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The Simple Truths of Safety at Sea for Alaskan Tender Vessels: Feasible Regulatory Changes to Prevent Vessel Casualties in the 17th Coast Guard District Tender Fleet

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SUBMITTED TO

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Abstract

Tender vessels in the United States will soon need to comply with new safety regulations as mandated by the Coast Guard Authorization Act of 2010. This thesis focuses specifically on assisting in the formation of an Alternative Safety Compliance Program (ASCP) for the unique tender vessel fleet and seeks to understand why tender vessels experience fatalities and vessel casualties. By analyzing data of tendermen fatalities and tender vessel casualties between 2000 and 2012, this report sheds light on the realities of these incidents. Among other findings, the data show that the most common cause of vessel casualty was striking rocks or the ocean floor, and most common human error was falling asleep at the helm. This thesis then proposes potential regulations that would be economically feasible and realistic for tenders by comparing the casualty data to the reported financial realities of current tender vessels. Notably, the analysis indicates that applying the current Alternative Compliance and Safety Agreement (ACSA) to tenders would not be beneficial. Ultimately, the proposed regulations herein should act as a foundation for a discussion regarding an alternative compliance agreement, as the final agreement will be reached through a much greater dialogue between many involved parties, including tendermen, regulators, safety compliance experts, and others.

Chapter 1: Introduction

1.1 The Goal of This Thesis

This report seeks to understand why tender vessels, and the lives of those on board, are lost in the 17th Coast Guard district. By working with tender operators, crews, the United States Coast Guard, and other experts in the field of vessel safety and procedures, this report analyzes recent data related to tender incidents and proposes reasonable and effective regulation to mitigate future losses aboard these vessels. While previous reports have thoroughly detailed cumulative vessel losses and worker casualties in both the United States at large and Alaska specifically, this will be the first report to focus exclusively on tender vessels, which is critically important to understand when creating new safety regulations that will affect the Alaskan tender fleet.

Tenders constitute a specific fleet of vessels that do not directly catch fish but instead act as a buying agent for seafood companies, purchasing, refrigerating, and transporting fish from the fishing vessels to the shore processing plants or floating processing vessels (hereafter referred to as “processors”). Tenders therefore have important differences from other fishing fleets, and the regulations they must comply with should be tailored to those differences. Just as an oil tanker and recreational ski boat have obvious distinctions, there are less obvious, but just as important, differences throughout commercial fishing fleets. Consequently, for a regulation to be effective, it needs to focus on the reality of the specific fleet’s challenges. This report will therefore shed light on the difficulties faced by tender vessels to help direct regulation that will be in accordance with their needs.

1.2 The Alaskan Fishing Business – Money and Jobs

The fishing industry in Alaska is an extremely lucrative and successful business. In 2011, a study completed by the Alaska Seafood Marketing Institute estimated the direct and secondary economic impacts of the industry on the United States' economy to be $15.7 billion. The combined value of Alaskan seafood exports and the retail value of those exports was estimated at $6.4 billion, $2.8 billion of which went directly to the employees involved in the business (McDowell Group, 2013). The Alaskan commercial fishing industry includes wild catches of Pacific salmon, Pacific halibut, Pacific cod, groundfish such as rockfish and sole, sablefish, herring, four species of shrimp, sea cucumbers, sea urchins, and pollock, plus 64 aquatic farms with oysters, littleneck clams, and geoduck clams (McDowell Group, 2013).

The commercial salmon fisheries are the most valuable type of fishing by far, accounting for nearly half of the entire economic value. Bristol Bay, off the southwest coast of Alaska, also has the largest sockeye salmon fishery in the world, which alone accounts for close to 100 million fish annually. While the pollock, Pacific cod, and other groundfish and flatfish account for the greatest wholesale economic impact, at about $2.88 billion in 2011, the salmon fishery has a higher multiplier because of the secondary effects in the Alaskan economy. The salmon fishery's wholesale value is about $2.45 billion. In 2011, Alaska hauled in 56 percent of the total U.S. commercial fishery harvest by volume, or 36 percent by value (McDowell Group, 2013).

