Fall 12-1-2016

Responding to Train Derailments of Crude Oil Cargos and the Use of NIMS/ICE

Laura Hartline Weems
Arkansas Tech University

RESPONDING TO TRAIN DERAILMENTS OF CRUDE OIL CARGOS AND THE USE OF NIMS/ICS

By

LAURA HARTLINE WEEMS

Submitted to the Faculty of the Graduate College of
Arkansas Tech University
in partial fulfillment of the requirements
for the degree of
MASTER OF SCIENCE IN
EMERGENCY MANAGEMENT AND HOMELAND SECURITY
December 2016

RESPONDING TO TRAIN DERAILMENTS OF CRUDE
OIL CARGOS AND THE USE OF NIMS/ICS

The evaluation committee hereby approves this thesis by Laura H. Weems in partial fulfillment of the requirements for the degree of Master of Science

Dr. Sandy Smith, Thesis Advisor — Date

Dr. Caroline Hackerott, Committee Member — Date

Dr. Larry Porter, Committee Member — Date

Dr. Mary Gunter, Graduate College Dean — Date

Permission

Title: Responding to Train Derailments of Crude Oil Cargos and the Use of NIMS/ICS

Program: Emergency Management and Homeland Security

Degree: Master of Science

In presenting this thesis in partial fulfillment for a graduate degree from Arkansas Tech University, I agree the library of this university shall make it freely available for inspection. I further agree that permission for extensive copying for scholarly purposes may be granted to my thesis director, or, in that professor's absence, by the Head of the Department or the Dean of the Graduate College. To the extent that the usage of the thesis is under control of Arkansas Tech University, it is understood that due recognition shall be given to me and to Arkansas Tech University in any scholarly use which may be made of any material in my thesis.

Signature

Date

Acknowledgements

I would like to acknowledge my husband, Scott, who was especially patient with all of my questions and requests for advice. Additionally, I want to thank my thesis committee, Drs. Sandy Smith, Caroline Hackerott, and Larry Porter, for their expert opinions and feedback. Dr. Porter, I will forever remember the differences in an en and em dash. Lastly, this paper would not have been possible without the experiences I gained while working in the United States Coast Guard and at the Center for Toxicology and Environmental Health, L.L.C. and the insights provided by the railroad responders with whom I am honored to have worked.

Abstract

Derailments of freight trains carrying bulk cargo are not a new phenomenon in the United States; they have occurred since the 19th century when the first shipment made its way across the nation. However, despite sweeping changes in the past decade to the structure of emergency management in the United States, how the railroads have responded to derailments has not changed. The railroad culture is to operate lean, meaning few people are needed to transport large quantities of cargos and commodities. When a derailment occurs, the culture does not change, and railroads respond with typically few of their own personnel to oversee response operations. The slowness with which railroads have acted to adopt the National Incident Management System (NIMS) / Incident Command System (ICS) had not become a concern until recently with the increasing number of crude oil derailments. As the volume of crude oil transported by rail is predicted to rise exponentially as it has over the past five years, the need to assess the suitability of NIMS/ICS for derailments becomes even stronger. This paper addresses the incident- and organizational-specific characteristics found by researchers to support the use of NIMS/ICS in planning and response operations and how those characteristics compare with those found in Class I railroads and bulk crude oil derailment response operations. By understanding these differences and the gaps they create, the railroads and governmental organizations may be able to bridge those gaps more collaboratively and effectively.

Keywords: railroads, NIMS, ICS, derailment, crude oil, Bakken, incident management system

Table of Contents

List of Tables

I. Introduction

Homeland Security Presidential Directive 5 (HSPD-5), promulgated in 2003, directed all levels of government to adopt and use the National Incident Management System (NIMS) for emergency planning, response, and recovery operations (Department of Homeland Security, 2003). Since its promulgation, multiple researchers have studied the effectiveness of NIMS within different incident contexts (Anderson, Compton, & Mason, 2004; Annelli, 2006; Buck, Trainor, & Aguirre, 2006; Jensen & Waugh, 2014; Moynihan, 2008a). However, no research has been focused on the effectiveness of NIMS and its main component, the Incident Command System (ICS), for responses to train derailments involving bulk crude oil. Research does contend that NIMS/ICS may not be appropriate for all incidents but is most suitable for routine and local emergencies (Bennett, 2011; Moody, 2010). While only public response agencies are required to use NIMS/ICS, the expectation of those responders that non-public responders use it as well is cause for concern.

For the railroad community, the expectation to use NIMS and ICS is a challenge as railroads have acted independently and effectively in the past to plan for, respond to, recover from, and remediate derailment sites without stringent oversight or a mandated incident management system (Anderson et al., 2004; Association of American Railroads, 2014a, 2015b, 2015c; Spraggins, 2010). Very little literature exists confirming that one system can and should be used for all types of incidents, and an ineffective command and control structure adds risk to an already high risk operation (Bigley & Roberts, 2001; Buck et al., 2006; Knapp & Lunsford, 2004; Moody, 2010).

Background

On July 6, 2013, a 72-car train, while left unattended, rolled downhill into the small Canadian town of Lac-Mégantic, derailed, overturned, and exploded (Campbell, 2013). Crews required two days to extinguish the fire (Wells & Hutchins, 2013). The derailment, unlike the majority of derailments that happen in remote stretches of track or in the rail yard, directly impacted the town of 6,000 residents (Wells & Hutchins, 2013). The incident damaged several blocks of businesses and homes and killed 47 people (Campbell, 2013; Wells & Hutchins, 2013). The 72 cars were carrying 7.7 million liters (2 million gallons) of light crude oil (Transportation Safety Board of Canada, 2014). Crude oil represents an exponentially increasing railway transport commodity due to the rapid increase of hydraulic-fracturing activities throughout the United States and the slow pace of pipeline construction (Association of American Railroads, 2015d; Nelson, 2013; Sussman, 2013).

Since 2008, Class I railroads, defined as railroads with the largest operating revenue, have seen a 5,100 percent increase in the amount of bulk crude oil they are transporting across the United States (Association of American Railroads, 2015d). To save time and money, the crude oil is moved primarily by unit trains—trains that are typically a mile long that consist solely of one type of commodity, including crude oil (Frittelli et al., 2014; Werner, 2015). Derailments of these unit trains often results in fires and has led to incidents including that experienced in Lac-Mégantic, Quebec, and the evacuations of several towns including Casselton, North Dakota (2013) and Mount Carbon, West Virginia (2015) (Earth Justice, 2015).

Due to high visibility and increasing governmental oversight of railroad derailment response, railroads are now being *expected* to use NIMS/ICS as their incident management system (IMS) (Pipeline and Hazardous Materials Safety Administration, 2014). The expectation to use NIMS/ICS as the standard railroad response framework is cause for concern because railroads have not been *required* to use it in the past and are likely unprepared to implement it during a response. Moreover, there may be solid reasons why NIMS/ICS is not the best tool for responding to derailments of crude oil.

Perspective

This thesis examines the characteristics of railroad organizations, specifically planning and response operations for crude oil derailments, to determine if they are aligned with those characteristics found by researchers to be most suitable for the use of NIMS/ICS. I became interested in the use of ICS during my career in the United States Coast Guard (USCG). As a former Marine Safety Officer, I began responding to maritime disasters and oil spills in 1990 and started to use the National Interagency Incident Command System (the predecessor to NIMS) in 1995. When NIMS/ICS became a formalized process for the entire Coast Guard in 2004, I observed the difficulties experienced by the change in response systems for the law enforcement officers, search and rescue teams, and vessel and aircraft operators. After retiring from the USCG in 2012 as a qualified Type 1 Incident Safety Officer and Type 3 Incident Planning Section Chief, I began working with a few Class I railroads to prepare for and respond to derailments of hazardous materials (hazmat[1]) and crude oil[2]. At that time,

---

[1] A hazardous material is defined by the Department of Transportation as a “substance or material…capable of posing an unreasonable risk to health, safety, and property when transported in commerce” (49 CFR §105.5, 2011).

most of the railroads had not formally adopted NIMS/ICS but operated using existing emergency response plans and a core group of hazmat officers, contractors (e.g., wrecking crews), and consultants (e.g., health and safety, air monitoring). During the Paulsboro, New Jersey, derailment in 2012 that led to an evacuation due to the release of toxic materials, I observed how the involved railroad implemented NIMS/ICS and the challenges that were encountered.

Previous positive experiences with NIMS/ICS led me to presume falsely that NIMS/ICS could be easily adopted by the railroads. Despite the challenges, Class I railroads are working to implement NIMS/ICS as demonstrated by the Transportation Rail Incident Preparedness & Response: Flammable Liquid Unit Trains (2015) training curriculum developed by the Pipeline and Hazardous Materials Safety Administration. In response to previous crude oil derailments, this training was developed in collaboration with other federal agencies, the Association of American Railroads, and Transportation Community Awareness and Emergency Response (TransCAER) (Pipeline and Hazardous Materials Safety Administration, 2014). As described in the Chapter II literature review, no research is available regarding the use of NIMS/ICS for responding to crude oil derailments or its effectiveness in these scenarios. Therefore, there is a gap in the understanding of what components of NIMS/ICS make it more or less suitable for responding to derailments of crude oil. Similarly, there is a gap in the understanding of the cause of the disconnect between the expectations of NIMS/ICS proponents and its

---

[2] Crude oil is defined as "a mixture of hydrocarbons that existed in liquid phase in underground reservoirs and remains liquid at atmospheric pressure after passing through surface separating facilities and which has not been processed through a crude oil distillation tower. Included are reconstituted crude petroleum, and lease condensate and liquid hydrocarbons produced from tar sands, gilsonite, and oil shale" (15 CFR §754.2, 2012).

actual use by the railroads. These gaps, if better understood, could reduce delays in initiating an on-site incident management system, miscommunication, and frustration between responders. My research explores these gaps and recommends a path forward for the railroad community and public first responders.

Purpose of Study

The purpose of this study is to expand on the current level of understanding emergency managers and first responders have regarding planning for and responding to derailments of bulk crude oil cargos that result in a spill. In particular, this study explores the incident- and organizational-specific characteristics of crude oil derailments and compares and contrasts those characteristics with characteristics identified as enabling the use of NIMS/ICS. The data from this research may be used to educate emergency managers and first responders regarding issues involving planning for and responding to bulk crude oil derailments, the challenges railroads face when employing NIMS/ICS, and the manner in which preparedness activities may remove or lower the barriers to implementing NIMS/ICS successfully during crude oil derailments.

Significance for Emergency Management

This research is important to the field of Emergency Management because it identifies issues in the implementation of NIMS/ICS during derailments of bulk crude oil. I also make recommendations regarding strategies to overcome the identified issues. Furthermore, this project challenges the underlying assumption made by the Department of Homeland Security when it stated NIMS could provide “a systematic, proactive approach to guide … agencies at all levels of government, …, and the private sector to work seamlessly to prevent, protect against, respond to, recover from, and mitigate the effects of incidents, regardless of size, location or complexity" (Department of Homeland Security, 2008, p. 1). Included within this assumption were numerous incident types where the suitability of NIMS/ICS had not been studied or assessed, including derailments. Therefore, understanding how the characteristics of planning for and responding to derailments differ from those found in incidents where NIMS/ICS has been successfully used is essential for the advancement of NIMS/ICS implementation within railroad organizations. This information will assist railroad emergency response planners and responders in recognizing when the characteristics of an incident are not well-aligned with those found to facilitate the use of NIMS/ICS. Identifying when to apply NIMS will result in minimizing overall risk to all responders.

Governmental agencies and other organizations responding to derailments of crude oil will become more familiar with the characteristics of bulk crude oil derailment planning and response operations. Additionally, they will obtain a better understanding of how these characteristics make NIMS/ICS more or less suitable as an IMS through the application of my findings. This knowledge will assist these agencies and organizations in planning for and responding to derailments of crude oil as they will have a more complete understanding of the differences between routine incidents and crude oil derailments. They will also better understand what obstacles the railroads face in using NIMS/ICS. This understanding may lead to modifications in the existing IMS to facilitate its use by responders for derailments of crude oil.

Research Question

NIMS/ICS has provided a suitable framework for many response organizations, but the railroads have not universally found this to be the case. This research questions examined are: 1. *What are the key incident and organizational characteristics researchers have found to be essential for NIMS/ICS to work as intended? 2. Are those characteristics aligned with the characteristics of incidents involving derailments of bulk crude oil that result in a spill and Class I railroads?*

Summary

This chapter introduced the issues surrounding crude oil derailments and examined the need for research in the areas of transportation of bulk crude oil by rail and derailments of such cargos. The researcher, having had prior emergency response and management positions while serving in the United States Coast Guard (1990–2012) and as a consultant to railroads (2012–2015) became interested in the applicability of NIMS/ICS for all types of incidents after responding to a hazardous materials derailment in 2012 where the difficulties of implementing NIMS/ICS were witnessed. This research will inform the field of Emergency Management because it uncovers gaps in the implementation and use of NIMS/ICS during bulk crude oil derailments and examines the question as to whether the characteristics of derailments and railroads align with the characteristics found by researchers to be needed for NIMS/ICS to be effective.

II. Literature Review

This chapter reviews the literature pertaining to the transportation of bulk crude oil by rail, the safety concerns surrounding that transportation, and the recent events that have drawn attention to the issue. Next, it examines prior research regarding NIMS/ICS and the characteristics of the incident and of the responding agencies that make its implementation effective. Lastly, this chapter outlines the gaps in current literature as they relate to this study. These topics were explored using electronic database searches in Google, Google Scholar, Academic Search Complete, and ProQuest by means of different configurations of the following terms: derailments, railroads, crude oil, Bakken crude oil, effectiveness of NIMS/ICS, and responses to train accidents. Incident-specific details were gathered using publically available federal investigative reports and after action reports. After a thorough literature search, no research was found on the use of NIMS/ICS during bulk crude oil derailments or how effective NIMS/ICS is for these types of incidents.

Overview of Rail Transportation of Bulk Crude Oil

Rail transportation started in 1830 with the first steam locomotive which was developed by Colonel John Stevens and chartered by the Baltimore and Ohio Railroad Company (Association of American Railroads, 2015a). The rail industry, comprised of privately-owned companies with federal oversight, continued to grow and expand and soon became a leader in the movement of commodities as well as passengers (Werner, 2015). However, around 1980 the industry began to go bankrupt due to a decreasing demand for services and overly strict federal regulations (Werner, 2015). To salvage the remaining survivors, Congress deregulated the industry and allowed railroads to let go of money-losing routes and merge with one another (Werner, 2015). The outcome was a convergence of the existing forty railroads to an oligopoly of seven Class I and numerous, smaller Class II and III railroads (Werner, 2015).

