Line Handling at American Ports: Decreasing Risk One Line at a Time

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Contents

About the Author

Port of Longview appointed Mark Price as Director of Marine Terminals in October 2017. In this role, he oversees all cargo operations, labor relations, facility security, and fleet management across the Port's marine terminal facilities.

Mr. Price began his waterfront career in 1994 and has since held a broad range of management positions within the maritime and terminal operations sector. Following college, he joined Rogers Terminal and Shipping as a Stevedore Superintendent, where he spent 12 years developing comprehensive expertise in grain terminal operations. During his tenure, he gained in-depth knowledge of the grain industry and traveled extensively to grain elevators throughout Oregon and Washington. In his final years with Rogers Terminal and Shipping, he assumed responsibility for accounting and business systems, further expanding his operational and administrative leadership experience.

He subsequently joined Marine Terminals Corporation as Planning Manager at Terminal 6 in Portland, Oregon, where he spent seven years strengthening his expertise in container terminal management. His responsibilities encompassed marine operations, gate and yard management, and maintenance oversight, providing him with a well-rounded foundation in containerized cargo operations.

In 2013, Mr. Price accepted a leadership position with Kinder Morgan, where he advanced rapidly in the management of export bulk terminals. He developed expertise across key operational areas, including health and safety, finance, environmental compliance and reporting, and operational excellence. He went on to manage one of the largest export bulk soda ash terminals in the United States before being promoted to Director of Operations, with business oversight of three bulk export terminals located in Portland, Vancouver, and Longview.

An Oregon native, Mark earned a Bachelor of Science degree from University of Oregon. He currently resides in Kalama, Washington, and enjoys spending time outdoors in his leisure time.

Acknowledgements

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Abstract

This paper will focus on dock line handling safety in America. I will examine line handling practices across American ports, addressing safety statistics, best management practices, training, and technical considerations with the goal of establishing universally applicable safety standards.

Some ports, like the Port of Longview, handle lines management directly, while others rely on third-party contractors or terminal operators. Regardless of the approach, the safety of line handlers, the workers who manage the critical interface between vessels and docks, must be a priority for all ports. By analyzing the challenges of line handling, I aim to facilitate a safer working environment nationwide.

Ports across the U.S. vary widely in terms of cargo types, infrastructure, equipment, and services, but one constant remains: the dangerous task of line handling for vessel mooring. Regardless of whether a port deals with container ships, bulk cargo vessels, tankers, or barges, line handling is a critical yet hazardous operation. At the Port of Longview, we manage line handling in-house across eight marine terminals. Following a tragic incident in 2018, where a vessel's spring line broke and claimed the lives of a longshoreman and the vessel's Chief Officer, the Port of Longview has been committed to enhancing the safety of line handling.

While the saying "once you've seen one port, you've seen one port" highlights the uniqueness of each port, it also underscores a shared reality: the inherent dangers of line handling. Whether serving as a major container port, a regional breakbulk port, or an inland river port, every port faces the same risks associated with mooring vessels. The Port of Longview experienced a significant safety incident in 2018, which spurred us to continuously ask, "how can the Port make line handling safer?" This paper will explore the current state of line handling across U.S. ports and offer solutions to mitigate the risks involved.

Introduction

Line handling is a fundamental but high-risk occupational activity central to maritime commerce. Broadly defined, line handling refers to the process of managing ropes, cables, synthetic lines, and mooring systems used to secure vessels to piers or docks. The coordination between vessel crews and dock side workers to manage the mooring process is critical and while the process appears routine, it involves managing tremendous stored mechanical energy under variable environmental and operational conditions. When failures occur, the consequences are often catastrophic.

The United States relies heavily on maritime transportation for both domestic and international trade. Ports along the Gulf Coast, Eastern Seaboard, West Coast, Great Lakes, and inland waterways such as the Mississippi or Columbia Rivers depend daily on skilled line handlers to secure vessels weighing thousands of tons.

Despite its critical importance, line handling remains one of the most dangerous occupational activities in maritime settings. Fatal injuries frequently result from “snapback” incidents, where tensioned lines recoil with explosive force after sudden failure or release. Crushing injuries, amputations, falls overboard, and struck-by hazards are also prevalent. These injuries are often preventable through engineering controls, regulatory compliance, and comprehensive safety culture initiatives.

This paper will focus on maritime mooring operations at U.S. Ports. I will drill down into the safety of shore-based line handlers and the interface between the dock and vessel. A separate analysis of vessel crew safety or different line handling applications in the offshore energy sector, military or how tugboats and barges manage line handling when adrift should be examined further. Some of the general recommendations for improving training, engineering controls, best management practices, and oversight might be applicable to all applications.

This paper examines line handling safety in the United States through historical, regulatory, technical and policy lenses. It is clear to me that while federal and state oversight and industry innovation have reduced certain risks, systemic challenges, particularly related to training, enforcement variability, technological disparities, and human factors, continue to expose workers to preventable harm. This paper provides an evaluation of current safety practices and proposes forward-looking recommendations.

Historical Development of Line Handling Practices in the United States

Early Maritime and Dock Operations

The history of line handling in the United States is closely tied to the development of commercial shipping and port infrastructure during the nineteenth century. Early American ports relied heavily on manual labor to load cargo, secure vessels, and manage docking operations. Longshore workers frequently handled natural-fiber ropes made from hemp, manila, and sisal. These materials were susceptible to moisture damage, rot, and inconsistent performance under load.

Port operations during the nineteenth and early twentieth centuries were characterized by physically demanding labor and minimal safety oversight. Workers learned line handling techniques through apprenticeship and practical experience rather than formal training programs. Often this is still the same as today. Safety procedures varied significantly among ports, and shipping companies, and accident reporting systems were largely absent.

As maritime trade expanded, large ports on the East Coast, West Coast and Gulf Coast became major commercial gateways. Increased vessel traffic created greater demand for efficient mooring practices and more durable rope technologies. Steel wire ropes gradually supplemented traditional natural fiber materials.

Despite technological improvements, occupational injuries remained common. Historical accounts document numerous fatalities involving snapped lines, crushing incidents between vessels and docks, and falls into the water. These events highlighted the need for systematic approaches to workplace safety.

Rise of Federal Workplace Safety Regulation

The modern era of workplace safety regulation emerged during the twentieth century as industrialization intensified concerns regarding workplace hazards. Prior to federal intervention, maritime safety standards were fragmented among state agencies, labor organizations, and private employers.

A significant milestone occurred with the passage of the Occupational Safety and Health Act of 1970 (OSHA, OSH Act of 1970, 1970). The legislation established the Occupation Safety and Health Administration (OSHA) and created a national framework for workplace safety enforcement. OSHA's mission included developing standards designed to protect workers from recognized hazards across numerous industries, including maritime operations.

The Occupation Safety and Health Act fundamentally altered responsibilities by requiring organizations to provide workplaces free from recognized hazards likely to cause death or serious physical harm. Maritime employers became subject to specific safety standards addressing longshore operations and marine terminals.

Simultaneously, the United States Coast Guard expanded its role in maritime safety oversight. Historically focused on navigation, vessel inspection, and marine environmental protection, the Coast Guard increasingly incorporated occupational safety considerations into vessel operations and crew management systems.

Throughout the latter half of the twentieth century, accident investigations, labor advocacy efforts, and academic research contributed to a growing body of knowledge regarding maritime occupational hazards, including line handling safety.

Modernization and Technological Advances

The late twentieth century witnessed substantial technological transformation within maritime industries. One of the most significant changes involved the widespread adoption of synthetic mooring lines constructed from nylon, polyester, polypropylene, and high-modulus polyethylene fibers (Insight, 2025).

Synthetic ropes offered numerous advantages, including reduced weight, improved durability, and enhanced resistance to environmental degradation. However, these materials also introduced new hazards. Their ability to store significant elastic energy increased the severity of snapback incidents when failures occurred.

Containerization further transformed port operations by dramatically increasing cargo throughput and vessel size. Modern container, cruise, and bulk vessels often require extensive mooring arrangements involving multiple high-capacity lines under substantial tension.

Recent decades have also seen increasing adoption of automated mooring systems. Technologies utilizing vacuum pads, magnetic systems, and remote-controlled equipment reduce the need for workers to enter hazardous line handling areas (Andriotis, 2022). In Andriotis' paper titled "Automated Mooring for Ships" he concludes that while conventional mooring continues to be widely used at ports and terminals all over the world it represents a genuine risk to personal health and safety. Although automated mooring systems are cost prohibitive for small to medium size ports, the innovations represent a significant shift toward engineering controls that eliminate or reduce worker exposure to risk.

Regulatory Framework Governing Line Handling Safety

Federal Regulations – OSHA Maritime Standards

The Occupational Safety and Health Administration serves as the primary federal agency responsible for workplace safety enforcement within maritime industries. OSHA regulations addressing line handling operations are primarily contained within 29 CFR Part 1917 (Marine Terminals) (OSHA, 29 CFR Part 1917, n.d.) and 29 CFR Part 1918 (Longshoring) (OSHA, 29 CFR Part 1918, n.d.).