The fishing industry is also the largest private employer in the state of Alaska. Overall, this means that one in seven Alaskans is employed because of Alaskan seafood, and in 2011, the industry directly created 63,100 jobs in the state. When viewed more broadly, the Alaska Seafood Marketing Institute's report estimated that the industry provides 165,800 American jobs, including 34,000 jobs for Washington state residents as well as thousands of jobs for hatchery managers, restaurateurs, grocers, and distributors throughout the nation (McDowell Group, 2013).

The Alaskan fishery business is quite impressive on the global scale as well. Somewhat surprisingly, about two-thirds of Alaskan seafood is exported around the world (McDowell Group, 2013), with Japan receiving the largest percentage of imports (Johnson & Byers, 2003). Only 10 percent of the U.S. seafood supply originates in Alaska, and wild Alaskan salmon only accounts for about 23 percent of the total U.S. salmon supply (McDowell Group, 2013). While the United States may not directly consume the products of Alaska's waters, the state of Alaska and the United States at large reap the economic and employment benefits of these waters.

With these impressive, profitable numbers, the Alaska commercial fishing industry may seem highly susceptible to overzealous fishermen and eager businessmen, and at one point in Alaska's history, it was. Between the 1940s and 70s, the Alaskan salmon population was at the brink of extinction, mostly due to overfishing. However, state legislation that limited the number of fishing permits per year and increased focus on habitat protection and hatchery production helped salmon populations rebound to record levels (Johnson & Byers, 2003).

Today, the entire industry is regarded as one of the most sustainable fishery endeavors in the world. According to the most recent report by the National Marine Fisheries Service, none of the Alaskan salmon or groundfish species are classified as overfished. For more than three decades, Alaskan salmon harvests have increased beyond historical levels, and the Monterey Bay Aquarium's *Seafood Watch* lists Alaska salmon as the only salmon to earn a "Best"[1] rating. Further, no species of Alaskan seafood has ever been listed as endangered under the United States' Endangered Species Act (Alaska Seafood Marketing Institute, n.d.).

To protect this haven for both fish and fishermen alike, each year the major fisheries are managed by state and federal agencies which look to scientists and experts to calculate sustainable harvests and set limits on total allowable catches. Some catches, such as salmon, herring, and particular crab species, are regulated by the state of Alaska, while federal entities regulate catches such as pollock, cod, halibut, and Bering Sea crab. Once scientists in these organizations establish the catch volumes for the year, catch volumes are allocated in order to best divide the available resources. By combining the knowledge of fishermen, scientists, policy advisors, and government officials, Alaskan seafood can be sustained for generations to come. The success and perpetuation of fishing in Alaska therefore seems to be an economically, politically, and environmentally profitable enterprise to pursue.

1.3 The Industry's Hurdles

While the Alaskan commercial fishery industry is both lucrative and sustainable, it also presents unique and momentous challenges. The United States Coast Guard recently published a comprehensive review of lost American fishing vessels and crew

[1] A "Best" rating is defined as a seafood that is "abundant, well-managed and caught or farmed in environmentally friendly ways" (Monterey Bay Aquarium Foundation, 2014).

fatalities throughout the entire nation.[2] Between 1992 and 2010, a total of 2,072 vessels were lost, and 1,055 fatalities occurred in United States waters. Alaskan waters had the highest death rate, with 239 individual deaths, or 22 percent of the total. They also accounted for the largest proportion of vessels lost, with a total of 479 vessel casualties, or 26 percent of the total vessels lost. Comparatively, the Eighth Coast Guard district, which includes Texas and a large part of the Gulf of Mexico, accounted for the second highest number of vessel casualties, at 365 vessels, as well as the second highest number of worker deaths, at 200 individuals (Dickey, 2011).