The seven Class I railroads are still privately-owned companies with nearly all of their regulations coming from the Federal Railroad Administration (FRA) within the Department of Transportation (DOT) (Klass & Meinhardt, 2015). The FRA governs such areas as the safety of transporting hazmat, training of train crews, operating practices, signaling and train control standards, and infrastructure (e.g., track, equipment) integrity (Federal Railroad Administration, 2015a). Although they are privately owned, railroads cannot deny service based on the commodity to be moved or its perceived risk. This is because the DOT classifies railroads as "common carriers" and as such requires them to carry all freight, including hazmat, as long as the shippers are reasonable and follow the regulations governing packing and transportation of the goods (Common Carrier Transportation, Service and Rates Act, 1995).

Railroads are "classed" by their operating revenue, a definition which changes periodically (Association of American Railroads, 2015a). In 2013, for example, United States (U.S.) Class I railroads were defined as line haul freight railroads with at least $467 million in operating revenue (Association of American Railroads, 2015a). Class I railroads own 70 percent of the tracks, employ 90 percent of railroad personnel, and collect 95 percent of freight railroad revenue (Frittelli et al., 2014). Class II and III railroads typically have shorter rail lines that service areas not on the main track routes, and in the case of oil drilling sites, are frequently involved in the transportation of the oil as drilling often occurs at remote sites not connected to the main lines (Frittelli et al., 2014). Many of the Class II and III tracks were those abandoned by the Class I railroads, and their infrastructure has not been well maintained due to a lack of capital (Frittelli et al., 2014; Werner, 2015). The Class I railroads, on the other hand, are allowed and have the resources to build additional tracks and terminals to meet the demands of their customers.

It is estimated that rail moves 40 percent of the goods in the United States, and 60 percent of the more volatile crude oil produced in the Bakken Formation located predominantly in North Dakota and Montana (Johnson, 2015; Werner, 2015). While oil only makes up 1.6 percent of the total number of car loads originated by the Class I railroads, it accounts for 11 percent of the total amount of oil produced in the United States (Association of American Railroads, 2015d). With the expansion in hydraulic-fracturing operations throughout the North American shale deposits, rail has seen an exponential increase in the volume of oil moved. In 2008, just before the spike in oil production, Class I railroads originated 9,500 car loads of crude oil; in 2014 that number jumped to 493,146 car loads (a 5,100 percent increase over six years) (Association of American Railroads, 2015d).

The current boom in oil production is not the first time railroads have had a large part in transporting crude oil. When the United States started to drill for oil in earnest during the mid-19th century, railroads were quickly employed in the movement of crude oil from the “Oil Region” (Klass & Meinhardt, 2015, p. 954) since they had already established means to transport goods in northwestern Pennsylvania to the United States and European markets. Rail lines were limited, however, and oil producers found it to be both costly and hazardous to move manually barrels of oil to the nearest rail line (Klass &

Meinhardt, 2015). Although it took many years, primarily due to laws regarding eminent domain that applied to railroads but not pipelines and the political influences of the railroad, pipelines began to transport crude oil in 1865 (Klass & Meinhardt, 2015). This opened the floodgate of pipelines that soon began to crisscross the nation; by 1879, a 115-mile long, six-inch-wide crude oil pipeline connected western Pennsylvania to the east coast, where the oil could then be moved by rail to New York (Klass & Meinhardt, 2015). With the cost savings realized by the pipelines, oil producers continued to build oil pipelines at record rates, laying 6,800 miles of pipe by 1900, thereby removing the need to use railroads for the bulk of the transportation (Klass & Meinhardt, 2015).

The railroad did not regain the crude oil market until recently with the rekindling of United States drilling made possible with hydraulic-fracturing. Fortunately for the railroads, the shale deposits where drilling occurs are within range of many of the existing rail lines—remote areas where pipelines do not already exist, including Montana, North Dakota, Arkansas, and northern Texas (Energy from Shale, 2015; Frittelli et al., 2014). As noted by Frittelli et al. (2014) in their Congressional report concerning rail transportation of crude oil, "railroads are a viable alternative to pipeline transportation largely because they offer greater flexibility. The nation's railroad network is more geographically extensive than the oil pipeline network, and better able to ship crude oil from new areas of production" (p. 5). Being positioned to support the oil market has resulted in railroads investing billions of dollars to expand and improve their main rail lines and equipment to meet the growing needs. For example, BNSF Railway announced that in 2014 it completed, for the third year in a row, record investments into expanding existing infrastructure ($1.03 billion) and added 613 new locomotives, 7,000 new employees, and 7,500 new railcars for a total capital expenditure of 5.5 billion dollars (BNSF, 2015). On the other hand, pipelines require an extensive approval process under both state and federal laws, and the time needed for their construction exceeds that needed to lay new track (Klass & Meinhardt, 2015).

With the growing demand to haul bulk crude oil from the inland, remote hydraulic-fracturing sites to coastal port terminals and refineries (45 percent of which are located in the Gulf Coast), railroads have begun to use unit trains (Association of American Railroads, 2015d; Frittelli et al., 2014; Klass & Meinhardt, 2015). Unit trains are trains made up of car loads hauling one commodity, range from 75 to more than 100 cars long, and can carry approximately 70,000 barrels (nearly 3 million gallons) of oil (Association of American Railroads, 2015d; Werner, 2015). This configuration allows railroads to keep the cost of transportation down as they only need to load and off-load once and do not need to stop en route to their destination (Association of American Railroads, 2015d; Werner, 2015). This concerns many environmental and public safety activists who believe that unit trains of crude oil increase the risk of a derailment and will increase the severity of one if it does occur (Abbasi, 2015; Johnson, 2015; Kolpack & MacPherson, 2013; Nelson, 2013; Wronski, 2015). After the Galena, Illinois, derailment in March, 2015, one coalition leader stated she was “disturbed” by the fact that railcars hauling crude oil transited through Chicago suburbs daily and that the risk they posed was “unbelievable” (Wronski, 2015, para. 23-24). Frittelli et al. (2014) note that the use of unit trains does change the risk—on one hand moving a large, concentrated amount of potentially flammable crude oil does increase the chances of fire and explosion if there is a derailment, but on the other hand reduces the need for human interaction in rail yards where human error has been found to be the greatest causal factor for accidents (Liu, Saat & Barkan, 2012). There are few options open to railroads to increase volumes moved. Federal laws limit the number of trains on the tracks at one time; therefore, railroads cannot simply build more locomotives or lease more rail cars to meet the demand (Werner, 2015). However, double tracking (adding rail lines next to existing tracks) is an option railroads are exploring to increase volume (Werner, 2015).

Another concern is the amount of hazmat that transits through major metropolitan cities (Klass & Meinhardt, 2015). Although consideration is given to routing trains around cities, many of which were built around the original track routes, oftentimes rerouting the trains increases the risk because the secondary tracks are not maintained as well as the main tracks and using the secondary track increases the miles and track time for the train (Klass & Meinhardt, 2015). Moreover, the commodities being transported, including crude oil, terminate at industrial parks located on the outskirts of the cities making movement of cargos near or through cities necessary (Klass & Meinhardt, 2015).

Even with 160,000 miles of track, the railroads maintain a lean organizational structure and rely heavily on contractors and consultants to support them when needed (Association of American Railroads, 2016a; Friedlaender, Berndt, & McCullough, 1992). A typical Hazmat and/or Environmental Response Department within a Class I railroad may have few full-time employees but will maintain close relationships with heavy equipment and wrecking contractors as well as hazmat and environmental consultants to assist the railroad (Association of American Railroads, 2016b). This lean culture is seen during response operations as well. For example, a unit train will have on-board one conductor and an engineer (Knapp, Watson, & Frangella, 2008). They are the first responders for the railroad when there is an incident, but neither of them is usually trained to do more than make an initial visual assessment and call the critical incident desk to report the event (Knapp et al., 2008). Immediately upon notification, the on-call emergency response team from the railroad (which is normally personnel from the Hazmat Department) and their oil spill qualified individual (who is typically a member of the department) will go onsite (Association of American Railroads, 2016b). As they are traveling to the location, they make calls to their local contractors and consultants to meet them at the incident site. These emergency response teams have few personnel. The in-house response team may consist of three or four personnel who are supported by contractors to do the labor and consultants to perform the administrative, logistical, and support functions including safety and health and public affairs (Association of American Railroads, 2016b).

Safety Concerns of Crude Oil Cargos

Crude by rail. Although the number of derailments of hazardous or flammable cargo is low and communities are rarely impacted, incidents do occur. As noted by Knapp and Lunsford (2004), the safety record of the railroads is extremely impressive when compared to other modes of transport for bulk cargos. According to a study of 25 years of rail safety data, more than 99.99 percent of all hazmat are transported without incident (Association of American Railroads, 2015c; Knapp & Lunsford, 2004). The sudden growth in rail traffic, however, resulted not only in substantial expansion of railroad infrastructure but in the number of accidents involving crude oil cargos (Kolpack & MacPherson, 2013). Since the boom in shale hydraulic-fracturing drilling around 2009, there have been 12 noteworthy derailments (2013–2015) in the United States starting with the spill in Parkers Prairie, Minnesota, in March 2013 (Earth Justice, 2015). Following Parkers Prairie, there were two more incidents in 2013, four in 2014, and five in 2015 (Dobuzinskis, 2015; Earth Justice, 2015; Karlamangla, 2013).

Concerns about the transportation of crude oil by rail have been rising since the Lac-Mégantic disaster and continue to build as more crude oil derailments resulting in fires and explosions occur (Kolpack & MacPherson, 2013; Nelson, 2013; Vartabedian, 2015; Wronski, 2015). The Association of American Railroads (2015c) agrees, stating that even though less than 0.01 percent of hazmat rail cars are involved in accidents, with the recent number of incidents, the issue of safety has been questioned. Derailments of crude oil usually result (about 66 percent of the time) in a fire, pollution, and on occasion, explosions (Vartabedian, 2015). The outcome has been an increase in media coverage, public outrage, and governmental oversight, including the expectation by public responders for railroads to use NIMS/ICS during all response operations where there is local, state, or federal involvement (Vartabedian, 2015). Due to the high visibility and public attention, government involvement during crude oil incidents has become the norm, not the exception.

After each major incident, the FRA and National Transportation Safety Board (NTSB) investigate the causal and contributing factors of the incident (Federal Railroad Administration, 2015a; National Transportation Safety Board, 2015). Most rail incidents are caused by derailments (72 percent) resulting in the derailment of an average of seven cars per accident (Liu et al., 2012). Investigations have found that the primary cause of derailments is track failure due to broken rails or welds, track geometry (excluding wide gauge), wide gauge (when the distance between the two rails goes beyond the prescribed

56.5 inches), and buckled track (Liu et al., 2012; Vartabedian, 2015). Although it would seem intuitive to think that the speed of the train could contribute to a derailment occurring, investigations have not found a significant relationship (Liu et al., 2012). Likewise, human error, which has been found to lead to siding and yard derailments, does not rank in the top ten causes for main line derailments (Liu et al., 2012).

Unfortunately, recent events (see Table 1) have only reinforced the perceived need for additional oversight and control. Just four months after the disaster at Lac-Mégantic, on November 8, 2013, the Genesee & Wyoming Railroad had a train carrying North Dakota light crude oil derail in a remote section of western Alabama, burst into flames, and take several days to burn out (Sussman, 2013). Unlike Lac-Mégantic, no one was injured or killed. The next month, just 25 miles from Fargo, North Dakota, a train carrying crude oil collided with another train, derailed, and exploded (Kolpack & MacPherson, 2013). Again, no one was injured or killed, but the local community (approximately 2,400 residents) of Casselton, North Dakota, was asked to evacuate in order to reduce their exposure to the gases and particulate matter in the smoke plume (Kolpack & MacPherson, 2013). More recently, an explosion and large fire occurred on a Monday afternoon, February 16, 2015, in Mount Carbon, West Virginia, when a unit train carrying 109 rail cars derailed (Constantino & Murphy, 2015). This incident was preceded by a derailment in Timmins, Ontario, just two days earlier that resulted in a fire (Valentine, 2015).

Table 1

Summary of U.S. Train Derailments of Bulk Crude Oil Resulting in a Spill (from January 2010 – December 2015)

Date	Location	Railroad(s) Involved	Incident Summary
March 27, 2013[a]	Parkers Prairie, MN	Canadian Pacific	Unit train with crude oil derailed and spilled 20,000-30,000 gallons of oil
November 8, 2013[b]	Aliceville, AL	Genesee & Wyoming (Class II)	90 car train of crude oil derailed, 25 cars involved, caught fire, and spilled an estimated 748,800 gallons of crude oil
December 30, 2013[a]	Casselton, ND	BNSF	Train collision caused unit train of crude oil to derail. Cars exploded and caught fire. Town was evacuated. Estimated 400,000 gallons of crude spilled
January 31, 2014[a]	New Augusta, MS	Canadian National	Unit train derailed, 13 cars involved, estimated 90,000 gallons spilled. Nearby residents were evacuated
February 13, 2014[a]	Vandergrift, PA	Norfolk Southern	130 car train carrying various cargos including heavy crude oil, derailed and spilled approximately 4,00 gallons
April 30, 2014[a]	Lynchburg, VA	CSX	Unit train derailed, 25 cars involved, exploded and caught fire. Nearby residents were evacuated. 300,000 gallons of crude oil spilled
May 9, 2014[a]	LaSalle, CO	Union Pacific	100 car train derailed and spilled 5,300 gallons of crude oil
February 16, 2015[a]	Mount Carbon, WV	CSX	Unit train with crude oil derailed, 26 cars involved, 20 cars ignited resulting in explosions. Property damaged. Town was evacuated
March 5, 2015[a]	Galena, IL	BNSF	103 car train of crude oil derailed resulting in fire and oil spill

May 6, 2015[a]	Heimdal, ND	BNSF	109 car train of crude oil derailed, 5-10 cars exploded and caught fire. Town was evacuated
July 16, 2015[c]	Culbertson, MT	BNSF	106 car train of crude oil derailed and spilled 35,000 gallons of crude oil. Nearby residents were evacuated
November 8, 2015[a]	Watertown, WI	Canadian Pacific	110 car train with 109 cars of crude oil, 13 cars derailed spilling crude oil. Nearby residents were evacuated

[a]Earth Justice, 2015
[b]Karlamangla, 2013
[c]Dobuzinskis, 2015

Emergency preparedness. Because removing all of the risk of transporting crude oil is infeasible, transporters have stepped up emergency response preparations. The Association of American Railroads (2015c) states that the railroads have prepared with emergency response plans, training, exercises, and full-time teams of hazmat safety and emergency response teams. Railroads have also agreed to voluntary safety measures including using pre-trip risk assessments that consider 27 risk factors (using the Rail Corridor Risk Management System software developed by the federal government in partnership with the railroads), reducing speed of travel, rerouting certain trains around cities, developing safety measures to improve track and equipment safety, more frequently examining tracks, and implementing a faster braking system for the trains (Association of American Railroads, 2014a; Gold & Stevens, 2014; McDonald, 2014). Efforts have been made to improve railroad communication with communities including notifying emergency responders when shipments of Bakken crude oil will transit their area, working with local communities on emergency response plans that ensure they have sufficient response capabilities to respond to a worst case discharge, assembling and staging response kits throughout high risk areas, and requiring the qualified person in charge of the response to be on site within three hours of being notified of an accident (Association of American Railroads, 2014b; Klass & Meinhardt, 2015; Werner, 2015). Additionally, railroads have begun to fund training for local emergency responders at the Transportation Technology Center, Inc. in Pueblo, Colorado, sending more than 1,500 personnel in 2014 for training (Association of American Railroads, 2015b). In response, Transportation Technology Center, Inc. developed a training program for train crews to educate them on the types of hazmat they move and first responder actions at the awareness level (Association of American Railroads, 2015b). Lastly, to ensure first responders had access to training materials, in March 2015 a new, NIMS-compliant crude-by-rail training course was developed and is now being offered online and in the classroom by the railroads (Association of American Railroads, 2015b).

