YOKE	$678.52	$34.32	$0.00	$0.00	$678.52

Glossary

Definitions for Acronyms and Abbreviations

Acronym / Abbreviation	Definition
FRA	Federal Railroad Administration
SD-70	An SD-70 locomotive is part of the Electro-Motive Diesel (EMD) series. Thousands of SD70s, and their variants, are in operation on numerous Class I railroads around the country (American Rails, 2007). Releases such as the SD70M, SD70MAC, and SD70I were considered to be widely successful and there is little difference between the designs in terms of overall mechanics and layout (American Rails, 2007). Norfolk Southern is the largest purchaser of the SD70M-2 in the United States, with over 130 units along the East Coast (American Rails, 2007). Photographers have captured the SD70M-2 in Kings Mountain North Carolina (Brian Rackley, 2010) and the SD70-Ace (Harold Hodnett) in Hamlet, North Carolina.[1]
Xing	Crossing

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[1] "EMD SD70 Locomotives." American Rails. 2007. Online: https://www.american-rails.com/926307.html | "Locomotives: CSX 4831(SD70Ace)." Railroad Picture Archives. April 2011. Online: http://www.rrpicturearchives.net/showPicture.aspx?id=2527906