As one of the most hazardous professions in the United States, Alaska commercial fisheries collectively have a death rate that is 26 times higher than the average for all U.S. workers (Lincoln & Lucas, 2010). Between 1991 and 1996, there were a total of 146 deaths in the Alaska fishing industry, equivalent to 140/100,000 full-time employees. Comparatively, for all workers in the United States, the annual fatality rate during this time was 4.4/100,000 workers (Thomas, Lincoln, Husberg, & Conway, 2001). Throughout the year, the shellfish industry accounted for 46 percent of these injuries, while in the summer months of July and August salmon fishing operations accounted for 61 percent of the injuries (Dickey, 2011). Since the early 1990s, specific efforts have helped reduce fatalities by 42 percent, yet between 2000 and 2010 there was still an average of 46 deaths per year, which equates to 124 deaths per 100,000 workers (Dickey).

Loss of life is clearly a serious and prevalent threat aboard commercial fishing boats in the United States. Yet mistakes and mishaps at sea are also often fiscally

[2] This report did not make distinctions between fishing and tender vessels. Therefore, we cannot reach conclusions on the death rates of workers on tenders from the reports in this section.

expensive. Capsizing, fires, and explosions can and have occurred on fishing boats, and all have potentially deadly and expensive consequences. As previously stated, the U.S. Coast Guard determined that 479 fishing vessels were lost between 1992 and 2007 in Alaska, including 58 vessels in the last 5 years of the study (Dickey, 2011). In this study, the most common cause of vessel loss was flooding, accounting for 36 percent of total losses. Fires and grounding (or the ship running ashore) were the second and third most likely causes of vessel loss, accounting for 20 and 16 percent of causes, respectively (Dickey, 2011).

These losses are expensive, too. Another analysis, prepared for the United States Coast Guard in 1997, estimated that the annual property, injury, clean up, and associated costs of accidents on marine vessels to be almost $531 million annually. Notably, the costs associated with U.S. commercial fishing vessel accidents were more than three times greater than the costs of tanker accidents (Marco, Frederick, & Thomas, 1997).

But the commercial fishing industry need not be plagued with vessel loss and worker casualties forever. The 1997 analysis ultimately concluded that implementing accident prevention programs that focused on both preventing technological failure and human error could save between $190.5 million and $317.5 million annually (Marco, *et al.* 1997). Already, the fatalities in Alaskan waters have declined significantly, likely due in part to a task force implemented in 1999 aimed at reducing vessel loss. The U.S. Coast Guard’s 2011 analysis concluded that simple measures, such as training workers for emergencies and using proper personal flotation devices and life rafts, could save many lives, as water exposure caused more than three-quarters of all fatalities. Additionally in this study, the Coast Guard found that only 10 percent of the individuals who died because of vessel loss were using a personal flotation device (PFD) or survival suit when they entered the water, but fishermen survive more than twice as often when survival equipment is properly used (Dickey, 2011).

Ultimately, there are obvious improvements that need to be made to protect employees who participate in this fast-paced and strenuous business. While previous data, including the analysis completed by the United States Coast Guard, clearly outlines and documents many types of maritime casualties throughout the nation, this report will be the first one to identify and document casualties that occur solely on tender vessels in Alaska. In this respect, it will shed a new light on the particular issues that plague the tender business and propose effective regulation to remedy the issues at hand. Some regulation has already been implemented to protect those onboard commercial fishing vessels of all types, but this report seeks to examine additional and/or alternative regulation to offer new solutions to problems that persist in this rewarding, yet risky, profession.

1.4 Alaskan Fishing Operations

The process of harvesting seafood is as varied as the fish consumers choose to buy. In many fisheries, fish are taken from the sea by vessels such as gillnetters, trawlers, seiners, crabbers, and trollers, and are then taken to a shore processing plant or floating processing vessel (hereafter referred to as “processors”) on a separate vessel called a tender. From the processor, fish are shipped throughout the world, oftentimes to buyers in Japan or Seattle. To better understand the fishing business in Alaska, some of the different types of vessels, including tenders, are described below. These various vessels seek different types of seafood and occupy various regions of the Pacific Ocean throughout the year, but they all operate commercially to catch fish and provide income.