Safety concerns. Questions are often posed about the safety of tank cars used to carry crude oil. The majority of cars are not owned by the railroads but by the shipper or rail equipment leasing companies, and because railroads want less risk exposure, they have lobbied for stricter federal tank car laws (Association of American Railroads, 2015b; Frittelli et al., 2014; Klass & Meinhardt, 2015). The concerns about the DOT-111 rail car, the type of car currently in service for shipping hazmat including crude oil, appear to be warranted. The NTSB in their Railroad Accident Brief on the Tiskilwa, Illinois, derailment and hazmat release and fire, cite five previous NTSB investigations involving DOT-111 cars that resulted in hazmat being released and summarized their findings by stating “the poor performance of DOT-111 general specification tank cars in derailments suggests that DOT-111 tank cars are inadequately designed to prevent punctures or breaches and that catastrophic release of hazmat can be expected when derailments involve DOT-111" (National Transportation Safety Board, 2013, p. 9). Although the Tiskilwa incident did not involve crude oil, it did draw attention to the risks inherent to the use of DOT-111 cars for transporting hazmat. As a result, the news media picked up on the safety concerns with DOT-111 cars and ignited the public's interest and demand for safer rail cars (Hays, 2014; Nelson, 2013).

The U.S. Department of Transportation (DOT) has listened to the railroads, NTSB, media, and the public, and in May 2015 announced that the older style tank cars, including DOT-111s, would be retrofitted in the next two years or phased out over the next 10 years by DOT-117 cars which are designed with thicker shells, head shields one half inch thick, jackets with a minimum 11-gauge steel, insulation, and re-closeable pressure relief valves (Thomas, 2015). The cost to retrofit or renew the railcars is estimated at $1.7 billion (Thomas, 2015).

In addition to the question about the safety of tank cars there is the new concern about the types of crude oil being produced, especially in the Bakken Formation due to its properties and the need to transport most of it by rail because of the lack of pipeline infrastructure in that region (Dangerous Goods Transportation Consulting, 2014; National Response Team, 2014). Crude oils are categorized by their American Petroleum Institute (API) gravity as light, medium, or heavy with the light crude oils being more volatile (i.e., contain more dissolved flammable gases including methane, ethane, butane and propane), having a lower specific gravity, higher vapor pressure, and lower flash point (Dangerous Goods Transportation Consulting, 2014; National Response Team, 2014). Bakken crude oil, unlike the majority of crude oil produced, is "younger" and much of it is very light (i.e., containing more dissolved gases than other crude oils) with a mean flashpoint of negative (-)16.8 degrees Fahrenheit (Dangerous Goods Transportation Consulting, 2014). These characteristics make it more prone to ignite during a derailment as the impact of the derailment creates enough energy and static discharge to ignite the material (National Response Team, 2014).

Mitigation. Public attention came to the forefront after the Lac-Mégantic disaster which involved Bakken crude oil because of the force of the explosions and the subsequent fire (Gold & Stevens, 2014; Hays, 2014; National Response Team, 2014; Nelson, 2013). American public outrage soon followed when two incidents involving Bakken crude oil occurred within the next six months in Casselton, North Dakota, and Aliceville, Alabama. On February 25, 2014, the DOT took the first step to address these concerns by releasing an Emergency Order requiring that shippers test the crude oil before assigning it a packing group (PG) number which is based on the physical properties of the material (e.g., flash point, boiling point) (Gold & Stevens, 2014). This has resulted in tank cars now being properly marked as high (PG I), medium (PG II), or low hazard (PG III) (Dangerous Goods Transportation Consulting, 2014; Gold & Stevens, 2014). Prior to this order, crude oil cargos were typically assigned the lowest packing group (PG III) as the presumption had been that crude oil, as a whole, is combustible but not flammable, and, therefore, had a small chance of igniting if released (Dangerous Goods Transportation Consulting, 2014; Gold & Stevens, 2014).

Evolution of NIMS/ICS

After the September 11, 2001 attacks, the Department of Homeland Security (DHS) by authority of Presidential Directive 5 (HSPD-5), Management of Domestic

Incidents, directed all federal, state, tribal and local governments to adopt and implement the National Incident Management System to prepare for, respond to, and recover from all incidents (Department of Homeland Security, 2003). HSPD-5's policy is:

> To prevent, prepare for, respond to, and recover from terrorist attacks, major disasters, and other emergencies, the United States Government shall establish a single, comprehensive approach to domestic incident management. The objective of the United States Government is to ensure that all levels of government across the Nation have the capability to work efficiently and effectively together, using a national approach to domestic incident management. In these efforts, with regard to domestic incidents, the United States Government treats crisis management and consequence management as a single, integrated function, rather than as two separate functions. (Department of Homeland Security, 2003, para. 3)

The National Incident Management System (NIMS), designed for all sizes and types of incidents, was soon thereafter implemented in 2004 (Department of Homeland Security, 2008).

NIMS was modeled after the FIRESCOPE system developed in the 1970s by California firefighters and an outgrowth of that system called the National Interagency Incident Management System (NIIMS) developed by agencies including the U.S. Forest Service and U.S. Coast Guard (Buck et. al., 2006; Jensen & Waugh, 2014). Firefighters and other responders within the government found NIIMS to be an effective disaster management tool because it provided a standardized organization, processes, and order to an otherwise chaotic situation (Annelli, 2006). With the 2004 revision, NIMS addressed three areas that were missing in the initial doctrine including preparedness, resource management, and communications and information management (Annelli, 2006). Within the preparedness component fall many of the critical elements needed to manage effectively an incident including planning, training, exercises, responder qualification and certification, equipment acquisition, and publication management (Annelli, 2006).

HSPD-5 limited its reach to governmental agencies meaning that the private sector was free to adopt or not adopt NIMS/ICS as they saw fit (Department of Homeland Security, 2003). DHS did, however, recognize the private sector as a key component in response operations and included them in the National Incident Management System doctrine (revised in 2008) stating that the system:

> provides a consistent nationwide template to enable Federal, State, tribal, and local governments, nongovernmental organizations (NGOs), *and the private sector* [emphasis added] to work together to prevent, protect against, respond to, recover from, and mitigate the effects of incidents, regardless of cause, size, location, or complexity. (Department of Homeland Security, 2008, p. 3)

Nevertheless, for many private sector companies and organizations, the requirement to implement NIMS and its components, including ICS, did directly impact them.

For example, the 1986 Emergency Planning and Community Right to Know Act (EPCRA) required fixed facilities to develop response plans that aligned with the local emergency response plan which oftentimes required the use of NIMS/ICS as the IMS (Environmental Protection Agency, 2015a, 2015b; National Transportation Safety Board, 2014). Because that requirement within EPCRA did not pertain to railroads, the railroads, in a sense, fell through the cracks (National Transportation Safety Board, 2014). Stricter governmental oversight and the push to use NIMS/ICS arose soon after the Paulsboro, New Jersey, hazmat derailment in 2012 that resulted in the release of a toxic by inhalation chemical prompting the community's evacuation (National Transportation Safety Board, 2014). As noted in their report, the NTSB (2014) explicitly points out the disconnect stating that because railroads are not required to develop contingency and response plans with local emergency responders, plans that would define the IMS to be used, communities are left "unprepared" to respond to releases of hazmat (National Transportation Safety Board, 2014, p. 50).

Suitability of NIMS/ICS for All Incidents

The effectiveness and efficiency of a response is often a result of the teamwork and contingency planning performed by the carrier (Bennett, 2011; Deal, de Bettencourt, Huyck, Merrick, & Mills, 2006). Railroads, having been their own first responders, have systems in place to handle emergencies. These systems are conducted with few personnel, including typically the hazmat officer, a railroad engineer, and third party contractors to remove the materials, lift the cars back onto the track (if feasible), restore the track's structural integrity, and clean up the impacted environment (Association of American Railroads, 2016b). On occasion the railroad is assisted by the local fire department or other emergency responders depending on the location, affected cars, severity, outcome, and materials involved (Knapp & Lunsford, 2004). On rare occasion, the federal government is involved (e.g., when a navigable waterway is impacted or the derailment has high visibility) (Federal Railroad Administration, 2015b). However, the findings of the NTSB (2014) coupled with the exponential increase of crude oil cargos and, although infrequent, devastating derailments, pushed railroads to adopt and implement NIMS/ICS as their IMS despite having responded effectively and efficiently to past derailments without such requirements.

Many NIMS/ICS proponents and practitioners assume that because the IMS works for their organization and performs as intended for their response operations that it must be a suitable approach for all incidents (Johnson, 2015). Proponents of NIMS/ICS, including Perry (2003), espouse the IMS's flexibility, while others have found that its key attributes of "common terminology… modular organization… management by objectives… incident action plans… integrated communications [and] chain of command" all contribute to its efficiency and effectiveness (Anderson et al., 2004, pp. 4-6; Bigley & Roberts, 2001).

Questionable assumptions. Since the implementation of NIMS/ICS in 2004, many scholars have begun to question the assumptions made by NIMS/ICS proponents that the IMS is suitable for all incidents (Jensen & Waugh, 2014; Moody, 2010). Moynihan (2008a) notes that "while the ICS illustrates the potential for mixing hierarchies and networks, it was mandated by policymakers willing to make broad assumptions about the applicability of the ICS on limited evidence" (p. 205). Buck et al. (2006) note that one way NIMS/ICS fails is by not focusing on the coordination needed between all of the responding organizations before an incident occurs and, therefore, are concerned about HSPD-5's mandate. "If ICS is flawed, expansion of ICS usage may exacerbate the difficulties in the organization of emergency response" (Buck et al., 2006, p. 3). Additionally, Buck et al. (2006) point out that the context of the incident (i.e., incident scenario and responding organizations) where NIMS/ICS is effective had not been examined prior to its implementation, and that this gap in understanding has made

NIMS/ICS only partially effective. Moynihan (2008a) supports Buck et al.'s (2006) assertions writing that there are crisis characteristics and management factors that directly impact NIMS/ICS's operation, factors that are not addressed in the IMS. These factors are summarized below.

Shared vision and trust. With respect to the response organization, Buck et al. (2006) found that NIMS/ICS was the most effective when the response organizations had a "shared vision of the response through planning, practice, and experience" (p. 12) and were a part of a community. These factors led to interagency trust and respect thus allowing for potentially pre-existing, diverging perspectives and goals to align more easily during a crisis so that decisions could be made collectively (Buck et al., 2006). Similarly, Moynihan (2008b) found that NIMS/ICS supported response operations best when there had been pre-incident coordination among the responding organizations to develop plans that were flexible and incident-specific and considered available resources—measures that fostered trust and delegation.

Related to this finding, researchers found that in addition to having plans, plans with collaboratively developed and agreed upon risk assessments and tactics led to NIMS/ICS being effectively used (Buck et al., 2006). Conversely, when there are multiple or diverse organizations responding, ICS becomes more difficult to use due to a lack of a previously formed network and prior coordination which may lead to distrust and conflict (Moynihan, 2009). Lutz and Lindell (2008) express concern with using NIMS/ICS when there are emergent, multi-agency responders that have never worked with one another as they are performing "novel tasks with a new staff" (p. 124). Shared experiences, training, and exercises allow responders to become more familiar with one another strengthening their underlying relationship, sense of partnership, and dependency (Buck et al., 2006). Buck et al. (2006) also found that "prior familiarity with the people and the response organizations [was cited as] the most important factor" (p. 13) in determining if NIMS/ICS would work.

Commitment to NIMS/ICS. Research by Jensen and Waugh (2014) suggests that there are other organizational factors influencing the effectiveness of NIMS/ICS including the need for the individuals responding to be a part of team (e.g., first responders) or perform emergency response as part of their paid duties and to have used NIMS/ICS in prior exercises or responses. Individuals are best suited when their training and experience using NIMS/ICS is frequent, comprehensive, and specific, and is combined with an understanding of response strategies and tactics they will face (Buck et al., 2006; Jensen & Waugh, 2014). In order for responders to attain this level of experience, response organizations need to adopt NIMS/ICS committedly and unreservedly throughout their entire organization (Jensen & Waugh, 2014). Lester (2007) adds that committed leadership is in itself not sufficient (as demonstrated by the failures experienced during the Hurricane Katrina response); rather, transformational leadership is needed. Transformational leadership challenges assumptions about the IMS, imparts among all response levels a shared vision, authorizes responders to make decisions in the field, and encourages initiative (Lester, 2007). Once they have committed themselves, organizations then need to demonstrate this commitment by training employees including those in support functions, developing plans and standard operating procedures that incorporate the IMS, exercising the plans, and completing after action reviews of how well the organization performed so that corrective actions can be taken (Jensen & Waugh, 2014; Moynihan, 2008a). These elements combine to create an "organizational memory" (Moynihan, 2008b, p. 359) upon which response decisions can be more accurately made. Perry (2003) had similar findings stating that the IMS must be used daily by the responders to lay the groundwork for future responses.