Part 1917 Establishes safety requirements applicable to marine terminal facilities where cargo loading, unloading, and vessel servicing activities occur. These regulations address hazards associated with mooring operations, vehicle movement, cargo handling equipment, and worker access to vessels.

Several provisions directly affect line handling safety. Employers must ensure safe access routes, adequate lighting, proper maintenance of mooring equipment, and protection from hazardous conditions. The standards also require training programs designed to ensure employee competency in recognizing workplace hazards.

Part 1918 governs longshoring operations and includes requirements related to vessel access, cargo handling procedures, and protection from struck by hazards. While not exclusively focused on mooring operations, these standards contribute significantly to line handling safety by addressing environmental and operational conditions frequently associated with maritime work.

OSHA additionally relies upon the General Duty Clause, which requires employers to protect workers from recognized hazards not specifically addressed by existing standards. This provision has likely been used by OSHA to support enforcement actions involving unsafe line handling practices and inadequate hazard controls.

United States Coast Guard Regulations

The United States Coast Guard complements OSHA's authority through regulation of vessel operations, crew qualifications, and maritime safety management systems. Coast Guard requirements affect line handling safety by establishing standards for vessel equipment, operational procedures, and emergency preparedness.

Commercial vessels operating in U.S. waters must comply with numerous Coast Guard regulations concerning navigation, crew training, maintenance practices, and operational safety. Vessel cranes, winches, vessel lines, and other vessel equipment used in mooring operations are all subject to inspection and certification requirements

designed to ensure safe operation. These regulations are codified under Title 46 of the Code of Federal Regulations (Coast Guard, n.d.).

The Coast Guard also investigates marine casualties and publishes safety recommendations intended to prevent future accidents. One such marine safety alert from the Coast Guard was issued in May 2011 highlighting mooring line operational safety. In Alert 01-11 from the Sector Houston-Galveston, marine investigators examined two significant line handling deaths aboard foreign flagged vessels and nine other injuries over the previous two years (Guard, www.dco.uscg.mil, 2011). These informational marine safety alerts from the Coast Guard indicate a serious and ongoing concern for line handling safety in the United States.

National Institute for Occupational Safety and Health

The National Institute for Occupational Safety and Health plays a research-focused role within the federal occupational safety framework. Unlike OSHA, NIOSH does not possess regulatory enforcement authority. Instead, the agency conducts scientific research, investigates workplace fatalities, and develops evidence-based deficiencies.

NIOSH's Fatality Assessment and Control Evaluation (FACE) program has documented line handling incidents involving maritime workers. These investigations provide valuable insight into recurring causal factors such as inadequate hazard recognition, equipment failures, communication breakdowns, and procedural deficiencies. One example cited here was of a dockman in New Jersey that drowned after falling off the dock after he had untied lines from a barge. In this case the FACE investigators recommended employers conduct a hazard assessment for all jobs, wear life vests when working on docks and engineering changes that could prevent a worker from falling from the dock (New Jersey Fatality Assessment & Control Evaluation Project, 1993).

Research conducted by NIOSH contributes to the development of training materials, best-practice guidance documents, and hazard awareness campaigns. The agency's findings often serve as the scientific foundation for future regulatory and industry initiatives.

State Level Oversight

Although OSHA establishes national workplace safety requirements, states may operate their own occupational safety and health programs through OSHA-approved State Plans. These plans must be at least as effective as Federal OSHA standards but may implement additional requirements addressing specific regional industries and hazards (OSHA, State Plans, n.d.).

Maritime Operations present unique challenges because federal OSHA generally retains jurisdiction over many waterfront activities. Nevertheless, state occupational safety

agencies frequently collaborate with federal regulators, port authorities, labor organizations, and maritime employers to improve workplace safety outcomes.

There are currently 22 State Plans covering both private sector and state and local government workers, and seven State Plans covering only state and local government workers. Because the Port of Longview is in Washington State, I will briefly focus on the State Plan of Washington.

Washington State represents an important maritime jurisdiction due to the presence of major commercial ports in the Puget Sound like Seattle, Tacoma, Everett and Columbia River Ports like Longview and Vancouver. The Washington State Department of Labor and Industries administers workplace safety regulations through the Washington Industrial Safety and Health Act (WISHA) (Industries, 2022).

Washington's maritime economy is diverse and includes cargoes ranging from containers, cruise, ferry operations, fishing fleets, bulk, and breakbulk cargoes to military. Consequently, state regulators have developed extensive expertise in maritime occupational hazards. Collaborative programs involving labor unions, port authorities, and employers emphasize injury prevention through training, hazard communication, and safety culture development.

At the state level it is also important to point out that Washington State operates the largest locally controlled public port systems in the world, featuring seventy-five distinct port districts across thirty-three of its thirty-nine counties (WPPA).

Line Handling Operations

Line handling encompasses a diverse range of activities across maritime transportation systems. Understanding the operational context is essential because hazards and control measures vary considerably among sectors. For this paper I will focus on cargo vessel operations. Other sectors that are worthy of research might include tug and tow operations, oil platforms, and supply vessels in the offshore energy sector, and tug and barge operations on inland waterways. Line handling hazards in the maritime sector also share some similar hazards with the rail and trucking industry, heavy lift construction, and crane and rigging trades. Cargo securement and tensioned tie-down systems can create risk factors including equipment degradation, inadequate training, and human error, which can cause serious injuries or even fatalities.

Commercial cargo vessels require secure mooring arrangements during loading and unloading activities. Modern container ships may exceed 1,300 feet in length and require multiple mooring lines positioned at carefully calculated angles to resist environmental forces. The ability to safely tie up a vessel can be influenced by many

varied factors including vessel size, dock configuration, tidal changes, cargo loading, weather, and experience of both vessel and shoreside crews performing the work.

Line handlers stationed on docks receive heaving lines from vessel crews and secure the mooring lines to shoreside bollards. In some cases, like the Port of Longview, vessels are required to shift up and down the dock to facilitate loading all hatches on bulk vessels. This shifting requires close coordination between the vessel crew and the line handlers, as lines get shifted from one bollard to another, to ensure safety while vessel crews are heaving on their winches trying to pull the vessel in the needed direction. This vessel shifting is often done without pilots or tugs since the vessel is technically not under motor power and is still tied up to the dock. During vessel departures, workers release lines while maintaining awareness of vessel movement and line tension.

Cargo vessel mooring operations often occur under time constraints because vessel schedules are tightly integrated into global supply chains. In addition, due to the prohibitive cost of mooring line operations with expensive pilots, tugs, labor, and equipment all working together there is always pressure to expedite vessel securement.

On a final note, regarding line handling operations, it is important to understand the communication aspect of the job. Vessel crews and shoreside line handlers often have dialect issues, and this can contribute to the risks associated with the line handling operations.

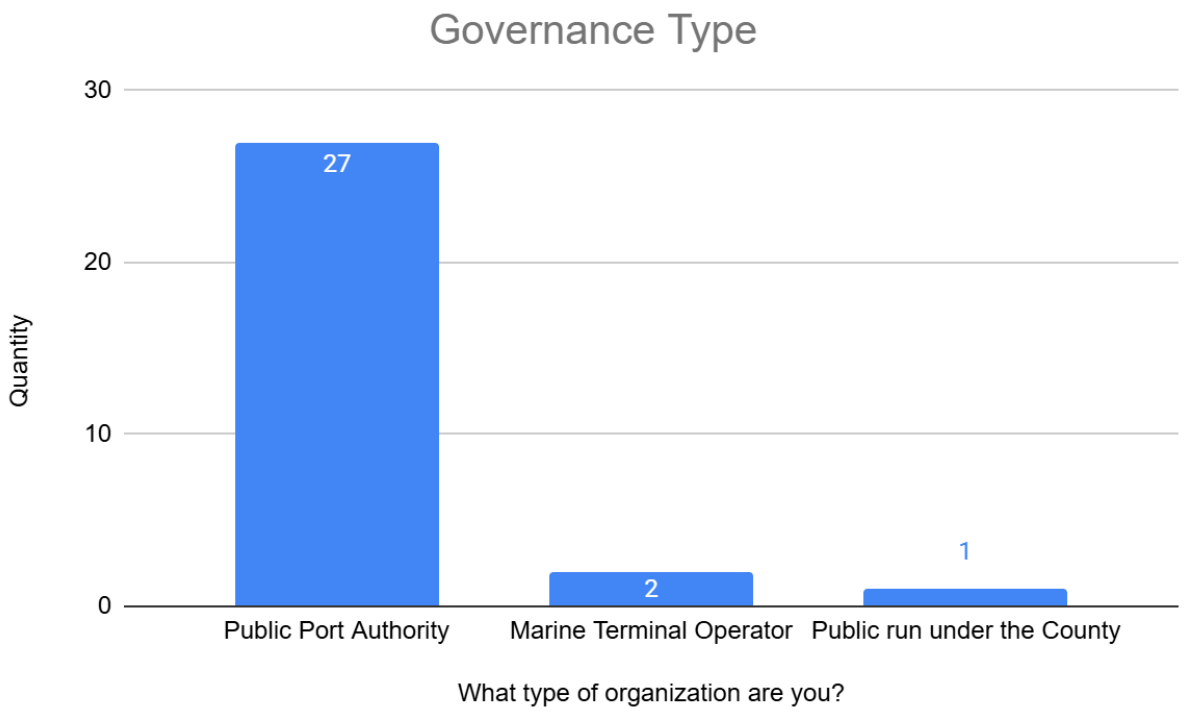
Line handling Survey

I have reviewed the historical development of line handling practices in the U.S., the regulatory framework governing line handling safety and a high-level overview of line handling operations. Before I dive into the hazard identification and risk factors associated with line handling, I wanted to better understand the current state of line handling at U.S. Ports and get inputs from AAPA's membership.