- Trawlers: These boats tow nets along the bottom of the ocean to scoop up fish which are too slow to outswim the net. Catches include pollock and cod.
- Gillnetters: These vessels put nets in the water and wait for fish to swim by and become entangled in the net. These generally seek fish such as salmon or herring.
- Setnetters: This type of fishing is similar to gillnetting, but one end of the net is tethered to shore while the other end extends up to 1,200 feet offshore. This type of fishing concentrates predominantly on salmon.
- Seiners: These boats drop nets into the water and attempt to surround a school of fish. They then close the bottom of the net and trap the fish. These boats concentrate efforts on salmon and herring.
- Trollers: These vessels use bait and hooks to catch salmon on a line while at sea. Because of the high quality of fish, these vessels generally produce the most expensive catch.
- Longliners: These vessels drop long lines with many baited hooks into the water attached to an anchor. The line is released and tethered to a buoy, and the fish become stuck on the hooks. These boats catch halibut, cod, sablefish, and rockfish.
- Pot Vessels: These vessels place baited pots on the ocean floor. Crabs and cod enter these pots but then cannot exit. The pots are later hauled aboard the vessel.
- Tenders: These vessels do not actively participate in fishing, but instead act as a buying agent for seafood companies. They purchase fish from the fishing vessel, chill the catch, and transport the fish to the processor and are responsible for

ensuring the delivery arrives in good condition. These vessels help increase economic and hourly efficiency for both the fishing vessel and processor. They mainly operate in the herring and salmon industry, but their operations can include cod, crab, sea cucumber, and catches from longline vessels. Further descriptions of the tender vessel's operations are discussed below.

Fishermen may also use a variety of fishing techniques throughout the year as the fishing seasons change. For example, an individual may fish for sablefish in April, herring in May, halibut in June, salmon in July and August, crab in the fall, and groundfish in the winter. Other fishermen may choose to fish aggressively for three or four months out of the year and pursue other interests or professions the rest of the year (Johnson & Byers). As is evident from the above section, pursuing the Alaskan harvest involves a wide variety of techniques, boats, and lifestyles.

While catching fish is the initial step in the Alaskan fishing industry, the fish must also be prepared for market at the processor. These vessels and plants take the raw fish and generally remove the head and eviscerate, trim, and wash each fish. The degree to which the product is prepared varies between processors; some fish are processed and frozen, some are canned, some are filleted and fully prepared for cooking or reprocessing, while others are packed with gel ice and shipped to restaurants to be served soon after they are caught.

Vessels that do not either process their fish directly or take their catch to a processing plant largely rely on tenders to transport fish for them. This allows the fishing vessel to stay on the fishing grounds for a longer period of time, thus maximizing their catch and profits. It also enhances processing efficiency at the processing plant or vessel because tenders can deliver large volumes of fish in a short amount of time, which allows processors to produce more product per hour without wasting time coordinating smaller deliveries. Since fishing vessels cannot carry as many fish in one load when compared to a tender, the turnover time to wait for fishing vessels to pull up to the processor, dock, unload, and leave is quite time consuming and inefficient.

When a fishing vessel arrives at a tender, the tender uses a large vacuum pump or a brailer bag hoisted by booms or cranes to transport fish from the fishing boat into the tender. The catch is weighed by a scale, and the fisherman is given a “fish ticket” which describes the weight and type of fish, the catch area, and the species of fish (for example, sockeye versus coho salmon). This fish ticket essentially acts as cash, and the fishing vessel may receive the money promised on the ticket at their earliest convenience.

On the tender, fish are either placed in slush ice or in refrigerated sea water tanks, which can hold upwards of 500,000 pounds of fish. Oftentimes, these boats also assist the fishing vessels by bringing supplies to those on the fishing grounds, including items such as drinking water and food, and other luxuries such as cold drinks, access to hot showers, and ice cream. A tender may unload more than a dozen boats before returning to the processor, which then prepares the fish to be sold in the market (Johnson & Byers, 2003). Unmistakably, the tender vessel, while not actively fishing, is still an integral part of the Alaskan fishing industry.