Uncertainty and complexity. Another factor affecting the effectiveness of NIMS/ICS is the number of organizations responding to an incident as multi-agency responses create additional uncertainty (Moynihan, 2008b, 2009). Buck et al. (2006) propose that NIMS/ICS works well for firefighters because they are a community of experienced responders who have trained and worked together to build their collective technical competence and relationships; for large incidents with numerous response organizations, this is not the case. Numerous organizations do not only add to the uncertainty and complexity, they may undercut the response leadership (e.g., command and general staff) because responders may not have an appreciation of the leaders' experiences, knowledge, or skills, thereby leading to questions of their legitimacy and resulting in responders questioning their work assignments (Jensen & Waugh, 2014; Moynihan, 2009). Additionally, large incidents make the key NIMS/ICS component of effective communications more difficult due to equipment interoperability issues and differences in leadership communication styles (Jensen & Waugh, 2014). Lastly, organizational size may hinder response flexibility and adaptability, a fundamental principle for effective IMSs (Perry, 2003).

Incident characteristics. With respect to the type of incident for which NIMS/ICS is being used, practitioners (Bennett, 2011; Bigley & Roberts, 2001; Knapp & Lunsford, 2004) may argue that because it was designed as an "all-hazards" approach that

NIMS/ICS is the best tool available for train derailment responses; however, Jensen and Waugh (2014) and Buck et al. (2006) would disagree. Buck et al. (2006) note that ICS works poorly for large or uncontrollable disasters that result in more than one hazard. Likewise, large disasters often require a multi-agency response which may introduce tension as each agency brings its own agenda (Buck et al., 2006). On the other hand, during routine emergencies, in which the responders had a pre-incident network and agreed upon understanding of the threats and response strategies and tactics, NIMS/ICS performed effectively (Buck et al., 2006; Moynihan, 2009).

Complicating this issue is that incidents are more and more frequently crossing geographical and political boundaries causing increased complexity and the "need for extreme adaptation and unprecedented cooperation under conditions in which these are most difficult to achieve" (Ansell, Boin, & Keller, 2010, p. 204). Although not directly related to derailments, other studies have found that effective preplanning and a thorough understanding of how to respond by all responders are necessary to ensure the success of ICS (Bennett, 2011; Jensen & Waugh, 2014; Moody, 2010; Perry, 2003). Chen, Sharman, Rao, & Upadhyaya (2007, 2008) maintain that the number of operating procedures and plans that can remain unchanged during an event enables responders to use NIMS/ICS more effectively. Likewise, they note that for complex events to be successful, the responders must have knowledge on how to respond to that type of event and have performed pre-incident coordination to ensure all of the responders know each other's capabilities and capacities (Chen et al., 2007, 2008). Moynihan's (2008a) case study of how well NIMS/ICS worked during the Exotic Newcastle Disease outbreak in 2003 had similar findings indicating that responder experience for the type of incident was a function of how well the IMS worked. His study notes that a lack of experience with the crisis at hand increases the demands placed on responders because they have to learn new tasks while at the same time coordinating with other organizations to complete the tasks (Moynihan, 2008a).

NIMS/ICS and derailments. Although the railroads have done extensive preplanning, most of the local communities do not have the resources or knowledge of how to respond to crude oil derailments and depend on the railroads for their expertise (Association of American Railroads, 2016b; Knapp & Lunsford, 2004). Chen et al. (2008) state that not only preplanning, but pre-incident coordination, is needed for ICS to work as intended. This may not be a reasonable expectation for the railroads. With over 160,000 miles of track, the coordination of the railroads with the communities is typically limited to those areas where there are large confluences of track or railroad operations (e.g., rail yards, terminals) and in urban centers or environmentally sensitive areas (e.g., National Parks) (Association of American Railroads, 2016a). Compounding this issue is one of frequency. Bennett (2011) states that incidents that have a high risk but low frequency are of the most concern for responders as they have limited experience upon which to draw and apply their training. Furthermore, as noted by Moynihan (2008b), learning during a crisis is extremely difficult for responders and organizations as crises "narrow focus and limit information processing" (p. 351) which can result in making poor decisions as responders call upon past lessons learned that may or may not apply which then leads to faulty reasoning. This can lead to stress and an inability to cope by the first responders negatively impacting their response capabilities (Kim, 2007).

Because the probability that local emergency responders will be involved in a crude oil derailment response is low, but the risk of operations can be high, the need for incident-specific response experience for NIMS/ICS to work is a concern. Furthermore, the complexity of a derailment varies based on the train's consist[3], location of the incident, status of the railcars (i.e., intact or breached), and presence or absence of fire and explosions. Incident novelty and complexity create a difficult situation for local first responders (Buck et al., 2006).

Generated Demands

Incident-specific characteristics can be defined as either response-generated or agent-generated demands (Quarantelli, 1997). Response-generated demands are those introduced by operations of the responding organizations while agent-generated demands pertain to the incident itself (Quarantelli, 1997). Examples of each are described in Table 2. As stated by Quarantelli (1997), emergency managers and planners need to understand the difference between response- and agent-generated demands to be effective. Response-generated demands are those variables that can be influenced by an organization prior to an incident, while agent-generated demands, although often predictable, are uncontrollable (Quarantelli, 1997). This distinction is important when considering how to prepare for and mitigate the threats associated with bulk crude oil derailments; for example, some response-generated demands can be addressed beforehand while planning may be the only tool available for agent-generated demands.

[3] The consist is complete list of all of the cars and locomotives in the train including a description of the cars, location of cars, and shipping papers for hazardous materials (National Transportation Safety Board, 2016b).

Table 2

Demands Generated by Incidents

Response-Generated	Agent-Generated
Mobilizing people and equipment	Location, date and time of incident
Defining goal and objectives	Type of incident / material(s) involved
Developing strategies and tactics	Number of hazards
Delegating work assignments and tasks	Severity (threat) and complexity of incident
Developing communication systems	Required number and type of tasks to be performed by responders
Tracking information and documentation	Jurisdiction of first responders
Decision-making	Pace of incident
Organizing efforts and collaboration	Size of incident

Note. Data compiled by author using information from Quarantelli, 1997, p. 5

Upon comparison, several response- and agent-generated demands were found to align with incident- and organizational-specific characteristics thought to enable the use of NIMS/ICS. Characteristics that align with *response-generated demands* include:

1. Level of preplanning, training, and exercises directly related to derailment response operations
2. Level of trust between responding organizations
3. Whether or not the different responding organizations shared a vision or common purpose upon arriving to incident
4. Degree to which a network or contact had been made prior to the incident
5. Whether or not an accurate assessment of the hazards and their associated risks had been made

6. Whether or not responders recognize or understand the hazards and associated risks
7. Level of training and experience of responders to incident type (e.g., being able to develop and deploy strategies and tactics)
8. Level of training and experience of responders to NIMS/ICS
9. Availability of personnel and equipment needed for the response
10. Level of commitment by responding organizations' senior leaders to NIMS/ICS
11. Level and effectiveness of communication at the site and in the command post

Characteristics that align with *agent-generated demands* include:

1. Proximity of incident to an urban area
2. Type of incident and whether it is novel or routine
3. Severity and complexity of the incident
4. Number of jurisdictions involved in the incident
5. The number of tasks required to respond to and resolve incident
6. How quickly the incident evolves or expands/contracts
7. How large the incident is (spatial size)
8. If the incident occurs on a jurisdictional boundary (i.e., spatial, temporal, political, or functional)

Railroads have the ability to affect change with the first set of [response-generated] demands, but can only anticipate, assess, and plan for the second [agent-generated]. Understanding the limitations railroads face when planning for and responding to derailments allows for a more complete discussion as how to best support and prepare first responders.

Conclusions

The National Incident Management and Incident Command Systems provide useful tools for many responders and have been readily adopted and successfully used by many governmental organizations (Bennett, 2011; Bigley & Roberts, 2001). This is not the case for railroads, however, who are struggling to implement the tools in a practicable manner while still adhering to the NIMS doctrine (Pipeline and Hazardous Materials Safety Administration, 2014). Historically, the Class I railroads have responded quickly and effectively using a few internal personnel and a team of contractors and consultants (Association of American Railroads, 2015c, 2016b). Recent events have led to greater oversight by federal, state, and local agencies that have begun to expect the use of NIMS/ICS by the railroad responders (Pipeline and Hazardous Materials Safety Administration, 2014).

Ever since responders began using NIM/ICS, researchers have tried to define what factors are needed for it to work (Jensen & Waugh, 2014). As noted above, recent research suggests that well-defined, routine, and simple incidents that involve few response organizations who have a pre-incident history of coordination and cooperation result in NIMS/ICS being more effectively used (Buck et al., 2006). Similarly, the IMS is supported when inter-organizational relationships have already been built and they share the same vision (Buck et al., 2006). Intra-organizationally, an IMS is best supported when there is full commitment of the organization from the most senior leaders down to the support personnel that is backed by plans, training, and exercises (Jensen & Waugh, 2014). These incident- and organizational-specific characteristics are more clearly understood when considered alongside Quarantelli's (1997) research on response-generated and agent-generated demands. Focus, therefore, should be on how railroads can develop or improve policies, programs, and procedures to affect change in their response-generated demands, and on obtaining a clearer understanding of how their agent-generated demands align with those found to facilitate the use of NIMS/ICS.

Summary

This chapter examined the issues surrounding transporting bulk crude by rail, the history of NIMS/ICS, and the characteristics believed to support the use of NIMS/ICS during a response. The literature review found that research to date does not appear to address the use of an IMS with train derailments. Additionally, there is limited literature on the efficacy of NIMS/ICS for all types of incidents no matter the size, location, or responding organizations (Buck et al, 2006; Jensen & Waugh, 2014). Therefore, research into how well the derailments' incident- and organizational-specific characteristics align with those thought to promote the use of NIMS/ICS as the IMS is needed. This research may help close the gap and facilitate the use of NIMS/ICS for these types of responses. Chapter III details the methodology.

Chapter III. Methodology

Background of Research Method

This study was conducted to compare the incident- and organizational-specific characteristics of bulk crude oil derailments that result in a spill with the characteristics found by researchers including Buck et al. (2006) and Jensen and Waugh (2014) that enable the effective use of NIMS/ICS during a response. The research method employed was qualitative with a descriptive case study design using semi-structured interviews. This method, which is often selected for topic areas that not already well researched, collects data through interviews, newspaper articles, and investigative reports (Leedy & Ormrod, 2013). Additionally, a review is typically performed of past and present factors that shape the issues regarding the selected topic area so that others may be better equipped to form their own conclusions as to the findings (Leedy & Ormrod, 2013).

Rationale for Selected Method

A review of the literature revealed that the suitability of NIMS/ICS for use during derailments had not been examined. Furthermore, due to the recency of bulk crude oil derailments, there was no literature on the characteristics or response operations of bulk crude oil derailments. There was literature on the characteristics of an incident and the response organization that made implementing and using NIMS/ICS more likely to be effective as an IMS. Therefore, a qualitative approach using a case study design was chosen as the method as it allowed examination of the issues surrounding bulk crude oil derailments and the use of NIMS/ICS. Interviews with railroad personnel provided insights to the issues faced by railroads when planning for and responding to derailments.

Research Processes

Responses to bulk crude oil derailments were researched by using National Transportation Safety Board and Federal Railroad Administration investigative reports and governmental after action reports. Interviews were performed with five full-time Class I railroad hazmat and/or environmental employees who had responded to a crude oil derailment resulting in an oil spill in the past five years. Participants were solicited by email; of the seven railroad personnel representing three of the Class I railroads contacted, five either agreed to be interviewed or arranged for another railroad employee to be interviewed on behalf of the organization. These three Class I railroads were chosen because they are headquartered in the United States and have had at least one bulk crude oil derailment in the time frame investigated. The interviews, which were conducted telephonically, assessed the characteristics of the incident and responding organizations and issues railroads have faced with implementing NIMS/ICS. The names and organizations of all participants were kept confidential.

Information gathered from railroad personnel interviews was merged with data retrieved from federal investigative and after action reports to provide a more complete picture of incident characteristics, response operations, and the use of NIMS/ICS. Analysis for this study entailed categorizing the incident and response data gathered during the research and interviews into two groups. The first data group was used to describe the characteristics of the four representative derailments. The second data group compared factors thought to enable the use of NIMS/ICS with findings from each of the four representative derailments. From this compiled data, four major themes were found and expounded upon in Chapters IV and V.

Institutional Review Board

Arkansas Tech University's Institutional Review Board approved this study prior to solicitation of railroad personnel to participate in the study. Before each interview, the participant was read the consent form (Appendix B) which included information on the purpose of the study, the rights of the participant to withdraw information or stop the interview at any time, and verification that each person understood that the interview was voluntary. Upon verbal consent, the electronically signable form was emailed to each participant.

Protection of Participant Rights

Due to the recency of the issue being studied and the fact that most of the incidents are still under investigation and/or litigation, the participants were assured confidentiality. None of the interviews were recorded; rather, hand-written notes were taken during the interview process and compiled as summary data electronically with all names removed. Materials were maintained in a private, locked office. All documentation, both hand-written and electronic, will be destroyed upon publication of this study.

Rigor and Credibility

In addition to the literature search, data concerning the incident- and organizational-specific characteristics was obtained through phone interviews with five participants from three of the seven Class I railroads that operate in the United States. Each of the participants was in the Hazmat or Environmental Department within his or her respective railroad and performed emergency response operations. Railroad first responders were chosen as participants due to their experience and firsthand knowledge of the issues faced by railroad and other first responders. Moreover, each participant had responded to derailments involving crude oil. Four of the five participants had responded to bulk crude oil derailments occurring on unit trains; one had responded to a mixed freight train derailment that involved crude oil. Interviews were reviewed to acquire factual data about the derailments that could not be found through open source information and to obtain their perspectives on NIMS/ICS and the challenges they have had with adopting and implementing its use for derailments of bulk crude oil.

Summary

This chapter covered the methods used to obtain information on the characteristics of crude oil derailments and the perspectives of railroad first responders on adopting and using NIMS/ICS as their IMS. The qualitative research method was chosen due to the recency of bulk crude oil derailments and the absence of research as to the incident or response characteristics and the suitability of NIMS/ICS for derailments of bulk crude oil planning and response operations. Before interviews were performed, approval was obtained through the University's Institutional Review Board to use human subjects, and each subject was verbally instructed upon and agreed to an informed consent form. Chapter IV contains the results of this study.