A line handling survey was sent out with the help of AAPA to help understand how lines are managed nationwide across our Port industry. The purpose of the survey was to gather information on subjects ranging from port & cargo characteristics, line handling operations, incidents & risks, training, procedures, and safety practices.

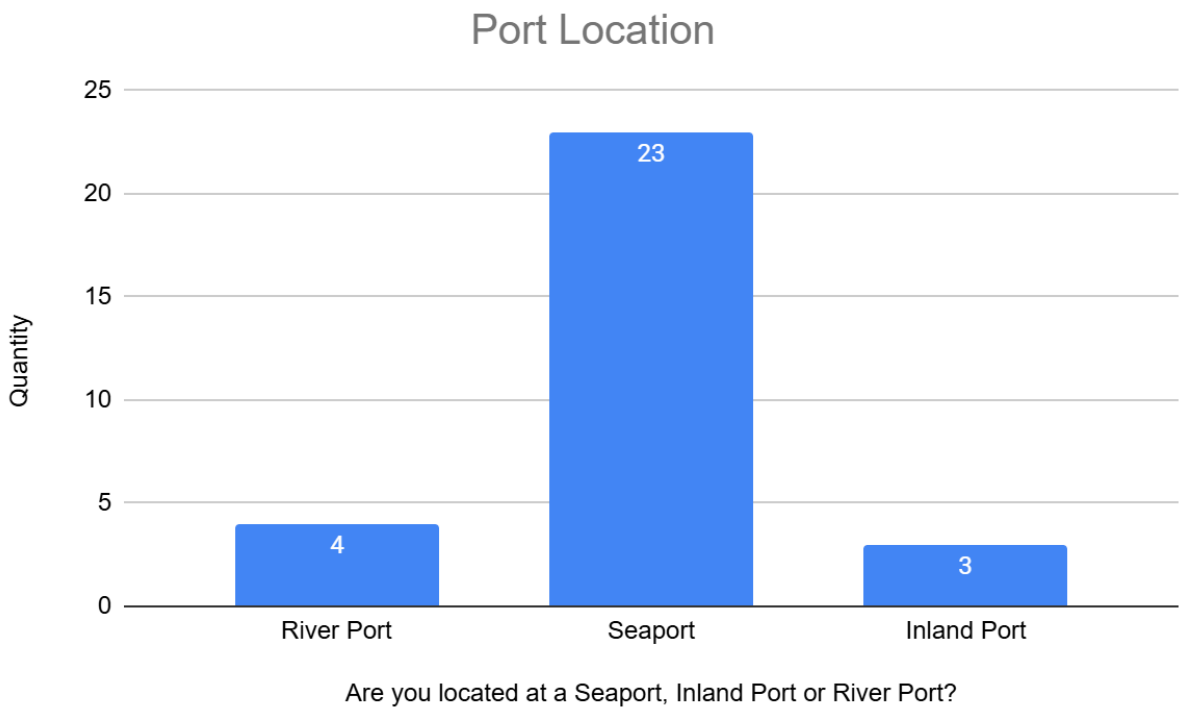
There was a total of thirty total respondents from across the country and the responses were as varied as I would expect.

One of the first questions was to try and understand what the governance model was of the different ports. Most of the responses (27) were public port authorities, although I did receive responses from marine terminal operators and ports that are governed by their local county authority.



Geographically I received a wide variety of responses from all over the country. I received responses from the Eastern Seaboard, Gulf states, Great Lakes, and West Coast.

Next, I tried to understand if the ports were located at a seaport, river port, or inland port. Seaports were the primary port type (23), but I also received responses from river ports and inland ports.

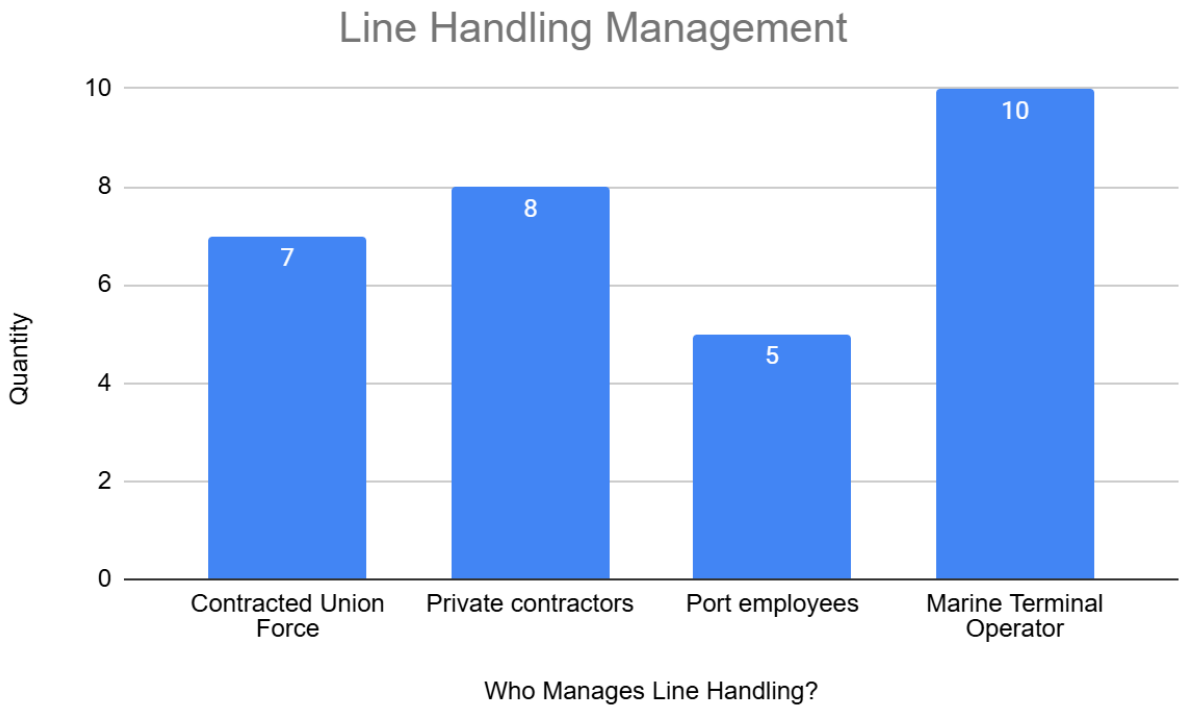


One of the primary goals of the assessment was to try and determine if there were any trends or patterns that would emerge that would help me understand how to make improvements for safe line handling in our industry. To further this goal, I next attempted to understand the cargo handled and common vessel types.

Most of our Ports are diverse economic engines and the responses I received indicated a well-rounded and diverse portfolio of cargo types. This diversity allows ports to remain flexible and competitive in ever-changing market conditions. There were no ports that responded that handled only one cargo type, although there were a couple ports where the primary focus was on containers and cruise business. Most of the ports handled general cargo (25) and bulk cargo (24), with the rest of the ports handling everything from containers, cruise, autos, liquids, and military. Not surprisingly, the most common vessel types were therefore general cargo ships (25) and bulk carriers (24).