Yet regulating tender vessels presents distinct challenges because of their unique place in the industry. Operating a tender is not as profitable as fishing or processing, and so owners often do not have large sums of money to invest in their vessel. Unlike other fishing vessels, which are paid for their catch, processors pay the tenders a daily rate for their efforts. In this respect, tenders are seen as a business expense to the processor, which means that their pay is minimal when compared to a processor or fishing vessel. Of the price that consumers pay at retail, about 3 percent of that price goes to tenders, while fishermen receive 10 percent, and processors earn 16 percent (Johnson & Byers, 2003). Even though tenders are guaranteed a somewhat consistent pay rate, they also do not experience the windfall profit that comes with a larger catch. Because of this fixed income situation, tender vessels are more likely to age and become worn without surplus funds that can be invested in maintenance and safety (Duz, 2013). Regulation, therefore, must account for a tender vessel's limited budget.

Additionally, some other types of vessels, such as crabbers and trawlers, are used as tenders during the salmon and herring seasons in order to generate income when they are not fishing (Johnson & Byers, 2003). This means that vessels may have to comply with two or more sets of regulations while also remaining profitable. Ultimately, tender operators and vessels pose unique challenges to the Alaskan fishing industry and safety at sea, and it is therefore important that those challenges are understood and met with relevant and reasonable regulations.

1.5 Regulation: The Coast Guard, Congress, and More

1.5.1 The Coast Guard's Authority and Jurisdiction

The United States Coast Guard (USCG) is "authorized to enforce, or assist in the enforcement of, all U.S. Federal laws applicable on, over, and under the high seas and waters subject to the jurisdiction of the United States" (14 U.S.C. § 2). The U.S. Coast Guard is therefore able to enforce laws that delegate exclusive power to its organization, and it also has the power to act when another Federal agency is referenced in a law. Further, the waters subject to U.S. jurisdiction include not only waters in U.S. territory, but also waters in which foreign countries have authorized U.S. law enforcement. By following and enforcing the laws passed in United States Congress, the USCG is given extensive authority to manage United States waterways.

The waters of the United States are divided into 9 districts, and each district has its own governing Coast Guard body and official headquarters. The state of Alaska makes up the 17th district, with its headquarters located in the state's capital, Juneau. The Pacific Northwest is included in the 13th district, with its headquarters located in Seattle. By dividing the nation into specific districts, the Coast Guard is better able to focus on certain issues that pertain to that area. For example, District 9 includes the Great Lakes region, and their responsibilities and areas of focus are much different than those of District 14, which is located in Hawaii. Therefore, this study seeks to work directly with the 17th and 13th Districts, as forthcoming regulations will predominately affect these regions. Undeniably, the USCG plays the central role in enforcing and maintaining laws and regulations throughout the United States' commercial fishing industry, and it is therefore important that they perceive the regulations proposed in this report as both enforceable and advantageous solutions to prevent tender vessel casualties.

1.5.2 Current Laws and Regulations for Commercial Fishing Vessels

In general, the laws and acts passed by United States Congress are codified in the United States Codes (USCs). Executive agencies, such as the United States Coast Guard or Occupational Safety and Health Administration (OSHA), then carry out these laws through the development and enforcement of regulations. Regulations are designed to increase efficiency and flexibility of Congressional laws, and they are generally created through a process that allows public participation in the construction of regulations that will affect the population. Unfortunately, citizens often overlook the opportunity to participate in this creation process, yet it is an important step in forming effective, yet reasonable, regulations. Agencies such as the USCG are assigned to promulgate regulation because of their expertise and depth in a given subject matter. The USCG has authority to enforce regulations in portions of Titles 33 and 46.

Title 33, *Navigation and Navigable Waters*, delegates regulations in Chapter 1 to the USCG while Chapters 2 and 4 are delegated to the U.S. Army Corp of Engineers and the Saint Lawrence Seaway Development Corporation, respectively. In Code of Federal Regulation (CFR) 33, the USCG ensures accordance with rules pertaining to vessel security, general boating procedures, transfers of hazardous materials, and navigation safety regulation, among myriad other topics. Title 46, entitled *Shipping*, is divided into 4 chapters, of which the U.S. Coast Guard is to regulate and enforce Chapters 1 and 3 (the U.S. Maritime Commission regulates Chapters 2 and 4). These chapters contain rules regarding proper vessel certification, general operation techniques, hazardous chemical management, safety procedures, and more. Chapter 1, Part 28 of this CFR concerns requirements for the commercial fishing industry in the United States, and thus serves as the basis for current regulations in the commercial fishing vessel industry.