IV. Results

Overview

Interviews were granted by five hazmat and environmental personnel from three Class I railroads. The interviews were semi-structured using the aforementioned topic areas to guide the discussion (see Appendix A for list of questions). Of the 12 crude bulk oil derailments (from 2010–2015) that resulted in a spill, four were examined more closely. These four were chosen based on the ability to obtain factual data on the incident or the ability of the involved railroad to discuss response operations. It should be noted, though, that many of the participants were reticent to discuss details about a particular derailment as most of the incidents are still under investigation and may have related litigation pending. Research into investigative reports and governmental findings found few public documents despite the high level of the public interest. The lack of data may be attributable to the relative recency of bulk crude oil derailments and the complexity of the investigative process; it is not for lack of federal interest—each incident has been investigated by the FRA and/or NTSB. Nevertheless, the final reports have only been published for two incidents (FRA: Mount Carbon, West Virginia, 2015; NTSB: Lynchburg, Virginia, 2014). Despite these obstacles, all participants openly discussed the issue of using NIMS/ICS during response operations and their efforts to improve existing emergency preparedness and relationships with first responders, state and federal regulatory agencies, and the affected communities.

Each interview was performed telephonically and lasted approximately one hour. Notes were taken by the researcher and summarized electronically. There were four major themes that arose from the interviews: (1) *derailments of crude oil have very similar properties and require similar response strategies*; (2) *railroad hazmat and environmental teams are finding strict adherence to NIMS/ICS difficult*; (3) *first responders not affiliated with the railroads have limited knowledge on how to respond to derailments and the risks involved*; and (4) *railroads are working hard to build relationships and train responders—efforts that have already paid off*.

The interviews focused on three incidents—Lynchburg, Virginia (April 2014); Galena, Illinois (March 2015); and Heimdal, North Dakota (May 2015). Additionally, using the FRA accident report, the incident that occurred at Mount Carbon, West Virginia (February 2015), was examined. These four derailments represent the range of incident-specific characteristics evident in the 12 derailments, including location, proximity to urban areas and sensitive habitats, incident severity, and complexity of the response operations. The table in Appendix C summarizes these characteristics while the table in Appendix D compares the NIMS/ICS enabling incident-specific characteristics to each of the four derailments. Organizational-specific characteristics, including senior leadership commitment, shared vision, and the level of pre-incident preparedness and training were discussed; however, due to the sensitive nature of the topics, the limited number participants and representative railroads, and the subjective nature of the information, these characteristics were not included in the Appendix D table. These characteristics are discussed collectively in the Findings.

Findings

Similar properties and response strategies. Responses to crude oil derailments typically follow a pattern similar to that of other hazmat derailments regardless of the incident's unique characteristics or the railroad involved, according to each participant interviewed. Key operations performed by the railroads and their contractors center on characterizing the site, containing the fire, stabilizing impacted railcars, removing residual product, containing the oil spilled, recovering the oil from the environment, removing debris, repairing track, and remediating the environment. One participant noted that his railroad has a standard strategy used by their contractors and response personnel. To support these operations, participants stated that each of their railroads has an in-house hazmat response team on-call at all times. In addition to these teams, participants noted that railroads contract the services of emergency responders, wreckers and heavy machinery operators, oil spill removal organizations, and environmental remediation companies. Each participant described the depth and breadth of contracted resources available to the railroads when there is an incident, each with contracts in place to provide services immediately upon notification.

Because responding to derailments of crude oil is similar to those involving other hazardous flammable materials, each participant felt prepared to respond. The data collected from the interviews did not indicate that response operations in rural locations have more difficulties than urban ones; there did not appear to be a correlation as the railroads bring in their own contractors, equipment, and subject matter experts no matter the location. Rather, the difference that was evident was the level of trust or prior relationships the railroad had with the local, state, or federal officials. One participant noted that when the local fire department allowed the railroad and their contractors to work while keeping the Fire Chief (as Incident Commander) informed, that the response went smoothly and quickly. Similarly, another participant noted that when they were faced with a derailment in a city where they had done previous training with the fire department and hazmat team, that the local responders trusted the railroad to take the best actions and respond appropriately. That trust enabled the railroad to complete operations expeditiously and enabled responders to use a modified planning process where Incident Action Plans were updated and revised by the unified command as needed using a verbal approval process. This flexibility allowed the Incident Action Plan to keep pace with operations and prevented operations from being held up by the planning cycle.

Trust is not a given, however, for the railroad hazmat teams—they are often faced with personnel who think they are "criminals" or worse. A participant remarked that in one state an official told him that if there was a spill that they would "shut the railroad down for at least 30 days," an action that would likely hurt the Nation just as much as the railroad. Each participant had experienced distrust before, and a few noted that tensions appeared when government officials, who had no previous experience with derailment response operations or the railroads, responded and inserted themselves in the response. For example, on one derailment, government officials, uneasy with the response actions of the railroad and distrustful of their intentions, slowed the response down, formed a robust incident command structure, and only relaxed their hold when they felt that they understood and could support the operations.

In order to change this perception, one railroad is focused on developing response plans collaboratively with state and federal officials to ensure that their needs are understood and met. Another railroad is focusing efforts on training first responders and state and federal officials on the hazards posed by the different types of crude oils, how to respond if there is an incident, and what the railroad does to prepare for the worst-case scenario. Their training program, according to the participant, is as much about outreach as it is education. Through their training school and hands-on training site, outreach training for fire departments, mobile "Safety Train," and free online training programs for first responders, they have reached thousands of responders.

Adherence to NIMS/ICS. The railroad personnel interviewed all indicated that they used an IMS akin to that of fire departments, but none of them felt that NIMS/ICS, as it is formally defined by the Federal Emergency Management Agency (FEMA), is effective for all of their operations. Several participants noted that they thought that NIMS/ICS is useful and needed, but that it is most suited for large incidents where there are numerous response agencies and personnel and communication over long distances is critical. From what several participants said, they formed this belief after seeing it work for responses including Hurricane Katrina and Deepwater Horizon but had experienced only difficulties when they used it during their relatively small responses. This opinion has been reinforced when they have had to work with state and federal officials who imposed a rigid interpretation of NIMS/ICS on their response operations, thereby interrupting the flow and hindering the response efforts.

Standing up an Incident Command Post and filling it with personnel in accordance with the standard organizational chart takes a lot of time, as noted by one participant. He added that by the time the organization is stood up that railroad responders are usually winding down their response operations and moving into the longer term remediation phase of the operation. He sees the governmental agencies as uncomfortable with the response operations (due to lack of familiarity) which causes them to bring more people with them than they may actually need, making the command post and incident management team an "entity of their own." He felt that the governmental agencies are more focused on the rules and processes than the operations or the people involved in those operations. A possible reason for this misalignment, he stated, was that the railroads—unlike the maritime industry—have not been planning, exercising, or using NIMS/ICS since the enactment of the Oil Pollution Act of 1990 (OPA 90)[4]. He felt that the federal government's expectations of them have been too ambitious given they are 20 years behind the oil companies in planning, exercises, and drills in accordance with OPA 90—the criteria to which they are being held. This thought was expressed by another participant as well.

The railroads are learning from these experiences what the expectations and needs are for the state and federal agencies and have begun to make changes to how they plan for and respond to incidents. As an example, two railroads are working with NIMS/ICS consultants to assess their needs and build an IMS platform complete with training and exercises to implement a company-wide program. Aspects of one program include NIMS/ICS facilitators to accompany responders, developing rail-specific exercises, providing classroom training for their personnel and contractors, and conducting joint drills and exercises with local responders, state, and Federal On-Scene Coordinators.

---

[4] The Oil Pollution Act of 1990 (OPA 90), which was created from Public Law 101-380 and codified in 33 U.S.C. §2701, amended the existing Federal Water Pollution Control Act and Clean Water Act. OPA 90 strengthened laws to prevent the discharge of oil into waters of the United States and the requirements for notification, contingency planning, removal, and environmental remediation.

Limited knowledge of non-railroad personnel. Of the four incidents examined, in three of them participants indicated that the local first responders had little to no experience or training in how to respond to a derailment of crude oil or what the potential risks were from the product. Fortunately, in none of the cases were any of the responders injured. Resources including the Emergency Response Planning Guide had been used to establish an exclusion (or hot) zone with a wide margin of safety. One participant noted that the fire department had training prior to the incident through the Transportation Community Awareness and Emergency Response (TransCAER) program and, because of that training, the Fire Chief increased the safety distance from the burning tank cars and waited for the railroad's hazmat team to arrive. Likewise, another fire department had been through training with the railroad not long before the incident, and it was believed that the Fire Chief felt more confident about being a part of the railroad's operations due to that training.

When asked if it was problem for the railroad hazmat teams to work with inexperienced local first responders, there were no concerns as they had worked together well and had maintained solid communication. One participant stated that the Fire Chief, as the Incident Commander, wanted to be kept in the loop on decisions and have regular meetings, but that he was comfortable with the railroad leading the response operations. The lack of knowledge had been an issue, however, when it was the state or federal officials who did not know how to assess the risk or control the situation. A participant noted several encounters with inexperienced Federal On-Scene Coordinators (FOSCs), each with a very different outcome. During one response operation, the FOSC stood aside and allowed the railroad to respond while on another occasion the FOSC nearly stopped operations in order to get his bearings. Lack of knowledge, it was believed, led to fear and uncertainty which drove that FOSC's decisions.

Working hard to build relationships. Every participant enthusiastically discussed the efforts being made by their organization to develop in-house capabilities for incident management and provide training for first responders and government officials on the hazards associated with crude oil derailments. They also discussed what the railroads are doing to mitigate and control the hazards, and the detailed, location-specific Geographic Response Plans that they are developing to complement their existing emergency response plans.

The focus of one of the railroads is to "start right" meaning that its goal is to build an IMS program that can work for every incident to ensure the responders get off to the best start possible. The initial concept is to build a core team of five to six personnel who are experts in NIMS/ICS and have them deploy with the hazmat response team to implement the ICS process from the very moment they begin their response. This Incident Management Team (IMT) would be modeled off existing IMTs, including FEMA's IMT, but would be supplemented with additional private sector NIMS/ICS experts who could relieve them or be a part of the command structure if needed after the initial assessment is made. In addition to building the IMT, this railroad has begun higher level NIMS/ICS team training for their personnel, response contractors, and consultants in order to build relationships and expertise amongst their response force. In conjunction with this team training, exercises and drills are being developed to train personnel on the issues encountered during a derailment. These exercises are being designed and executed with the collaboration of the local responders and state and federal representatives in order to ensure everyone's exercise objective is met and to build stronger networks.

Another railroad has focused on training first responders, Environmental Protection Agency (EPA) and USCG FOSCs and their staffs, and their own contractors and consultants on how to respond to a derailment of crude oil. One main issue the railroad has encountered is the misconception that all crude oils are alike when in fact every batch is different, and the physical properties make some oils more hazardous than others. This railroad's outreach includes providing, free of charge, classroom training to fire departments and hazmat teams, instruction for all responders and government officials at their in-house training center which contains a hands-on field portion, availability of a mobile training platform (Safety Train), online training curriculum, and support of the Association of American Railroad's training center, Transportation Technology Center, Inc., in Pueblo, Colorado. It was noted that their outreach efforts in 2015 resulted in 6,000 personnel being trained.

The third railroad's focus is on outreach to emergency managers and first responders through the Local Emergency Planning Committees (LEPCs) throughout their operating area. Railroad representatives attend LEPC meetings where preparedness activities are performed, provide first responders continuous education and training through programs including TransCAER, Safety Train, and the Transportation Technology Center, Inc., and participate in numerous exercises and drills with its spill management team. Additionally, exercises involving state and federal emergency managers and responders are developed and executed approximately 40 times a year, thereby expanding their outreach to all levels of government.

Summary

The five interviews revealed common themes uniting the experiences and opinions of railroad first responders. The first major theme discovered was that railroads followed a pattern when responding to derailments of hazmat and that the pattern did not change substantially for derailments involving bulk crude oil. The railroad first responders and their contracted support personnel understood the operations that needed to be performed and in which order. Left as the primary response force, railroads were equipped and prepared to respond to derailments with little to no support from outside agencies. However, when outside agencies became involved and inserted themselves in to the decision making, as was done when a unified command was stood up, operations were often inhibited until everyone was comfortable with the operations.

The second major theme found was that how formally NIMS/ICS was used determined how well it was able to be implemented at the time of the incident. All participants indicated familiarity with NIMS/ICS but felt that modifying it to fit the circumstances and size of the incident made its use feasible. Strict adherence to the IMS appeared to lead to creating large incident management teams independent of the incident’s actual need. Likewise, strict adherence was seen as slowing down the process, especially during the emergency phase, when operations begin and end quickly.

The third theme uncovered the lack of experience first responders outside of the railroad have with derailments, in particular those involving bulk crude oil. Statistically, due to the 160,000 miles of track and the relatively few incidents that occur, this was not unexpected. The railroad participants all indicated, though, that the lack of first responder experience was not an issue as long as they took initial actions according to the

Emergency Response Guide or used the information provided by the railroad. In fact, fire departments appeared to defer to the expertise of the railroads when involved in an incident which enabled the railroad responders to act swiftly and decisively.

The fourth and final theme was that of introducing new programs or reviving old ones to build partnerships with communities as well as regulatory agencies. All of the participants discussed the actions their railroads were doing to move forward with adopting and implementing NIMS/ICS, preparedness initiatives, and cross-organizational training. All of their programs were geared towards building relationships or renewing existing ones so that their first encounter with other responding agencies was not when there was a derailment. Collectively, these themes uncover the challenges but also shed light on potential opportunities that may both improve the railroads' use of NIMS/ICS and lay the foundation for a solid response network in the future. Chapter V follows with a discussion of the findings and recommendations for future studies.

V. Discussion

Introduction

Due to the surge in hydraulic-fracturing around 2009, railroads have had to increase exponentially, year after year, the amount of bulk crude oil they transport across the United States (Association of American Railroads, 2015d). The crude oils they haul, however, have a range of chemical and physical properties with some of the oils containing above average concentrations of dissolved gases which makes them light crude oils (National Response Team, 2014). These light crude oils behave more like fuel oils and are prone to ignite if there is a sudden release during a derailment (National Response Team, 2014). The potential hazards associated with the transportation of bulk crude oil (especially the light crude oils) gained national attention after the Lac-Mégantic, Quebec, derailment in Canada in 2013 caused the massive destruction of a town and took the lives of 47 people (Kolpack & MacPherson, 2013; Nelson, 2013; Vartabedian, 2015; Wronski, 2015).