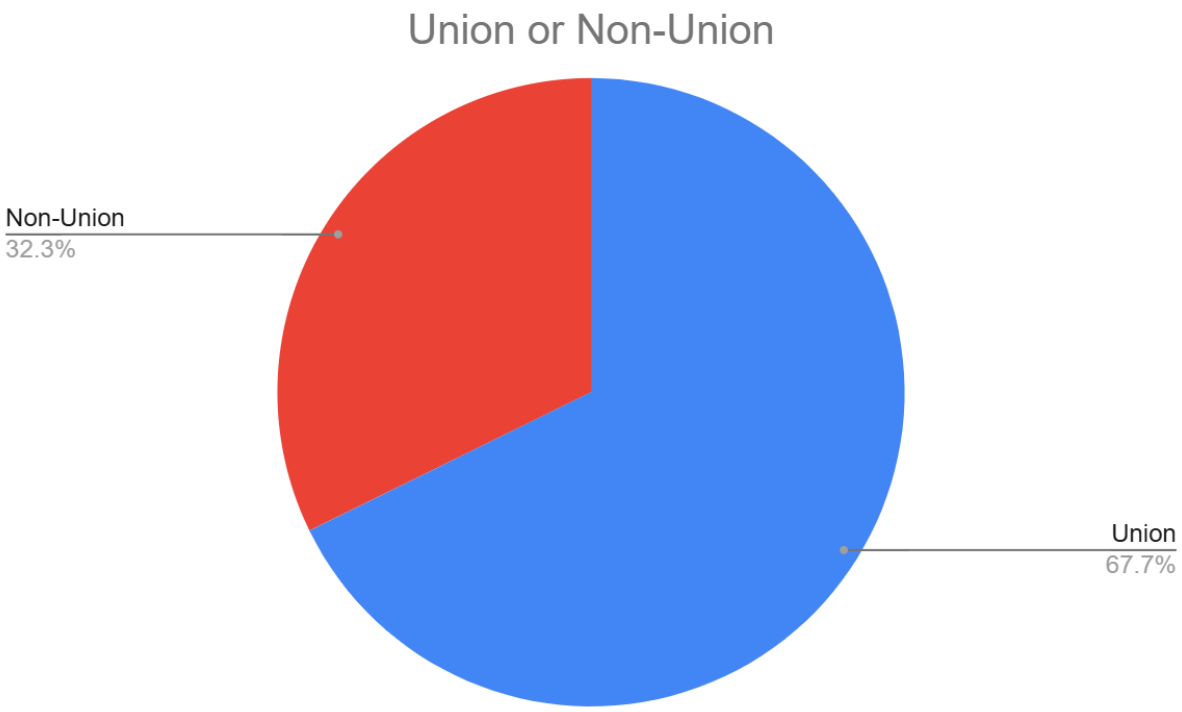
Now that I had a good understanding of what types of ports responded, where they were located, what types of cargo they handled and what types of vessels typically called their ports I could now explore categories of operations and safety.

One of the next things I tried to better understand was who was responsible for handling lines at the different ports. Overall, I would say I got a varied mix of responses from the different ports, but they fell into four main categories: contracted union force (7), private contractors (8), port employees (5), or it was the responsibility of the marine terminal operator (10).

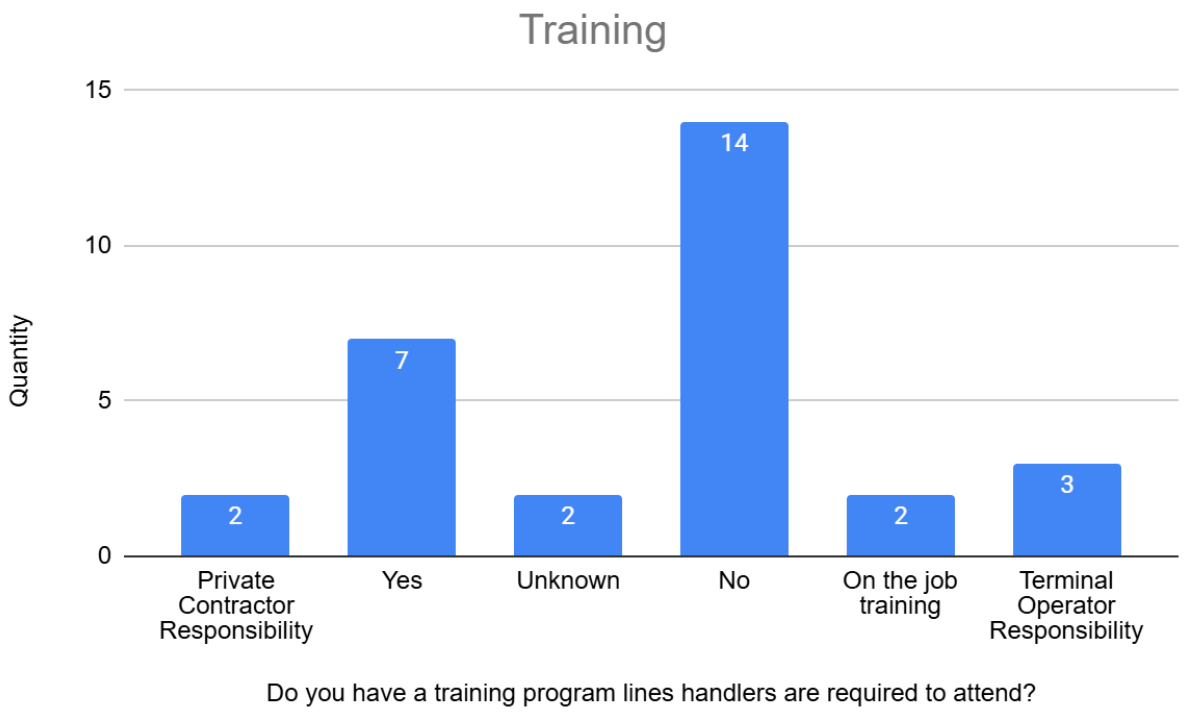


I was a bit surprised by the lack of consistency of line handling responsibility among all the different ports, but now that I had a picture of the organizations that were responsible for line handling, I next wanted to understand if the people that were handling lines were union or non-union.

As you can see from the following chart, 68% of the ports had union personnel handling lines at their ports and 32% of the ports had non-union personnel handling lines.



Now that I had determined that most of the workforce handling lines across our ports were union personnel I wanted to better understand what type of training programs existed or were being used. The following chart illustrates that although some ports put the responsibility of training linesmen on either private contractors or terminal operators, almost half (17) of the thirty ports that responded either did not know if there was any training for line handling or was no training. This is a major takeaway and something that I will discuss later in the paper.

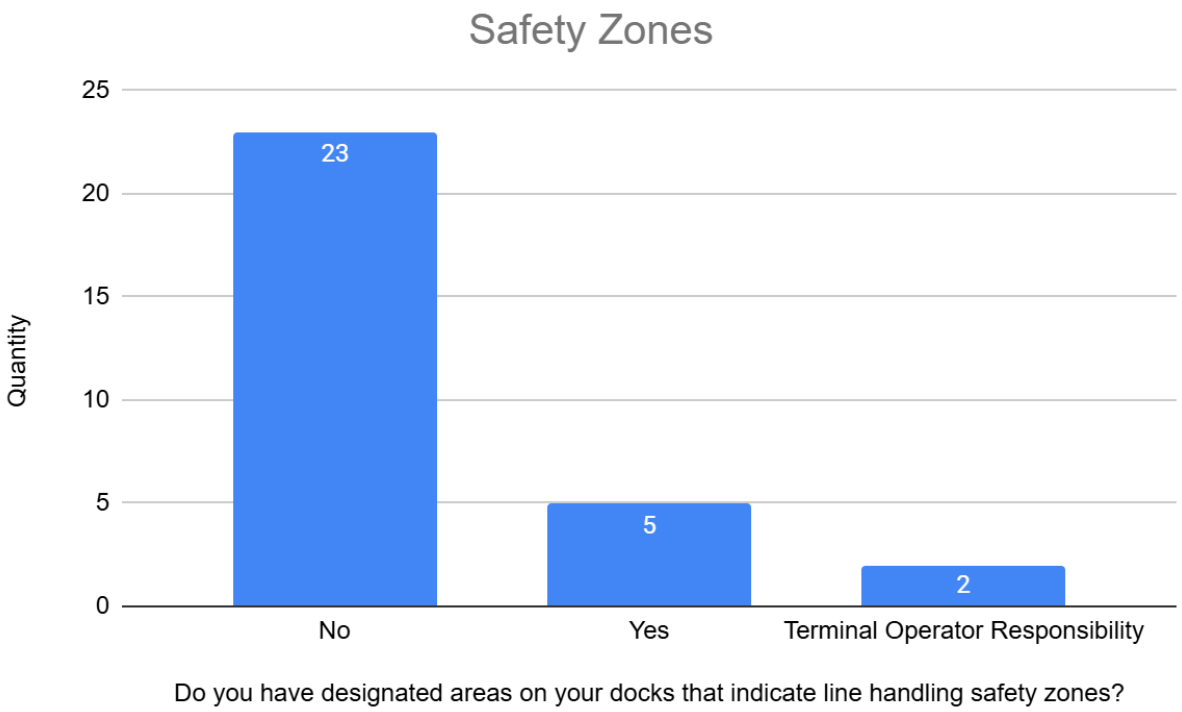


Do you have a training program lines handlers are required to attend?

The next question I asked in the survey was to determine if ports used a checklist for best management practices related to line handling safety at their facilities. Now that I know that there is clearly a lack of identified training programs related to line handling at our Ports, I wasn't surprised to see that most ports either put the responsibility of a best management checklist on the private contractor, terminal operator or simply didn't have one at all. I think that along with the lack of training that a lack of a best management practices checklist will be something that will be explored later in this paper.

Line handling can be extremely dangerous and so one of the questions I wanted to better understand is if ports had designated areas on their docks to identify safety zones, snapback dangers, signage, or other visible markers indicating line handling hazards.