Two major pieces of legislation, the *Commercial Fishing Industry Vessel Safety Act of 1988* and the *Coast Guard Authorization Act of 2010* resulted in significant amendments to Titles 33 and 46, and the *United States Coast Guard and Maritime Transportation Act of 2012* made changes as well. These Acts are the most important pieces of legislation affecting safety for the commercial fishing industry in the United States today, and they are discussed in greater depth below.

1.5.3 The Commercial Fishing Industry Vessel Safety Act of 1988 (CFIVSA)

The Commercial Fishing Industry Vessel Safety Act of 1988 (P.L. 100-424) initiated regulation of the commercial fishing industry. This Act took effect in 1992 and sought to address the unnecessarily high number of fatalities at sea. These new regulations required vessels to carry life saving equipment, survival crafts, distress signals, emergency positioning indicating radio beacons (EPIRBs), fire extinguishers, emergency alarms, bilge pumps, and more. This Act also developed regulations for watertight integrity.

The Act was very successful, as worker fatalities declined significantly after its implementation (Garofolo, 1997). Notably, two important aspects of this Act helped foster its success. First, it established an advisory committee, named the Commercial Fishing Industry Vessel Advisory Committee, made up of fishermen, marine-safety representatives, safety equipment vendors, and other experts to help set safety regulations and recommend measures to the Coast Guard. Fishermen and policy-makers alike favored this advisory board, as it helped guide effective, yet efficient, regulatory standards. Second, the voluntary dockside examination program was also a key component to fostering this Act's success (Garofolo). This program allowed fishermen to request a free, no-fault examination by the Coast Guard to ensure their vessel's compliance with the law. These safety checks were extremely helpful in allowing fishermen to get recommendations for improvements without fear of punishment.

This Act also broadened the USCG's authority. It gave the Coast Guard permission to complete safety checks at sea and to prevent vessels from operating if they are not in compliance, helping to further enforce safety measures mandated by the Act. The combination of no-fault, no-cost safety checks and the threat of enforcement action helped enhance vessel safety and decrease lives lost in commercial fishing operations (Garofolo).

A study completed by the National Institute for Occupational Safety and Health (NIOSH) found that between 1991 and 1999 the survival rates of workers in vessel capsizing and sinking events steadily increased from a 77 percent survival rate between 1991 and 1993 to a 94 percent survival rate between 1997 and 1999 (Lincoln & Lucas, 2010). This data suggests that CFIVSA helped reduce worker fatalities when vessels sink or capsize. However, while this Act improved the safety of many boats, there were still many vessels classified as "uninspected," which meant regular safety compliance examinations were not mandatory. Additional legislation addressed these issues to further enhance vessel safety.

1.5.4 The Coast Guard Authorization Act of 2010

The Coast Guard Authorization Act of 2010 (P.L. 111-281), signed by President Obama on October 15, 2010, sought to address the persistent hazards in the commercial fishing industry and improve upon the legislation in CFIVSA (United States Coast Guard, 2013). This Act amended USC 46, required new safety protocols and equipment, made significant changes to the sections regarding load lines and uninspected fishing vessels, and further defined the requirements for the Alternative Safety Compliance Program (discussed in greater detail below).

This Act required many new safety protocols. Instead of requiring simply a "lifeboat or liferaft" as previously outlined in CFIVSA, all vessels that operate beyond 3 nautical miles are now required to carry "a survival craft that ensures that no part of an individual is immersed in water" (46 U.S.C. § 4502(b)(2)(B)). Also, to improve overall vessel safety, individuals in charge of vessels that operate beyond 3 nautical miles must complete a training program every 5 years that includes topics such as fire fighting, emergency drills, navigation, seamanship, stability, and more.