With the additional attention, federal and state emergency responders and regulators have begun to oversee crude oil derailment response operations more closely and oftentimes expect the railroad personnel to use the same IMS they use—NIMS/ICS (Pipeline and Hazardous Materials Safety Administration, 2014). The railroads have not historically used NIMS/ICS as formally as the public response agencies and have found its adoption and implementation to be challenging. The railroad culture is to use their own, streamlined IMS, operate quickly with few personnel, and contract the services of wreckers, hazmat responders, and safety, health, and environmental consultants. The additional push by governmental agencies to use NIMS/ICS for incidents appears, to the railroad, to slow down response operations.

The purpose of this qualitative study was to examine the incident- and organizational-specific characteristics of planning for and responding to bulk crude oil cargo derailments to see how well they aligned with the characteristics found by researchers including Buck et al. (2006) and Jensen and Waugh (2014) that enable the use of NIMS/ICS. This research will inform the field of Emergency Management because it characterizes incident- and organizational-specific characteristics pertaining to bulk crude oil derailments and uncovers potential difficulties in using NIMS/ICS during these types of derailments. This data may be used to fill the gaps in understanding which features of NIMS/ICS are suitable for use during a crude oil derailment response and which ones should be further investigated. Once understood, the gaps can be addressed, thereby enabling railroads, first responders, and local, state, and federal governmental agencies to implement NIMS/ICS more effectively and collaboratively.

Derailments in the United States during 2010–2015 that resulted in a spill were considered as the boom in hydraulic-fracturing did not begin until around 2009; however, no incidents fit this description until 2013. From 2013–2015 there were 12 incidents, but only two of them had their formal governmental investigative reports available to the public. To fill the data gaps and to gain perspective from the railroads that had been involved in an incident, interviews were conducted with five hazmat and environmental personnel from three Class I railroads. The interviews were semi-structured and followed a line of questioning to uncover incident- and organizational-specific characteristics relating to recent events. Four incidents were included in the results.

The literature review found numerous incident-specific characteristics thought to enable the use of NIMS/ICS. Incident-specific characteristics included sufficient responder resources, responders trained and experienced in the type of incident, previous collaboration and coordination of response agencies, low incident complexity, and low risk response operations. These characteristics along with several others were compared with the four examined incidents and are summarized in Appendix D. Organizational-specific characteristics were not included in the table but were summarized in the Findings.

Discussion

Four themes emerged from the research and the interviews, and they were (1) derailments of crude oil have very similar properties and require similar response strategies; (2) railroad hazmat and environmental teams are finding strict adherence to NIMS/ICS difficult; (3) first responders not affiliated with the railroads have limited knowledge on how to respond to derailments and the risks involved; and (4) railroads are working hard to build relationships and train responders. There is overlap between the themes with the overarching theme being that there are common concerns about using NIMS/ICS among railroad hazmat and environmental responders, but that each of these railroads is working to implement NIMS/ICS as their IMS. Using the incident- and organizational-specific characteristics thought to enable the use of NIMS/ICS discussed in Chapter II, this section discusses how the response- and agent-generated demands faced by the railroads during crude oil derailments may be addressed.

Similar properties and response strategies. Despite the differences in types of cargos, locations, and the responding organizations involved, railroads have similar strategies and protocols for responding to derailments of bulk crude oil that result in a spill with or without a fire and/or explosion. For the three incidents discussed during the interviews, each participant felt that the railroad was well prepared and equipped to respond no matter the circumstances involved. Even though the hauling of bulk shale crude oil is relatively new, as far as the quantities being shipped, each railroad has moved bulk hazmat since their inception. Their training and expertise in responding to hazmat, many of which also pose fire and explosion hazards, appears to have enabled them to transition seamlessly to responding to spills of bulk crude oils, even the more flammable ones.

Perhaps unique to the railroad industry, due to their extensive network of 160,000 miles of track and the oftentimes remote locations where they operate, railroads ordinarily operate autonomously when there is an emergency, calling upon preselected and trained contractors and consultants to support operations (Association of American Railroads, 2016a). This history of independence seems to not have been often questioned, however, until recently with the increased public's interest in the shipping of bulk crude oil by rail and the subsequent governmental involvement during response operations. Moreover, federal and state governmental oversight increases considerably when the crude oil impacts or has the risk of impacting waters of the United States due to the OPA 90 regulations.

The potential negative impacts of this oversight appear to vary and depends on the external parties, not on the railroad involved or incident complexity, severity, or proximity to a large population. Key to the successfulness of the response operations and ability to use NIMS/ICS effectively, according to the findings, appears to be the preexisting trust and respect of the local responders and the organizations' willingness to "modify" NIMS/ICS process to meet the operational demands—response-generated factors that, so far, appear to be inconsistent. This finding is supported by the data as shown in the Appendix D comparison table. In three of the four derailments, local first responders were not trained for derailments, the railroad personnel had not worked previously with the first responders, and no prior coordination had occurred. These factors appear to have hindered joint operations more than the incidents' level of complexity, severity, or number of emergent organizations.

These findings suggest that if railroads can network with local, state, and federal emergency managers and responders and if they can train first responders on crude oil derailment operations, they may be able to close the IMS gaps created by these issues. For example, railroads may be able to use the similarities in response operations to build upon NIMS/ICS enabling factors including creating a shared vision, building trust, and reducing uncertainty and complexity (Buck et al., 2006; Jensen & Waugh, 2014; Moynihan, 2009). One possibility is to have the railroads create universal, template Incident Action Plans for derailments of crude oil. These plans would not address all of the incident-specific response- or agent-generated demands created during a derailment, but they may be able to cover a majority of the ones found at most incidents including the strategies, tactics, work assignments and tasks, and communication systems [response-generated], and type of materials involved [agent-generated]. These plans could then be reviewed by other response agencies to confirm their understanding and agreement. If possible, for high risk locations, risk assessments and plans could be developed collaboratively with local, state, and federal resources included, and incorporated into existing local emergency response plans. This effort would put into practice the finding that collective preplanning leads to NIMS/ICS working more effectively (Buck et al., 2006).

Additionally, railroads may be able to leverage the property and response similarities of crude oil derailments by continuing to develop and offer training and education programs for first responders. Training first responders takes time and resources. By expanding on current emergency response training programs to include the hazards and response tactics unique to crude oil derailments, railroads may be able to facilitate the integration of new information into existing educational material. Similarly, training may be used to demonstrate how well planned and executed railroad response operations are. These efforts may build the trust and gain the confidence of other response organizations, which are key NIMS/ICS enabling factors (Jensen & Waugh, 2014).

Adherence to NIMS/ICS. Railroads have independently developed an IMS that meets their needs, and although it resembles NIMS/ICS in overall organization, the planning process it follows appears to be less rigid than the IMS imposed by federal and state regulators during recent events. The railroad IMS is streamlined and starts with the assumption that they will need to be self-supporting. Railroad responders' plans account for support from local fire departments but do not depend on it, as many past derailments have occurred in remote areas where the fire department is entirely staffed by volunteers with limited training in handling derailments, or where the fire department is physically unable to reach the incident site.

It may appear that the need to be self-sufficient created a culture of independence within the railroads that makes integrating into an external command and control structure difficult for them. However, the interviews did not indicate that this was a factor. For the railroads, the need to use a prescribed IMS does not seem to be the main hurdle; it appears, rather, that their lack of experience and preplanning using NIMS/ICS has hindered its successful adoption and implementation. Compounding this problem is that NIMS/ICS is only *required* when governmental agencies join the response and form a unified command. Because this currently only occurs when there is an actual or potential spill of oil into waters of the United States, railroads may not employ NIMS/ICS for every emergency response operation.

As noted in Chapter II, researchers have found many characteristics thought to enable the use of NIMS/ICS, including a strong organizational commitment to NIMS/ICS, support of transformational leaders, and a system in place to employ NIMS/ICS in planning, training, and exercises (Jensen & Waugh, 2014; Lester, 2007; Moynihan, 2008a; Perry, 2003). Employing these factors may support the railroads as they work towards strengthening their adherence to NIMS/ICS and building their external relationships. For example, railroads may want to reconsider when they use NIMS/ICS and begin implementing it for all incidents. This would be a paradigm shift for several of the railroads who indicated that, contrary to the researchers' findings (Ansell et al., 2010; Buck et al., 2006), from what they had seen NIMS/ICS was best suited for large, complex incidents, expanding over large geographical areas, including Hurricane Katrina in 2005.

This perception may stem from the limited number of times that the railroads have been required to use NIMS/ICS by the governmental agencies and the infrequency in which crude oil derailments occur. Railroads, having worked predominantly in the past with fire departments that appear to also have their own, streamlined form of NIMS/ICS, have typically found collaboration with the local responders seamless as both parties tend to be flexible, a factor found by Moynihan (2008b) to foster trust among responders. Moving into a large, multi-agency command structure where rules are rigidly enforced seems to add layers and complexity to what is otherwise considered by the railroad personnel a straight-forward operation. More importantly, the use of a multi-agency unified command, so far, appears to slow down the process, adding risk. There may be some truth to the observation—a lack of experience using NIMS/ICS by the railroads may be perceived as incompetence by the governmental responders, resulting in the governmental representatives feeling the need to insert themselves even further into the response operations.

Railroad senior leaders need to become involved, though, if the expectation is to use NIMS/ICS, as resources are needed to develop NIMS/ICS-compliant plans, training, and exercises. Furthermore, in order to maintain skill competency and confidence, railroads will likely need to build a comprehensive system to ensure all elements of the program are developed, maintained, and used for all incidents—a necessary step, according to Jensen and Waugh (2014), if leadership desires personnel to achieve and maintain expertise. Using NIMS/ICS for all response operations should hone their skills and improve their proficiency as well. Next, contractors and consultants, as needed, should be trained and begin using NIMS/ICS regularly to ensure the railroad IMT has sufficient personnel depth. Eventually, railroads may consider including public sector organizations and governmental agencies in their planning, training, and exercises in order to build relationships and trust, coordinate plans, and to begin to agree upon response strategies and tactics. Use of the aforementioned NIMS/ICS-compliant Incident Action Plans may bolster these efforts.

Limited knowledge of non-railroad personnel. Just as the railroad's lack of experience in using NIMS/ICS has made collaboration with some external responding organizations more tenuous, so has the lack of experience in responding to train derailments by those organizations. Inexperience appears to become an issue primarily when state and/or federal command personnel do not trust the responding railroad personnel or want to become more familiar with strategies and tactics before Incident Action Plans are approved. Researchers have found that when responders are not familiar with the response operations and have not had incident-specific training, implementing NIMS/ICS is difficult (Buck et al., 2006; Jensen & Waugh, 2014). Further diminishing the effectiveness of NIMS/ICS is the need to perform new tasks within a new, emergent organization (Lutz & Lindell, 2008). Although, some of the impetus to train outside responders lies with the railroads, local, state, and federal responders should be equally held accountable to learn these types of response operations if public responders could be involved.

This finding opens opportunities for the railroads to network and create partnerships with other response organizations and governmental agencies—activities found to enable NIMS/ICS (Jensen & Waugh, 2014). For example, developing strategies and tactics and decision-making protocols are two response-generated demands that can be performed collaboratively by all response organizations prior to an incident. Response organizations and governmental agencies may find that working with the railroads to understand their existing emergency response plans, standard operating procedures, and safety systems enables them to support operations immediately upon arrival.

Not only do the railroads need to take into account the needs of the local community in their plans, the state and local plans need to address derailments. To support this endeavor, the railroads should continue their outreach using tools including TransCAER and the Safety Train, perform outreach to federal agencies through the regional offices in the states where they operate, educate other responders on their operations, offer no- or low-cost training, and jointly plan and exercise response plans. These efforts may build the competence and confidence of local, state, and federal first responders, thereby reducing the incident's complexity and uncertainty and enabling NIMS/ICS to be more effective (Buck et al., 2006).

Working hard to build relationships. As seen by a few of the railroad personnel interviewed, not all of the other response organizations trust that the railroads will respond to a derailment with the interests of the community or environment in mind. Although none of the research has indicated that railroad responders do not keep public safety and environmental health a first priority, when governmental first responders distrust the railroads, response operations appear to be impeded, as does the formation of an effective IMS. Compounding this distrust may be the fear that the derailment will cause a fire or explosion putting the safety and health of the community and local responders at risk. State and federal agencies, because they have not worked with the railroads before, may be unfamiliar with their established response strategies and suspect their "agenda." Furthermore, without previous experience and understanding of railroad operations, response activities may appear to these agencies to be rushed and unorganized and, therefore, unsafe.

Because of the nearly universal lack of familiarity with railroad response operations for responders outside of the railroad community, each participant discussed the ways in which his/her railroad is reaching out to public organizations and governmental agencies to build stronger relationships. The railroads have employed different but overlapping techniques including developing hands-on and online training materials, networking at meetings and conferences, developing and holding multi-agency exercises, and reaching out to local experts to develop Geographic Response Plans. In order to "start right," each railroad is taking action to improve relationships with stakeholders and other response organizations and is updating response plans and training programs to include the possible establishment of a NIMS/ICS command structure during future incidents.

The railroads' efforts are backed by research which has found that the use of NIMS/ICS is enhanced when there is a high level of trust and prior planning or networking between responding organizations, an understanding by the responders of the incident hazards and how to respond, and incident-specific training (Bennett, 2011; Jensen & Waugh, 2014; Moody, 2010; Perry, 2003). Expanding on these efforts, railroads may find that working with regional EPA and USCG Sector offices builds relationships and creates a shared vision with the federal agencies most likely to oversee response operations and dictate the style in which NIMS/ICS is used. Trust from the federal agencies involved may lead to trust from the state and local representatives. Resource and time allowing, railroads may also consider expanding first responder outreach to state agencies, including those that govern environmental quality and natural resources, as they may be represented within the command structure. These initiatives appear to be in the direction desired by the federal government as they are similar to the National Preparedness for Response Exercise Program (PREP) Guidelines (Department of Homeland Security/United States Coast Guard, Environmental Protection Agency, Department of Transportation/Pipeline and Hazardous Materials Safety Administration, & Department of the Interior/Bureau of Safety and Environmental Enforcement, 2016) developed post-OPA 90 by several federal agencies to help industry understand their requirements. If this is the case, railroads should be in-line with possible upcoming changes to existing regulations and able to collaborate more directly with USCG and EPA, the two main agencies that use PREP.

Methodological Insights

There were several challenges with this study with the main one being the ability to obtain objective information about the incident- and organizational-specific characteristics of bulk crude oil derailments. Due to the recency of the issue and their infrequency, only two of the federal investigations had been completed and were available for review. With respect to the railroads, all but one of the incidents discussed by the participants were still under investigation or had pending litigation which restricted their ability to give incident preparedness and response details or personal opinions. This lack of information reformed the emphasis of the study which broadened from a direct comparison of characteristics, to obtaining a better understanding of how railroads can work towards implementing NIMS/ICS more effectively. Should this type of study be reconsidered, expanding the scope to include similar incidents (e.g., derailments of hazmat) may produce more comprehensive data as they occur more frequently, have occurred over a longer period of time, and there are numerous federal investigative reports available to the public.