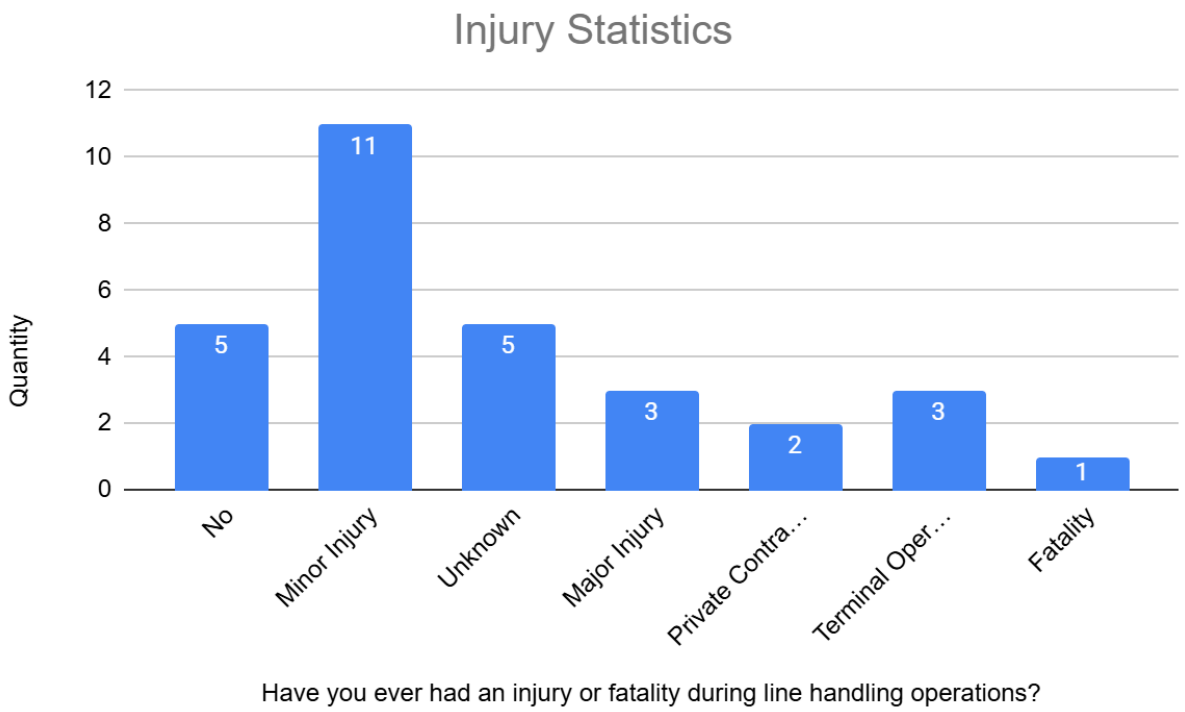
As you can see from the chart below, many Ports do not have designated areas on their docks identified as safety zones for line handling operations. Considering the potential severity of line handling accidents associated with snapback dangers, this is a surprising statistic and one that will be reviewed in great depth later.



With the lack of identified safety zones, the next logical question for me to ask was about supervision. I asked the question of whether ports have specially trained supervisors that are present on all line handling jobs. The following chart shows that at a lot of ports have trained supervisors, although some of the positive responses indicated that the supervisors are not able to be on all line handling jobs. About half of the ports that responded said they did not have trained supervisors, were unaware of them having trained supervisors or put the responsibility on private contractors or terminal operators. Again, this lack of consistency in having trained supervisors on all line handling jobs is indicative of ports not understanding the risks associated with this dangerous occupation. This is another area for improvement to be discussed later in this paper.

With the lack of trained supervisors on line handling jobs, I was also curious about how pervasive it was for pre-shift safety talks before line handling jobs. As you can see from the chart below many of the ports indicate that there is not a pre-shift safety talk before line handling jobs. How are the hazards being discussed with the crews?

Now that I had a better understanding related to safety practices at the ports related to line handling, I wanted to find out what the injury statistics say about our ports. Although there were five out of the thirty ports that said that they had not had any injuries, which is good, that is still only 16% of the ports surveyed. This is an eye-opening statistic. The shared reality is that there was one port that had a fatality, eleven ports indicating minor injuries and three ports with major injuries reported. Preventing injuries in the line handling industry is clearly something that needs to have more focus and the hope is that this paper will highlight the need for more safety oversight, training, supervision, and awareness on the dangers of line handling at American ports.



I really appreciate all the responses from everyone that took the time to answer my survey. Researching line handling safety can be difficult due to many of the online references citing or including vessel crew statistics. With the help of all my port colleagues and the wide range of responses both geographically, and diversity of port type, this survey really helped create a real-world picture of the state of line handling safety in the U.S. and some key takeaways as listed next.

Key Takeaways

1. Inconsistent safety standards across ports.
2. Lack of formal training programs for line handlers.
3. Limited use of structured safety practices (briefings, signage, checklists).
4. Lack of established safety zones.
5. Lack of trained supervisors.
6. Real risk remains—injuries and fatalities still occur.

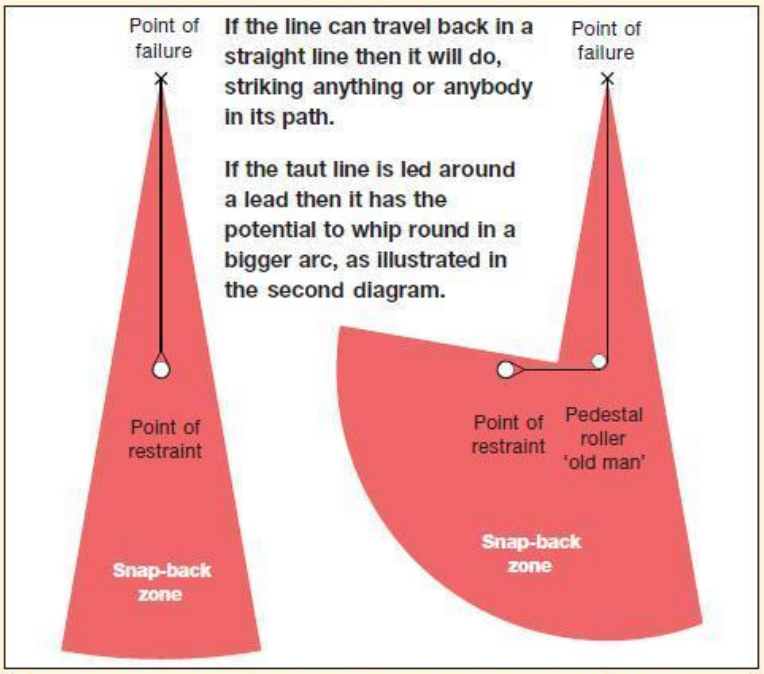
Hazard Identification and Risk Factors

Effective prevention requires understanding the hazards responsible for line handling injuries and fatalities. My online research consistently identifies four primary categories of risk: snapback hazards, environmental conditions, human factors, and equipment failures.

Snapback Zones

Snapback represents the most widely recognized line handling hazard. When a rope or wire is subjected to tension, mechanical energy becomes stored within the material. If the line suddenly fails, this energy is released almost instantaneously. Mooring lines under tension can store extraordinary amounts of energy. If a mooring line fails, the line will recoil and the path followed by the recoiling line within the snap back zone face significant risk of traumatic injury or death.

Snapback hazards are mooring line failures and according to Hodgins, et. Al snapback failures account for over 50% of all recorded mooring incidents and constitutes some of the most serious injuries (Hodgins, 2023).



▲ Figure 2: Method of estimating snap-back zones (from MCA Code of Safe Working Practices for Seamen)

In the diagram above a snapback zone is illustrated showing that the If the vessel line breaks it will typically snap back towards and past the point to which it is secured. A snapback zone can be exacerbated when the line is led around a lead (Institute, 2009).

In some cases, vessels are tied up with multiple lines on one bollard and thereby can create snapback zones across different angles, making identification and protection from snapback complicated.

My research indicates that workers either underestimate the extent of snapback zones, do not fully understand the risk associated with snapback dangers or have not been educated on what a snapback zone is. More education, training, and physical markings on docks, indicating snapback zones, should be a priority.

Environmental Conditions

Often the weather we work in can create some of the biggest hazards in our workplace. Environmental conditions influence line handling risk. High winds increase vessel movement and line tension, while rough seas can create dynamic loading conditions capable of overstressing mooring systems. Tide can also play a dangerous role in safe line handling operations, where in Northern latitude large tidal swings can influence how a vessel gets tied up to the dock and create challenges at the interface between vessel crew and shoreside line handlers. Along with tidal challenges, river currents can also present challenges at inland river ports.

Ice and snow accumulation can reduce traction on walking surfaces and potentially obscure dock hazards. Rain may impair visibility and increase slip and trip hazards. Chilly weather can play a role in worker fatigue. Standing water in low spots where line handlers are working can also create hazards.