Other regulations in this Act apply directly to vessel construction and maintenance. Vessels operating beyond 3 nautical miles are now required to complete a dockside safety check every 2 years and carry certification documents on board, whereas CFIVSA did not mandate such safety checks (the voluntary exams are still encouraged for vessels that operate closer to shore). The Act also amended the section in Title 46 regarding load lines (the point at which the hull of the boat meets the water), making the load line requirement mandatory for all vessels 79 feet long or greater and built after July 1, 2012 (*Determining a Vessels Load Line Length*, 2013). Additionally, alternative load line requirements for vessels that do not meet these specifications must also be formed through cooperation between the fishing and regulatory factions.

The classification system for vessels has also increased in scope to include not only processors but also fishing and tender vessels. This classification system is essentially a series of safety checks and regulations outlined by the American Bureau of Shipping and completed by the Coast Guard to ensure seaworthiness. Vessels that are at least 50 feet in length, were built after July 1, 2013, and operate beyond 3 nautical miles from shore are now required to comply. Fishing vessels, fish processors, and fish tenders that do not meet the requirements for the classification system are required to comply with an Alternative Safety Compliance Program (ASCP) to be written by the fishing industry and regulatory agencies by January 1, 2017 and implemented by July 1, 2020. The tender vessels that must comply with this program must participate in Aleutian trade and fall into one of the following categories:

1) A vessel that is at least 50 feet in length, built before July 1, 2013, and is 25 years of age or older (in or after 2020), *or*
2) A vessel that is built before July 1, 2013 that undergoes a "substantial change to the dimension of or type of vessel completed after the later of July 1, 2013, or the date established by the Secretary" (46 U.S.C.§4503(d)).

If an owner operates 30 or more vessels that are mentioned in (1), they may enter a compliance agreement effective January 1, 2030. This alternative compliance agreement is an important program for understanding this thesis, and the details and reasons for this legislation are discussed in Section 1.5.6 on page 19. There is currently one similar agreement in place, and the tender fleet in the United States will adopt another, adapted compliance agreement as mandated by this Act.

The Authorization Act of 2010 will likely improve vessel safety in commercial fishing fleets in the future due to the enhanced safety requirements and new classification system. Yet this thesis seeks to understand why tenders specifically experience casualties, with the ultimate goal of proposing effective regulations for this particular fleet.

1.5.5 The United States Coast Guard and Maritime Transportation Act of 2012

President Obama signed the United States Coast Guard and Maritime Transportation Act of 2012 (P.L. 112-213) on December 20, 2012. The changes this Act made to Title 46 were not as significant as CFIVSA or the Authorization Act of 2010, but are important for understanding current regulation nonetheless. This Act changed dockside examination policy for relevant vessels by requiring checks every 5 years instead of every 2. The examinations are also required for vessels built after July 1, 2013, rather than July 1, 2012 as previously mentioned. Other changes in this Act leave the Alaska fishing industry largely unaffected.

1.5.6 Alternative Safety Compliance Programs (ASCPs)

Federal regulation of the commercial fishing industry is, undoubtedly, more stringent for newer and larger vessels. To avoid the burden of more stringent regulation, many fishermen delay purchasing new boats and instead choose to run older, generally less-safe vessels, which leads to more vessel and worker casualties. Maintenance costs can also be very high on sea-going vessels, so fishermen may also decrease the amount of processing or fishing they do in order to continue operating as vessels under less regulation. Yet while this may be cost-effective for individual boats, these vessels are much more prone to casualties and fatalities. In Dickey's (2010) study on vessel casualties between 1991 and 2010, vessels were more likely to capsize and lead to casualties the older they were, and to combat these issues a number of Alternative Safety Compliance Programs (ASCPs) are in development as required by the Authorization Act of 2010.