Another challenge encountered included obtaining interviews from Class I railroad responders due to their limited numbers and time constraints. All of the personnel reached graciously agreed to be interviewed or were able to provide another representative. One of the responders interviewed had not responded to a bulk crude oil derailment, but had been on several hazmat incidents and was knowledgeable about the issues surrounding the railroads' use of NIMS/ICS for derailments. Future studies may consider also interviewing non-railroad affiliated personnel who have responded to crude oil derailments to add depth and breadth to the findings.

Recommendations for Future Study

This study considered how NIMS/ICS enabling incident- and organizational-specific characteristics align with those found at derailments of bulk crude oil, but did not fully answer how to use the findings of which characteristics were misaligned to close the IMS gaps. Broad recommendations were made as to how the railroads can network and support first responders and local, state, and federal governmental agencies as they prepare for and respond to derailments, but it is unknown if these actions will facilitate the use of NIMS/ICS during the response. Past research indicates that these are the steps necessary to enable the use of NIMS/ICS, but until these steps have been completed, they cannot be assessed.

I recommend future study to track the efforts of the railroads as their processes evolve to incorporate NIMS/ICS to see if they met their goals and objectives, and to determine which of the changes led to the most substantial improvement in their ability to execute a crude oil derailment response operation using NIMS/ICS. This research should start immediately as these findings show that the current governmental expectations are for railroads to be able to use NIMS/ICS when there is derailment. Railroad emergency managers and contingency planners may also consider working collectively within their industry to create standardized organizational charts, template Incident Action Plans, and training programs for first responders. These actions may reduce the uncertainty for first responders and governmental agencies, thereby facilitating the use of NIMS/ICS.

Conclusions

The purpose of this study was to examine how well aligned the characteristics of a bulk crude oil derailment resulting in a spill were with those found to enable the use NIMS/ICS in order to understand and close the gaps preventing railroads from its effective use. This purpose was partially achieved through interviews and case studies, although objective information was limited, and participants were not at liberty to discuss the details of many of the incidents. The research discovered that although there are several incident-specific characteristics that make NIMS/ICS less suitable for responses to bulk crude oil derailments, the railroads are pursuing its use due to governmental oversight and the need to have a common IMS during multi-agency operations. Building upon this data, future research is needed to determine which, if any, of the changes railroads are implementing are improving the efficiency and efficacy of using NIMS/ICS during derailments.

References

15 C.F.R. (Code of Federal Regulations) §754.2 (2012).

49 C.F.R. §105.5 (2011).

Abbasi, J. (2015, November 9). The fight to stop an oil pipeline (on rails) in its tracks. Retrieved (Sept. 2016) from http://www.audubon.org/news/the-fight-stop-oil-pipeline-rails-its-tracks

Anderson, A. I., Compton, D., & Mason, T. (2004). Managing in a dangerous world--The National Incident Management System. *Engineering Management Journal, 16*(4), 3-9.

Annelli, J. F. (2006). The national incident management system: A multi-agency approach to emergency response in the United States of America. *Revue scientifique et technique-Office international des épizooties, 25*(1), 223.

Ansell, C., Boin, A., & Keller, A. (2010). Managing transboundary crises: Identifying the building blocks of an effective response system. *Journal of Contingencies and Crisis Management, 18*(4), 195-207.

Association of American Railroads. (2014a). Freight railroads join U.S. Transportation Secretary Foxx in announcing industry crude by rail safety initiative. Retrieved (Sept. 2016) from https://www.aar.org/newsandevents/Press-Releases/Pages/Freight-Railroads-Join-U-S-Transportation-Secretary-Foxx-in-Announcing-Industry-Crude-By-Rail-Safety-Initiative.aspx

Association of American Railroads. (2014b). Railroads and community safety. Retrieved (Sept. 2016) from https://www.aar.org/Fact%20Sheets/Safety/Railroads %20and%20Community%20Safety%20Fact%20Sheet.pdf

Association of American Railroads. (2015a). Railroad 101. Retrieved (Sept. 2016) from https://www.aar.org/Pages/Railroad-101.aspx

Association of American Railroads. (2015b). Chronology of crude-by-rail safety actions taken by the freight rail industry. Retrieved (Sept. 2016) from https://www.aar.org/Fact Sheets/Safety/CBR chronology_April 30 2015.pdf

Association of American Railroads. (2015c). Moving crude oil safely by rail. Retrieved (Sept. 2016) from https://www.aar.org/BackgroundPapers/Moving%20Crude%20Oil%20Safely%20by%20Rail.pdf

Association of American Railroads. (2015d). U.S. rail crude oil traffic. Retrieved (Sept. 2016) from https://www.aar.org/BackgroundPapers/US%20Rail%20Crude%20Oil%20Traffic.pdf

Association of American Railroads. (2016a). Class I railroad statistics. Retrieved (Sept. 2016) from https://www.aar.org/Documents/Railroad-Statistics.pdf

Association of American Railroads. (2016b). Emergency response. Retrieved (Sept. 2016) from https://www.aar.org/todays-railroads/safety

Bennett, B. (2011). Effective emergency management: A closer look at the incident command system. *Professional Safety, 56*(11), 28-37.

Bigley, G. A., & Roberts, K. H. (2001). The incident command system: High-reliability organizing for complex and volatile task environments. *Academy of Management Journal, 44*(6), 1281-1299.

BNSF. (2015). BNSF service overview. Retrieved (Sept. 2016) from http://bnsf.com/customers/service-page/index.html

Buck, D. A., Trainor, J. E., & Aguirre, B. E. (2006). A critical evaluation of the incident command system and NIMS. *Journal of Homeland Security and Emergency Management*, *3*(3).

Campbell, B. (2013, October 22). The Lac-Mégantic disaster: Where does the buck stop? *Canadian Centre for Policy Alternatives*. Retrieved (Mar. 2014) from https://www.policyalternatives.ca/publications/reports/lac-m%C3%A9gantic-disaster

Chen, R., Sharman, R., Rao, H. R., & Upadhyaya, S. (2007). Design principles for critical incident response systems. *Information Systems and eBusiness Management*, *5*(3), 201-227. Retrieved (Nov. 2015) from doi:10.1007/s10257-007-0046-0

Chen, R., Sharman, R., Rao, H. R., & Upadhyaya, S. J. (2008). An exploration of coordination in emergency response management. *Communications of the ACM*, *51*(5), 66-73.

Common Carrier Transportation, Service and Rates Act, 49 U.S.C. § 11101 (1995).

Constantino, M. & Murphy, M. (2015, Feb 16). Crude oil train derails in Fayette County, WV. *Charleston Gazette*. Retrieved (Sept. 2016) from http://www.wvgazettemail.com/article/20150216/DM01/150219449

Dangerous Goods Transport Consulting, Inc. (2014). A survey of Bakken crude oil characteristics assembled for the U.S. Department of Transportation. Retrieved (Sept. 2016) from http://www.afpm.org/crude-oil-and-natural-gas/

Deal, T., de Bettencourt, M., Huyck, V., Merrick, G., & Mills, C. (2006). Beyond initial response: Using the national incident management system's incident command system. Bloomington, IN: AuthorHouse.

Department of Homeland Security. (2003). Homeland security presidential directive/ HSPD-5: Management of domestic incidents. Retrieved (Sept. 2016) from https://www.dhs.gov/publication/homeland-security-presidential-directive-5

Department of Homeland Security/Federal Emergency Management Agency. (2008). National incident management system. Retrieved (Sept. 2016) from https://www.fema.gov/pdf/emergency/nims/NIMS_core.pdf

Department of Homeland Security/United States Coast Guard, Environmental Protection Agency, Department of Transportation/Pipeline and Hazardous Materials Safety Administration, and Department of the Interior/Bureau of Safety and Environmental Enforcement. (2016). 2016 National Preparedness for Response Exercise Program (PREP) Guidelines. Retrieved (Sept. 2016) from https://www.bsee.gov/sites/bsee_prod.opengov.ibmcloud.com/files/final_2016_prep_guidelines.pdf

Dobuzinskis, A. (2015, July 17). Montana train derailment spilled 35,000 gallons of crude oil. *Reuters*. Retrieved (Sept. 2016) from http://www.reuters.com/article/2015/07/17/us-usa-derailment-montana-idUSKCN0PR24R20150717

Earth Justice. (2015). Crude by rail across America. Retrieved (Sept. 2016) from http://earthjustice.org/features/map-crude-by-rail

Energy from Shale. (2015). What is shale gas? Retrieved (Sept. 2016) from http://www.energyfromshale.org/articles/what-shale-gas

Environmental Protection Agency. (2015a). Key elements to include in a facility response plan (FRP). Retrieved (Sept. 2106) from http://www2.epa.gov/oil-spills-prevention-and-preparedness-regulations/key-elements-include-facility-response-plan-frp

Environmental Protection Agency. (2015b). Emergency planning and community right-to-know act (EPCRA). Retrieved (Sept. 2016) from http://www2.epa.gov/epcra

Federal Railroad Administration. (2015a). Railroad safety – divisions overview. Retrieved from https://www.fra.dot.gov/Page/P0397

Federal Railroad Administration. (2015b). Accident data & reporting, investigations. Retrieved (Sept. 2016) from https://www.fra.dot.gov/Page/P0037

Friedlaender, A. F., Berndt, E. R., & McCullough, G. (1992). Governance structure, managerial characteristics, and firm performance in the deregulated rail industry. *Brookings Papers on Economic Activity,* 95-186.

Frittelli, J., Parfomak, P. W., Ramseur, J. L., Andrews, A., Pirog, R., & Ratner, M. (2014). US rail transportation of crude oil: Background and issues for congress. CRS report, Washington: Congressional Research Service.

Gold, R., & Stevens, L. (2014, February 26). U.S. issues emergency testing order to crude oil rail shippers: Move by transportation department response to crude-by-rail accidents. Wall Street Journal. Retrieved (Sept. 2016) from http://www.wsj.com/articles/SB10001424052702303880604579405412862500426

Hays, K. (2014, May 13). Safety debate eyes taming Bakken crude before it hits rail. *Rueters*. Retrieved (Sept. 2016) from http://www.reuters.com/article/2014/05/12/us-davegrailways-safety-crude-idUSBREA4B0JD20140512#7Hy4ro6uBGjfGQJJ.97

Jensen, J., & Waugh, W. L. (2014). The United States' experience with the incident command system: What we think we know and what we need to know more about. *Journal of Contingencies & Crisis Management, 22*(1), 5-17. doi:10.1111/1468-5973.12034

Johnson, D. (2015). Blood, sweat & fears on the Bakken oil field. *ISHN, 49*(6), 1-1,30,32,34.

Karlamangla, S. (2013, November 9). Train in Alabama oil spill was carrying 2.7 million gallons of crude. *Los Angeles Times*. Retrieved (Sept. 2016) from http://www.latimes.com/nation/nationnow/la-na-nn-train-crash-alabama-oil-20131109-story.html

Kim, J. K. (2007). *Three essays on critical incident management systems* (Doctoral dissertation, State University of New York, Buffalo). Retrieved (Nov. 2015) from http://search.proquest.com/docview/304766972?accountid=8364

Klass, A. B., & Meinhardt, D. (2015). Transporting oil and gas: U.S. infrastructure challenges. *Iowa Law Review, 100*(3), 947-1053.

Knapp, J., Watson, P., & Frangella, L. (2008). Responding safety to railroad emergencies: Locomotive systems and operation. *Fire Engineering, 161*(11), 55-62.

Knapp, J., & Lunsford, M. (2004). Responding to railroad emergencies: Understanding the railroad system-Firefighter safety depends on knowing how to protect against the hazards inherent in rail operations. *Fire Engineering*, *157*(11), 57-66.

Kolpack, D., MacPherson, J. (2013, December 31). Safety questions after ND oil train derailment. *Associated Press*. Retrieved (Nov. 2015) from http://www.denverpost.com/music/ci_24821236/weather-shift-near-nd-derailment-worries-officials

Leedy, P. D. & Ormrod, J. E. (2013). *Practical research: Planning and design*. Upper Saddle River, New Jersey: Pearson Education Inc.

Lester, W. (2007). Transformational leadership and NIMS. *The Public Manager*, *36*(3), 11-16.

Liu, X., Saat, M., & Barkan, C. (2012). Analysis of causes of major train derailment and their effect on accident rates. *Transportation Research Record: Journal of the Transportation Research Board*, (2289), 154-163.

Lutz, L. D., & Lindell, M. K. (2008). Incident command system as a response model within emergency operation centers during Hurricane Rita. *Journal of Contingencies and Crisis Management*, *16*(3), 122-134.

McDonald, C. (2014). Safety rules put railroads back on track. *Risk Management*, *61*(3), 8-8,10.

Moody, T. J. (2010). *Filling the gap between NIMS/ICS and the law enforcement initial response in the age of the urban jihad* (Doctoral dissertation, Naval Postgraduate School, Monterey, California). Retrieved (Sept. 2016) from http://www.dtic.mil/dtic/tr/fulltext/u2/a531492.pdf

Moynihan, D. P. (2008a). Combining structural forms in the search for policy tools: Incident command systems in US crisis management. *Governance, 21*(2), 205-229.

Moynihan, D. P. (2008b). Learning under uncertainty: Networks in crisis management. *Public Administration Review, 68*(2), 350-365.

Moynihan, D. P. (2009). The network governance of crisis response: Case studies of incident command systems. *Journal of Public Administration Research and Theory, 19*(4), 895-915.

National Response Team. (2014). Emerging risks responder awareness training: Bakken crude oil [presentation]. Retrieved (Sept. 2016) from http://rrt10nwac.com/Files/FactSheets/140930125335.pdf

National Transportation Safety Board. (2013). *Railroad accident brief accident no. DCA-11-FR-001* (NTSB/RAB-13/02). Retrieved (Sept. 2016) from http://www.ntsb.gov/investigations/AccidentReports/Reports/RAB1302.pdf

National Transportation Safety Board. (2014). *Railroad accident report: Conrail freight train derailment with vinyl chloride release, Paulsboro, New Jersey, November 30, 2012* (NTSB/RAR-14/01). Retrieved (Sept. 2016) from http://www.state.nj.us/dca/divisions/dfs/pdf/paulsboro_vinyl_chloride_rpt_by_ntsb.pdf

National Transportation Safety Board. (2015). The investigative process. Retrieved (Sept. 2016) from http://www.ntsb.gov/investigations/process/Pages/default.aspx

National Transportation Safety Board. (2016). *Railroad accident brief: CSXT petroleum crude oil train derailment and hazardous materials release, Lynchburg, Virginia,* *April 20, 2014* (NTSB/RAB-16/01). Retrieved (Sept. 2016) from http://www.ntsb.gov/investigations/AccidentReports/Reports/RAB1601.pdf

Nelson, J. (2013). Lac-Mégantic disaster spurs demands for safe oil transport Oil tanker cars known for years to tear open in accidents. *CCPA Monitor*, *20*(4), 16-17.