Night operations are common at many ports, but with reduced visibility comes increased risk. Visibility challenges can complicate hazard recognition and communication with vessel crews. Poor lighting conditions can make it difficult to inspect and identify line defects, see moving equipment, or even fellow shoreside workers. Adequate illumination remains a critical safety requirement for maritime facilities.

Human Factors

Maritime industries frequently rely upon extended work schedules and rotating shifts. Combating worker fatigue can be difficult to manage, as in many cases including with casual union labor forces, it is unclear the level of competency or fatigue of a non-steady employee. Fatigue can impair judgement, reaction time, and situational awareness.

Research across many different industry types consistently demonstrates associations between fatigue and workplace accidents. In fact, the National Safety Council says research indicates that 13% of all workplace injuries can be attributed to fatigue (Council, n.d.). In line handling operations, even minor lapses in attention can have catastrophic consequences.

Inadequate training remains a recurring factor in accident investigations. Workers may not fully understand snapback hazards, slip and trip hazards or even exactly what their responsibility is when working with a group of line handlers. Training deficiencies can be especially problematic among new employees or union workers who lack practical experience with mooring operations.

Earlier in this paper I talked about an employer's responsibility by OSHA that requires training programs designed to ensure employee competency in recognizing workplace hazards. From my research I cannot find any specific training requirements for line handling in the U.S. Every employer must analyze and determine what hazards exist at their facilities and create their own training programs catered to line handling operations.

The Port of Longview adopted a line handling training program that is specific to our facilities, manning, and unique operations (Appendix A). Although I provide copies of this training program at all our dock side locations, it remains a challenge to try and educate all the casual union labor force that come to our jobs on line handling safety.

Communication failures are another human factor that is especially unique in the maritime industry. Often vessel crews speak foreign languages and the interface between a crew and shoreside workers can rely on hand signals, and unfortunately foul language. Effective communication is essential during vessel arrivals, shifting, and departures. Misunderstanding regarding line tensioning, vessel movements, or operational sequencing can result in dangerous situations. Facilities should have clear protocols for radio communications and command structures during line handling operations.

Equipment Failure

Shoreside line handling crews should always inspect mooring lines for degradation. Mooring lines deteriorate over time due to abrasion, UV exposure, saltwater exposure, and repeated loading cycles. Sometimes internal damage to a mooring line may not be visible during routine inspections. Line handlers should be able to report their concerns with mooring line integrity to their supervisor and be prepared to request a new line be put in service from the vessel crew. Failure to identify or act on bad mooring lines before use significantly increases accident risk.

Vessel winches play a critical role in controlling line tension. Mechanical failures involving brakes, drums, controls, or power systems can result in sudden load releases. Although inspecting vessel equipment prior to handling lines can be physically impossible before a vessel ties up to the dock, shoreside crews should be on alert if vessel crews are struggling with their equipment. This could be an indicator of poorly maintained equipment and linesmen should be prepared to question their equipment or stop an operation if they feel unsafe.

Other types of equipment sometimes used in line handling are vehicles, forklifts and capstans or windlasses to maneuver vessel lines onto dock bollards. A capstan or windlass is a rotating drum powered by an electric or hydraulic motor used on docks (and ships) to pull heavy mooring lines. These types of equipment provide line handlers with the mechanical advantage needed to secure heavy mooring lines onto bollards. Making sure line handlers understand how the capstans or windlasses work and ensuring they are in good working order is essential for line handlers' safety.

Injury Patterns

Effective prevention of injuries requires understanding not only the hazards responsible for line handling injuries and fatalities, but also the most common types of injuries that occur during line handling operations. My online research consistently identifies five primary categories of injuries: slips, trips and falls, struck-by hazards, sprains and strains, pinch points, and drowning.

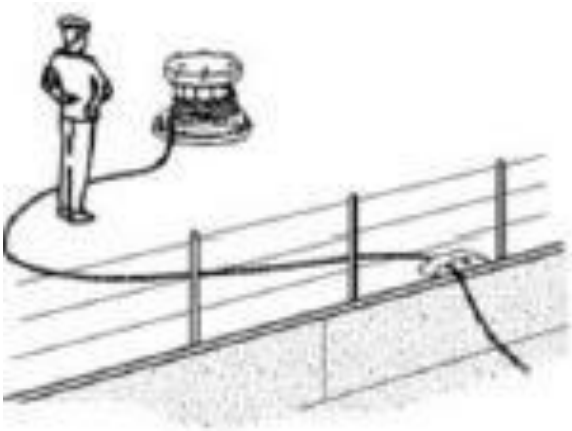
Slips, Trips and Falls

Slips, trips, and falls can occur anytime due to poor housekeeping or environmental conditions, such as snow, ice, or standing water. In addition, cargo residue buildup during bulk cargo operations can create slippery conditions. Ensuring the dock surface is clear of any unnecessary equipment, tools or dunnage is essential for a safe working environment for line handling operations. Cleaning the dock of any buildup of snow, ice or cargo build up should be a normal part of pre-work before starting line handling operations.

Struck-by Hazards

Struck-by hazards, or otherwise known as snapback, are caused by broken lines or cables and can cause severe injury or fatality. Understanding the snapback dangers at your facility is critical. Each mooring line is different and can break if overloaded. To avoid snapback injuries linesmen should communicate with the vessel crews to make sure they understand that they should not be heaving unnecessarily on their lines to make fast or until they are secure. They should inspect the vessel's mooring lines to make sure they do not show degradation. Linesman should listen to warning signs of line failure, i.e., creaking, cracking, and whistling sounds, which could mean the line is under extreme pressure and potentially reaching failure. Facilities should create a safety zone, which could be a painted area on the dock where there is a greater risk of snapback dangers or they should explore creating a safety barrier, which could be a physical barricade or cage where people could move to in the event of unsafe mooring line conditions are observed.

Standing in the bite of a line can also cause serious struck-by injuries. Linesman can get injured when standing, sitting, or stepping inside the bite of a line, even when it appears completely slack and resting on the dock. Linesman should also never step over or stand astride a tensioned mooring line. Unlike a snapback injury, which occurs when a line fails, injuries related to standing in the bite of line results from a line that comes under tension and the worker is in the path of the tensioned line. These injuries can include crushing, pinching, or trapping a worker.



Sprains and Strains

Sprains and strains can occur from the physical demands of pulling on heavy lines. Linesman should always work with a partner if possible and some ports have successfully introduced the use of vehicles and forklifts to assist with moving mooring lines up and down the dock to the desired bollard positions. Capstans or windlasses can also be good, engineered solutions, if the facility ensures their workforce knows how to operate and maintain them safely. Although it sounds elementary, some employers do a decent job of stressing pre-shift stretching to help minimize the potential for sprains and strains during line handling operations.

Pinch Points

Pinch point injuries during mooring line operations occur when a line handler's body part, typically hands or fingers, get trapped between a moving rope and equipment like a bollard. These incidents often result from sudden line tensioning caused by vessel movement or the vessel crew heaving on their winches unexpectedly. Line handlers should never let the line slide between or along their hands and they should always handle the mooring lines by the throat of the eye (not the crown of the eye) when placing it on a bollard (OSHA, Line Handling Safety, 2023).

Drowning

Drowning from falling or being pulled into the water can be fatal. Linesman can get dragged or fall overboard a dock due to line entanglement, an unexpected vessel movement, or getting caught in a bite (a loop or slack part of a vessel line). Slippery docks can cause falls directly into the water, sometimes resulting in head trauma prior to submersion. Swift currents, chilly water, and injury during the fall can all exacerbate the potential for drowning. Linesman should always wear a Personal Flotation Device (PFD) when working near the edge of a dock. When possible, employers should install grab lines or rails on the sides of permanent structures where walkway or apron widths are insufficient for safe footing. The facility where linesmen are working should always have a U.S. Coast Guard approved 30-inch life ring, with at least thirty feet of line, readily accessible at each waterside work area where workers are exposed to drowning hazards (29 CFR 1917.26(f).

Case Study – Port of Longview

On June 27, 2018, the freight vessel Ansac Splendor was moored at the Port of Longview, Washington on the Columbia River being loaded with calcined petroleum coke, a solid material derived from oil refining. The vessel was being loaded at Berth 5. The loading spout at this berth was fixed; it did not have the ability to travel along the dock. The vessel had just completed loading hold no. 5 and needed to shift down river (astern) along the dock to load cargo into hold no. 2 in accordance with the cargo loading plan. Just before 11:00 pm the vessel Master requested line handlers to move the vessel's mooring and spring lines. The Ansac Splendor was intending to use the vessel's engine to shift down the dock and align the loading spout with the no. 2 cargo hold.