Oil Pollution Act, 33 U.S.C. §2701 (1989).

Perry, R. W. (2003). Incident management systems in disaster management. *Disaster Prevention and Management*, *12*(5), 405-412.

Pipeline and Hazardous Materials Safety Administration. (2014). Crude oil rail emergency response: Lessons learned roundtable report. Retrieved (Sept. 2016) from https://www.hsdl.org/?view&did=764937

Quarantelli, E. L. (1997). Ten criteria for evaluating the management of community disasters. *Disasters, 21*(1), 39-56.

Spraggins, H. B. (2010). The case for rail transportation of hazardous materials. *Journal of Management and Marketing Research*, *3*, 1.

Sussman, A. L. (2013, November 12). Analysis: As Alabama derailment flames fade, new oil-by-rail questions arise. *Reuters*. Retrieved (Sept. 2016) from http://www.reuters.com/article/2013/11/13/us-oil-train-risks-analysis-idUSBRE9AC02U20131113

Thomas, D. (2015, May 1). DOT-117 tank car rule debuts with controversy. *Railway Age*. Retrieved (Sept. 2016) from http://www.railwayage.com/index.php/regulatory/dot-117-tank-car-rule-debuts-with-some-controversy.html

Transportation Safety Board of Canada. (2014). Lac-Mégantic runaway train and derailment investigation summary. Retrieved (Sept. 2016) from http://www.tsb.gc.ca/eng/rapports-reports/rail/2013/r13d0054/r13d0054-r-es.pdf

Valentine, K. (2015, February 16). Oil train derails in Canada, spills unknown amount of crude oil. *Climate Progress*. Retrieved (Sept. 2016) from http://thinkprogress.org/climate/2015/02/16/3623379/oil-train-derails-in-canada/

Vartabedian, (2015, October 7). Why are so many trains crashing? Track problems may be to blame. *Los Angeles Times*. Retrieved (Sept. 2016) from http://touch.latimes.com/#section/-1/article/p2p-84538493/

Wells, P., & Hutchins, A. (2013). How could this happen? *Maclean's*, *126*(28), 1.

Werner, M. (2015). The state of rail: Untangling the issues. Retrieved (Sept. 2016) from http://www.house.leg.state.mn.us/comm/docs/9a9916ba-7d24-46d1-9299-a32a6d985f55.pdf

Wronski, R. (2015, March 6). BNSF: Oil train derailment near Galena involved safer tank cars. Associated Press. Retrieved (Sept. 2016) from http://my.chicagotribune.com/#section/-1/article/p2p-82985886

Appendix A

Summary of Survey Questions

1. Incident demographics (incident is a derailment of crude oil that resulted in a spill or release)

   a. Date
   b. Time
   c. Location
   d. Proximity to town and size of town
   e. Incident features (Fire? Spill?)
   f. Local jurisdictions for location
   g. Severity of incident or overall risk (qualitative assessment)
   h. Were the news media involved? How much? How long? Was press positive or negative?

2. Response organizations

   a. Who responded (organizations, agencies, NGOs, etc.) (Incident Command System (ICS) organizational charts with agency/organization identification is fine)
   b. Number and type of railroad responders (estimates are fine)
      i. Railroad personnel
      ii. Contractors
      iii. Consultants
      iv. Other?

3. Response operations

   a. What tasks were performed? (e.g., ICS-204 forms)

b. Did the response have an appropriate level and type of equipment needed?

c. Did the equipment arrive when needed or when expected?

4. Non-railroad (RR) technical knowledge

a. What was the technical knowledge (qualitative) of the non-RR affiliated responders (e.g., fire, police, emergency medical services (EMS), U.S. Coast Guard (USCG), Environmental Protection Agency (EPA), Department of Environmental Quality (DEQ), etc.) on how to respond to a train derailment of crude oil? (In other words, were they familiar with your response operations or was this a new type of incident for them?)

b. Did the non-railroad affiliated organizations and agencies understand the hazards and their associated risks?

c. Were the non-railroad affiliated organizations and agencies able to prioritize the risks/threats accurately?

5. Was there an incident management system (IMS)? If yes – please describe (Was it the National Incident Management System/Incident Command System (NIMS/ICS) or another IMS? Who was in the command? Was there a unified command? Was it represented by state, local and/or federal agencies, etc.?)

6. Time/duration

a. Did the response operations or command grow over time? (e.g., Did more responders or government representative appear as the incident progressed?)

b. How long did the emergency phase last?

c. How long did the recovery / remediation phase last?

7. Planning

    a. Prior to the incident had there been preplanning for derailments of bulk crude oil shipments by the RR?
    b. Prior to the incident had there been preplanning for derailments of crude oil or hazmat by the RR with local response agencies or state agencies?
    c. Prior to the incident had there been preplanning for derailments of crude oil or hazmat by the RR with Federal agencies, including EPA, USCG, or Federal Emergency Management Agency (FEMA)?
    d. Prior to the incident, do you know if any local or state agencies had performed preplanning for derailments of any type?

8. Inter-agency Climate

    a. If non-RR organizations or governmental agencies were involved, did you feel that there was trust or a shared vision between you and them?
    b. If not immediately present, did the trust or shared vision grow as the response operations matured? Describe climate of the operations.

9. Personnel Expertise and Experience

    a. What was, prior to the incident, the level (subjective/qualitative) of NIMS/ICS training, experience and expertise of the:
        i. RR responders
        ii. Local
        iii. State
        iv. Federal
        v. Contractors and consultants

b. Had the railroad responders performed drills or exercises using NIMS/ICS prior to incident?

10. Does the railroad organization as a whole (from the most senior leaders down to the field personnel) support the implementation and use of NIMS/ICS for all response operations? Describe any programs, policies or procedures in place currently and if applicable, plans going forward.

11. Any additional information about the incident or the railroad that would help in understanding its characteristics or response operations.

Appendix B

**Informed
Consent Form**

**Arkansas Tech
University**

Title of Project: Responding to Train Derailments of Crude Oil Cargos and the Use of NIMS/ICS

Principal Investigator: Laura Hartline Weems

Other Investigators: None

Participant's Printed Name: ____

Section 1. Introduction
I am in graduate school at Arkansas Tech University and am performing research for my thesis on derailments of bulk crude oil and the use of the National Incident Management System and Incident Command System (NIMS/ICS).

The question that I am addressing with this research study is what are the incident and organizational-specific characteristics of planning for and responding to derailments of bulk crude oil that result in a spill or release.

The purpose is to gain a better understanding of the characteristics of these responses and compare them to the incident and organizational-specific characteristics found by researchers to facilitate the use of NIMS/ICS, such as those found at marine oil spills. The goal is to provide railroads and governmental agencies and organizations information that can help them with planning for and responding to future derailments of bulk crude oil.

Taking part in this research study is completely voluntary. If you decide to participate, you are free to withdraw your consent and to discontinue participation at any time. Likewise, at any time during the interview, you may choose to stop the interview or retract information. Otherwise, completion of the survey indicates your consent to participate in the survey. Your comments within this study will not be identified as your own.

Section 2. Procedures

This study is being performed by doing research and interviews with emergency responders from the Class I railroads that operate in the United States. The focus is on those railroads that have responded in the past 13 years to derailments of bulk cargos of crude oil that resulted in a spill or release. You will be asked questions concerning the characteristics of planning for and responding to derailments of crude oil, and I will transcribe those notes electronically.

This information will be combined with other case study information and details with respect to the railroad(s) involved, names of interviewees or responders, or other information that may disclose sensitive or personally identifiable information will be removed.

Section 3. Time Duration of the Procedures and Study

If you agree to take part in this study, your involvement will last approximately one to one and a half hours.

Section 4. Discomforts and Risks

There are no known risks associated with this study.

Section 5. Potential Benefits

1) Through this research, there is the possible benefit that railroad emergency management and response personnel will obtain a better understanding of what incident and organizational-specific characteristics are most suitable for using the National Incident Command System / Incident Command System during an emergency response. This information should provide railroad emergency planners and responders with a better understanding of how the characteristics of crude oil derailment planning and response operations make NIMS/ICS more or less suitable as their incident management system. Having this knowledge should enable railroads to plan for and respond to derailments in a manner that minimizes or eliminates the risks posed by misaligned characteristics.

2) Likewise, through this research, there is the possible benefit that governmental agencies and other organizations responding to derailments of crude oil will become more familiar with the characteristics of bulk crude oil derailment response operations and will obtain a better understanding of how these characteristics make NIMS/ICS more or less suitable as an incident management system when responding. This knowledge should assist these agencies and organizations in planning for and responding to derailments of crude oil as they will have a more complete understanding of the incident and organizational differences between a marine oil spill and a derailment of crude oil and what obstacles the railroads face in using NIMS/ICS.

Section 6. Statement of Confidentiality

Privacy and confidentiality measures

All research material, including hand written and electronic notes taken during interviews will be kept on my personal, password-protected laptop computer or my file cabinet.

Once the thesis has been approved by the committee, all interview files will be either shredded or erased from any electronic media.

In the event of any publication or presentation resulting from the research, no personally or organizational identifiable information will be shared.

The following people/groups may inspect and copy records pertaining to this research.

- The Office of Human Research Protections in the U. S. Department of Health and Human Services
- The Arkansas Tech University Institutional Review Board (a committee that reviews and approves research studies) and
- The Arkansas Tech University IRB Office

Section 7. Costs for Participation

There are no costs for participating in this study.

You will not lose any legal rights by consenting to be a participant.

Section 8. Compensation for Participation

You will not receive any compensation for being in this research study.

Section 9. Research Funding

No funding has been received to perform this research.

Section 10. Voluntary Participation

Taking part in this research study is voluntary. If you choose to take part in this research, your major responsibility will include a phone interview. You do not have to participate in this research. If you choose to take part, you have the right to stop at any time.

Section 11. Contact Information for Questions or Concerns

You have the right to ask any questions you may have about this research. If you have questions, complaints or concerns related to this research, contact Laura Weems at 501-425-5969 (mobile) or my advisor, Dr. Smith, at 479-498-6039 (office).

If you have questions regarding your rights as a research participant or you have concerns or general questions about the research contact the research participant's protection advocate in the Arkansas Tech University's IRB Office at (479) 968-0319. You may also call this number if you cannot reach the research team or wish to talk to someone else.

For more information about participation in a research study and about the Institutional Review Board (IRB), a group of people who review the research to protect your rights, please visit Arkansas Tech University's IRB web site at https://www.atu.edu/research/human_subjects.php. Included on this web site, under the heading "Participant Info," you can access federal regulations and information about the protection of human research participants. If you do not have access to the internet, copies of these federal regulations are available by calling the Arkansas Tech University office at (479) 968-0319.

Verbal Consent/Permission to be in the Research

Participant:

_______________________ __________________ __________

Name of Participant Date verbal consent given Time

Person Explaining the Research: Your signature below means that you have explained the research to the participant/participant representative and have answered any questions he/she has about the research.

_______________________ ________________ ______

Signature of person who explained this research Date Time

____

Printed Name

Appendix C

Summary of Incident-Specific Characteristics for Four Representative Derailments

Incident **Characteristics**	**1- Heimdal, ND**	**2 – Galena, IL**	**3 – Lynchburg, VA**	**4 - Mount Carbon, WV**
Population of impacted county (rounded)	4,000	22,000	55,000	46,000
Incident proximity in miles to urbanized area[5] within state (>50K)	124 (Bismarck, ND)	77 (Rockford, IL)	0 (Lynchburg, VA)	38 (Charleston, WV)
Incident proximity in miles to large metropolitan area (>1M)	420 (Minneapolis, MN)	164 (Chicago, IL)	113 (Richmond, VA)	193 (Columbus, OH)
Had a derailment (of any hazmat or oil) occurred within that county in the previous decade	No	No	No	No
Severity[6] of incident (low, moderate or high)	Moderate	Moderate	Moderate	High
Complexity[7] of incident response (low, moderate or high)	High	High	High	High
Did incident response expand after initial response	No	Yes	No	Yes
Size[8] of incident (spatial)	Small	Small	Small	Small

[5] As defined by the US Census Bureau

[6] Severity is determined by the characteristics of the incident. Low is defined as spill or release only; moderate is a spill or release with a fire and no injuries or illnesses or evacuations; high is a spill with a fire and explosion or injury/illness by residents or responders.

[7] Complexity of incident response is relative to a typical oil spill response on land or water. Low complexity is where there are <4 major tasks; moderate includes 5-8; high includes >8.

[8] Using the "football field" analogy presented by one interviewee, small is less than two fields (<100K ft^2); medium is between two and 10 fields (100K-500K ft^2); large is more than 10 fields (>500K ft^2)

Appendix D

Comparison of NIMS/ICS Enabling Factors to Four Derailments

Incident Characteristic	NIMS/ICS Enabling Factor	Finding: Heimdal, ND	Finding: Galena, IL	Finding: Lynchburg, VA	Finding: Mount Carbon, WV
Availability of local resources for incident type	Sufficient local resources for incident	Not Present	Not present	Present	Not present
Uniqueness of incident for first responders	Having experienced responders for incident type	Not present	Not present	Not present	Not Present
	Having trained first responders for incident type	Not Present	Not present	Present	Not present
Multi-agency response	Responders worked or trained together previously	Not Present	Not present	Present	Not present
	Few organizations responding	Not present	Not present	Present	Not Present
	Few emergent organizations or agencies	Present	Not present	Present	Not present

	Prior coordination and planning	Not Present	Not present	Present	Not present
Level of complexity of incident response	Less complex incidents	Highly complex	Highly complex	Highly complex	Highly complex
Level of severity or risk	Low risk, particularly when pair with low frequency	Moderate	Moderate	Moderate	High
Expansion of incident response over time	Response contracts over time as tasks are accomplished	Present	Not present	Present	Not present
Size of incident	Smaller incidents	Small	Small	Small	Small