At 1:00 am on June 28, 2018, a team of four linesmen arrived at Berth 5. The ship's crew instructed them to shift two bow spring lines (main and secondary) from dockside bollard three hundred back to dockside bollard two hundred to enable the ship to warp forward. The Ansac Splendor had already shifted astern using the engine but was now positioned too far astern and needed to shifted forward. There were three crew members on the forecastle deck of the Ansac Splendor for the warping maneuver: the Bosun, an Able-bodied Seaman, and an Ordinary Seaman. At 1:30 am, the vessel crew slackened both bow spring lines. The linesmen relocated both spring lines to a bollard down river, toward the stern of the vessel. The vessel began to swing off the dock and drift forward, upriver. The vessel crew began to take up tension on the main bow spring line utilizing the winch. The tension created by heaving the main bow spring line pulled the vessel back alongside the dock. The Ansac Splendor's Chief Officer arrived at the forecastle to monitor the movement. On the dock, three of the linesmen were located approximately twenty-five feet back from the dock edge, nearly aligned with the front edge of cargo hold no. 2. One lineman moved away from the others to a location behind a manlift just as the main blow spring line parted. Upon retraction, the line first struck one of the two linesmen on the left side of his body, throwing him into the second lineman who was also struck by the parted spring line. Both men were thrown to the ground. The retracting line also struck a security guard standing further down the dock toward the stern of the vessel. On board the Ansac Splendor, the Chief Officer was struck by the recoiled spring line and thrown to the deck. The first linesman suffered fatal injuries because of being struck by the parted line and died at the scene. The second linesman was treated at a local hospital for his injuries and released. The security guard on the dock suffered minor injuries. The Chief Officer on the Ansac Splendor suffered serious injuries and died several hours later at a local hospital.

Through its investigation, the Coast Guard determined the initiating event to be the parting of the main bow spring line. Causal factors contributing to the spring line parting were: 1) the tension on the line from the pull of the winch working against the

push of the flooding tide; 2) the severe angle of the main bow line coming off the bow guide roller to the dockside bollard, and 3) the material condition of the bow guide roller used to the guide the main bow spring line off the vessel. Subsequent events were the death of a linesman on the dock, injuries sustained to a second linesman and a security guard on the dock, and the death of the Chief Officer on board the Ansac Splendor. Causal factors contributing to the personnel casualties were: 1) the observation position on the forecastle deck maintained by the Chief Officer, and 2) the observation positions of the linesmen and security guard on the dock (Guard, MISLE Incident Investigation Report for Ansac Spendor - Parted Spring Line-Loss of Life, 2018).

The Coast Guard concluded in their report on the Ansac Splendor incident that "there are no proposed actions to add any new or amend existing U.S. laws or regulations, international requirements, industry standards, or U.S. Coast Guard policies and procedures as part of this investigation." Although the Port was not found liable for any fines or penalties, I wanted to make sure this type of event never happened again. This tragic event is what led the Port to make changes to how we operate.

Here are the changes to our line handling safety program that have been introduced since this tragic event:

1) Increased supervision on every line handling job.
2) Establishment of a Line Handling Training program (Appendix A)
    a. This training program is given annually to all Operations Department personnel and facility security personnel that are present during line handling operations.
    b. Copies of the training program are provided to the ILWU workforce and made available at all dockside breakroom locations.
    c. This training is designed to increase awareness on safety hazards, PPE requirements, and procedures.
3) Requirement to use an anti-snapback or overload fuses.
    a. Port of Longview uses MoorGuard Anti-Snapback fuses (MoorGuard, n.d.) on all spring lines when a vessel needs to be shifted or warped up and down the dock.
    b. Signage for snapback fuse use and safety is provided at all docks.
4) Every vessel calling the Port of Longview receives a copy of our "Safe Berthing and Line Handling" document (Appendix B).
    a. This document outlines requirements and recommendations for all vessels to ensure vessel safe berthing and personnel safety.
5) In the case of a vessel violating rules set forth in our "Safe Berthing and Line Handling" document, the Port will put a vessel on notice by issuing a "Warning Letter re Safe Berthing and Lines Management Violations" (Appendix C).

a. This warning letter creates a formal and elevated focus on potential safety concerns that the Port believes could lead to unsafe conditions for our line handlers.

The Port of Longview directly employs and supervises ILWU longshoreman for all line handling activities at all our terminals. Even with all the improvements we have made after the tragic events in 2018, line handling safety continues to be a major concern for Port Management. The Port will continue to review our practices and procedures and strive to make line handling safety a top priority. Although the fatalities that occurred at the Port in 2018 did not require us to make any changes, Port Staff are constantly looking for ways to improve line handling safety, and recommend all Ports do the same.

Safety Training and Prevention Strategies

Preventing line-handling injuries requires a comprehensive approach that combines worker education, engineering controls, administrative procedures, and appropriate personal protective equipment (PPE). Because line handling injuries can be sudden and catastrophic Ports must focus on eliminating or controlling hazards before workers are exposed.

Training Requirements

The Occupational Safety and Health Administration (OSHA) requires employers to provide safety training on hazards that exist at their workplace. Line handling is certainly a hazardous activity, and employers need to create a specific training program, like what the Port of Longview has done. This training should be task-specific, regularly reinforced and documented to ensure employees remain competent in safe line-handling practices.

An effective training program should include instruction on:

- Snapback zone recognition. Line handlers should understand how tensioned lines behave when they fail and be able to identify danger zones where recoil is most likely to occur. Personnel should be trained to be outside these danger zones whenever possible and recognize snapback paths can extend well beyond the immediate work area.
- Line inspection procedures. Personnel should be taught to inspect ropes, cables, fuses, etc. before each use. Inspection should include identifying signs of wear, abrasion, corrosion, broken strands, cuts, UV degradation, excessive stretching, or other factors that could compromise the integrity of the line.
- Proper tensioning techniques. Although it is the vessel crew members that manage how to tension vessel lines with their winches, linesmen on the dock should have some familiarity with the dangers of a crew pulling on their winches

in an unsafe manner. This improper tensioning can often be the reason for broken lines.

- Emergency stop procedures. Every linesman should have the ability to stop an operation if they observe any unsafe conditions or equipment. Linesmen should be aware of how to stop an operation, how to communicate unsafe conditions, and emergency evacuation routes.
- Communication protocols. Clear communication is essential during line handling operations. Standardized hand signals, radio procedures, and how to communicate in an emergency is critical.
- Hazard recognition and situational awareness. Linemen should learn to identify changing environmental conditions such as vessel movement, high winds, poor visibility, unstable footing, and poor housekeeping that increase line-handling risks.

Engineering Controls

Engineering controls are often the most effective preventive measures of reducing injuries because they reduce or eliminate hazards at their source rather than relying solely on worker behavior.

- Physical barriers. Fixed barriers, guardrails, or temporary barricades could prevent personnel from entering high-risk snapback zones when a vessel is tensioning their lines.
- Exclusion zones. When physical barriers might not be feasible due to dock design, employers can paint areas red to indicate a dangerous snapback zone. Linesmen should be trained to not be in these exclusion zones during vessel line tensioning operations.
- Anti-snapback or overload fuses. These are specialized safety devices used in conjunction with vessel lines. The vessel line is attached to the line fuse and then attached to the dock bollard. If the line tension exceeds a safe threshold, the device line fuse yields in a controlled manner, absorbing energy and preventing the main vessel line from snapping back (MoorGuard, n.d.).
    - The Port of Longview uses these line fuses and believes they are essential in reducing snapback risks and injuries.
- Capstans and windlasses. Because line handling is often still reduced to manually handling heavy vessel lines from the vessel to a dock bollard a capstan or windlass can provide engineered assistance in pulling or adjusting mooring lines.

Administrative Controls

Administrative controls establish work practices and procedures that reduce exposure to hazards through planning, supervision, and effective communication. While administrative controls do not eliminate hazards, they significantly reduce the likelihood of human error.

Key administrative controls include:

- Job Hazard Analysis (JHAs). Before work begins, crews should systematically identify hazards associated with each task, evaluate potential risks, and establish appropriate control measures. JHAs encourage proactive hazard recognition and facilitate crew discussions regarding safe work methods (OSHA, Job Hazard Analsis, 2002).
- Pre-shift safety talks. Short safety meetings reinforce critical hazards, define individual responsibilities, and review communication procedures. These pre-shift safety talks can be especially important to discuss how environmental conditions right before an operation, like wind, rain, snow, etc. can impact the safety of the job.
- Standard Operating Procedures (SOPs). Written procedures ensure consistent practices for all steps required in line handling operations. Each Port should design these procedures to meet their specific requirements based on their unique situations.
- Supervision. All Ports should have designated and trained supervisors that can lead a safe line handling operation. Although this seems like an obvious administrative control the supervision of a line handling operation often falls to someone in a lead position or someone that has not been formally trained as a supervisor.
- Fatigue management. Worker fatigue can lead to poor judgement and slower reaction times. Employers should have a system in place to identify and replace workers that are showing signs of fatigue. Adequate staffing and work rest schedules are ways to reduce worker fatigue.
- Incident reporting and lessons learned. Near misses, equipment failures, and unsafe conditions should be reported, investigated, and incorporated into future training or pre-shift safety talks to eliminate recurring incidents and unsafe conditions.

Personal Protective Equipment

Personal protective equipment serves as the final layer of protection when hazards cannot be eliminated through engineering or administrative controls. Although PPE can reduce some injuries, it cannot prevent the immense forces generated during snapback events or equipment failures.

Recommended PPE includes:

- Hard hats when overhead hazards exist.
- High-visibility clothing or vests to improve worker visibility.
- Safety toed shoes to protect against crushing hazards and improve footing.
- Cut resistant gloves, especially when handling wire ropes.
- Eye protection to guard against flying debris, broken wire strands, dust, or other weather-related conditions.
- Personal flotation devices (PFDs) for operations conducted near the dock edge or wherever there is a risk of falling or being pulled into the water.
- Weather appropriate clothing to reduce worker fatigue and reduce heat or cold stress.

The most effective line handling safety program will utilize a combination of training, engineering controls, administrative controls, and personal protective equipment. When a Port completes a systematic look at how to improve one or more aspects of all these control measures the risk of injuries should be reduced. A good template for analyzing all these risks should be used, such as the one proposed below (Appendix D).

Line Handling Safety Toolkit Checklist

LINE HANDLING SAFETY CHECKLIST					
Section	**Checklist Item**	**Yes**	**No**	**N/A**	**Comments / Corrective Action**
A. Training & Competency	All crew members have completed required line-handling safety training.	☐	☐	☐	
	Workers understand snapback zones and danger areas.	☐	☐	☐	
	Personnel have been trained in proper line inspection procedures.	☐	☐	☐	
	Workers understand safe tensioning techniques and working load limits.	☐	☐	☐	
	Emergency stop procedures have been reviewed.	☐	☐	☐	
	Communication methods (hand signals/radios) have been established and understood.	☐	☐	☐	
	New personnel have received task-specific orientation.	☐	☐	☐	
	Emergency response drills have been conducted within the required timeframe.	☐	☐	☐	
B. Engineering Controls	Physical barriers are established around tensioned lines.	☐	☐	☐	
	Exclusion zones are clearly marked and communicated.	☐	☐	☐	

	Anti-snapback or overload fuses are being used and functionable.	☐	☐	☐	
	Capstans and windlasses have been inspected.	☐	☐	☐	
	Equipment guards and line guides are professionally installed.	☐	☐	☐	
	Damaged or defective equipment has been removed from service.	☐	☐	☐	
C. Administrative Controls	Job Hazard Analysis (JHA) has been completed before work begins.	☐	☐	☐	
	Pre-job safety briefing/toolbox talk has been conducted.	☐	☐	☐	
	Roles and responsibilities have been assigned.	☐	☐	☐	
	Exclusion zones are clearly marked and communicated.	☐	☐	☐	
	Weather and environmental conditions have been evaluated.	☐	☐	☐	
	Communication devices have been tested and are functioning properly.	☐	☐	☐	
	Emergency evacuation routes are identified and unobstructed.	☐	☐	☐	
	Only essential personnel are within the work area.	☐	☐	☐	
D. Personal Protective Equipment (PPE)	Hard hats are worn and in good condition.	☐	☐	☐	
	Cut-resistant gloves are available and worn.	☐	☐	☐	
	Steel-toe, slip-resistant footwear is worn.	☐	☐	☐	
	High-visibility clothing is worn.	☐	☐	☐	
	Eye protection is available and worn.	☐	☐	☐	
	Hearing protection is available when required.	☐	☐	☐	
	Personal flotation devices are worn when working over or near water.	☐	☐	☐	
	PPE has been inspected and is free from damage.	☐	☐	☐	
F. Final Verification	All hazards identified during planning have been addressed.	☐	☐	☐	
	Crew members understand stop-work authority.	☐	☐	☐	
	Emergency contacts and rescue equipment are readily available.	☐	☐	☐	
	Supervisor has authorized work to begin.	☐	☐	☐	
Supervisor Sign-Off					
Project/Job					
Location					
Date					
Supervisor					
Crew Leader					
Number of Crew Members					
Supervisor Signature					

Conclusion

Line handling will always be an essential part of port operations, but it should never be treated as a routine task simply because it occurs every day. The research, survey responses, regulatory review, and Port of Longview case study presented in this paper all point to the same conclusion; the risks associated with mooring operations are real, recurring, and too often underestimated. Snapback hazards, environmental conditions, communication challenges, fatigue, inadequate training, and inconsistent supervision can combine quickly and create catastrophic consequences for line handlers, vessel crews and others working near the dock.

The survey of U.S. ports confirms that line handling practices vary widely across the industry. Some ports rely on port employees, others on union labor, private contractors, or terminal operators. Some have formal training programs, trained supervision, safety zones, checklists, and pre-job safety talks, while others do not. This lack of consistency does not mean that ports are indifferent to safety; rather, it demonstrates the need for a more deliberate and organized approach to line handling risk management. Every port is different, but the hazards created by tensioned mooring lines are common to all ports.

Improving line handling safety requires ports and marine terminal operators to move beyond informal experience-based practices and adopt structured, repeatable safety systems. At a minimum, those systems should include task-specific training, documented job hazard analyses, pre-shift safety talks, clearly identified exclusion or danger areas, competent supervision, effective communication protocols, equipment inspection procedures, appropriate PPE, and stop-work authority for every worker involved in the operation. OSHA's Line Handling Safety guidance provides a useful starting point for employers and workers, but each port must also evaluate its own berth configurations, cargo operations, vessel types, workforce model, weather conditions, and operational realities.

The Port of Longview's experience following the 2018 Ansac Splendor tragedy illustrates why continuous improvement matters. Although the Coast Guard investigation did not result in new laws, regulations, or enforcement actions against the Port, the incident made clear that compliance alone is not the same as prevention. In response, the Port strengthened supervision, developed training, improved vessel communication, implemented safe berthing and line management expectations, and introduced anti-snapback technology for vessel shifting operations. These actions reflect an important lesson for the broader port industry; meaningful safety improvements often begin when organizations choose to act before they are required to act.

No single control measure will eliminate every risk in line handling. Painted zones alone are not enough. Training alone is not enough. PPE alone is not enough. A safer line handling program depends on layering controls together so that engineering solutions, administrative procedures, supervision, communication, worker competency, and personal protective equipment all support one another. The Line Handling Safety Toolkit Checklist included in this paper is intended to help ports begin that process by turning general safety principles into practical field-level actions.

Ultimately, decreasing risk one line at a time requires leadership, accountability, and shared commitment from port authorities, terminal operators, labor organizations, vessel crews, contractors, regulators, and industry associations. Ports should not wait for another significant injury or fatality before reviewing their line handling practices. By standardizing training, improving hazard recognition, strengthening supervision, learning from near misses, and sharing best practices across the industry, U.S. ports can significantly reduce preventable harm.

Line handlers perform one of the most critical and dangerous jobs on the waterfront. Their safety deserves the same level of planning, investment, and attention given to every other essential part of port operations. If this paper encourages even one port to reassess its practices, improve its training, mark or manage its danger areas, empower its workers, or strengthen its supervision, then it will have served its purpose. The goal is simple; every vessel can be safely moored, every operation can be better planned, and every line handler should go home safely at the end of the job.

Reflections on Learning

Researching and writing about line handling in America has been one of the most meaningful learning experiences of my professional career. As someone who works at the Port of Longview, where line handling is directly managed across our eight marine terminals, the safety and performance of our labor partners is not simply part of my job, but instead a responsibility that I carry with me every day.

This capstone gave me the opportunity to step back from the day-to-day operations and examine line handling from a broader perspective. My goal was not to discover a revolutionary solution or present groundbreaking theories, but to develop a comprehensive overview of the work, the inherent hazards it presents, and the practical strategies that can help make it safer. If this research helps even one industry professional better understand the risks involved in line handling, then it has achieved something worthwhile.

At the heart of this project is a tragedy that will always remain with me. In 2018, the Port lost two members of our community in a devastating line handling accident. That loss serves as a constant reminder that behind every safety policy, procedure and

operational decision are real people with families, friends and futures. Their memory reinforces why improving safety can never become routine or secondary to operational demands.

My hope is that this capstone sparks meaningful conversations throughout the maritime industry, particularly at ports that may not fully recognize the risks their line handlers face every day. We have all seen the heartbreaking videos of mooring lines parting with explosive force. We know the dangers are real. The challenge is ensuring that awareness leads to action.

If this capstone encourages even a handful of organizations to reexamine their practices, invest in better training, strengthen safety cultures, or adopt new approaches to protecting their line handlers, then it will have served its purpose. Writing this paper has made me realize that we can do better at the Port of Longview as well.

Ultimately, my hope is that this capstone contributes, in some small way, to preventing future tragedies and honoring those we have lost by helping protect the hardworking men and women who perform this demanding work, one line at a time.

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Appendix A: Port of Longview Training Program

Line Handling Training (002).pdf

Appendix B: Safe Berthing and Line Handling

Safe Berthing and Line Handling_July 1

Appendix C: Warning Letter to Vessel Master

Warning letter to Vessel Master and L

Appendix D: Line Handling Toolkit Safety Checklist

Line Handling Safety Checklist.xlsx