There is one similar safety agreement currently developed, called an Alternative Compliance and Safety Agreement (ACSA), and it applies to three different catcher/processor (C/P) sectors: the non-pollock freezer trawler, the cod freezer longline, and the pot cod sector. These vessels both catch and process fish, but there are restrictions on the amount of processing a vessel may carry out under this program. For example, a vessel in this program may remove the head, guts, and tail of the fish and also process stomachs, cheeks, and roe. However, they are not allowed to fillet or process the bones or belly flaps. These types of processing actions would classify the vessel as fully classed and loadlined, which would create more costly regulation for the owner. This program was first established by the United States Coast Guard in 2006 and last revised in December of 2012.

To create agreeable regulatory standards for all parties involved, the Coast Guard worked closely with C/P stakeholders and arrived at the current, evolving ACSA. While the full agreement and guidelines are quite lengthy, the main priorities of this Alternative Compliance and Safety Agreement (ACSA) are highlighted below and divided into 11 subsections. These 11 inspection standards may serve as the starting point for future regulation in the tender fleet and may be modified, augmented, and reduced as the data prove necessary.

- *Vessel Stability*: To ensure that the vessel is stable at sea, the boat must have watertight bulkheads and closures, and the sea valves, automatic closure devices, and sump pumps must be examined for integrity.
- *Drydock and Internal Structural Exams*: The propeller, stern bushing, sea connections, weldments, shell plating, sea chest, sea strainers, emergency bilge suction, internal spaces, anchors, chains, and wires are inspected.
- *Hull Thickness and Gauging*: Gauges must be on sections in the midship, saltwater peak tanks, main deck plating, sea chests, and others.
- *Tail Shaft and Rudder Exams*: The tail shaft and rudders are analyzed to ensure that they are within the manufacturers specifications and that corrosion and wear are at a minimum.
- *Watertight and Weathertight Integrity*: High water alarms must be installed and audible, door coamings are installed when necessary, and the vessel must have watertight doors, hatches, and bulkheads.
- *Machinery Systems*: Fuel systems must be made of specific materials, and gauges on the tanks must be welded to standards. The fire safety hazards must be identified, relief valves tested, and certain parts on the vessel must be fire resistant, among other things.

- *Life Saving Equipment and Arrangements*: Life rafts must be approved under 46 CFR and one person must be able to launch them. Ladders must be installed for embarkation, and immersion suits must be maintained to manufacturer's specifications and fitted with a strobe.
- *Fixed Fire Fighting Equipment and Arrangements*: There must be fixed firefighting systems in certain places on the vessel, and fire extinguishers must be stored in specific areas, depending on the circumstances.
- *Other Fire Fighting and Safety Equipment*: The vessel must carry portable dewatering pumps and proper firefighting attire. Certain crewmembers must be trained in fire fighting. A safety plan must be used in case of emergencies, and Freon and halon detection systems must be used.
- *Emergency Drills and Training*: Drills must be conducted by a trained individual for disasters such as fire, flooding, abandon ship, and person overboard. Records of these drills must be kept.
- *Emergency Communication and Navigation*: Automated Identification System (AIS) and Global Maritime Distress Signal System (GMDSS) must be installed and operable.

After the vessel passes inspection, the Officer in Charge of Marine Inspections (OCMI) may grant exemptions to regulation, and the vessel owner must carry a copy of the exemption letter aboard the vessel. These safety checks must be performed periodically (usually every two years) in order to maintain status under the ACSA (United States Coast Guard, 2012).

The Alternative Safety Compliance Programs mandated under 46 USC 4503 by the Authorization Act of 2010 have not yet been implemented. However, the Coast Guard, in partnership with stakeholders and experts, is currently working toward the creation of mutually agreeable programs for different commercial fleets. The programs seek to be specific to each fleet, taking into account the difficulties encountered by different vessels. Thus, this report seeks to provide direction for the development of an ASCP for tenders in the United States. By examining the C/P's current, evolving ACSA and its potential effectiveness and feasibility for tenders in light of their past accidents, this report seeks to propose solutions that will effectively address problems that persist on uninspected tender vessels at sea.

1.5.7 Other Means of Safety Enforcement

While the USCG plays an instrumental role in ensuring vessel and worker safety through regulation and enforcement of federal laws, there are also other means of improving vessel safety. The USCG can require vessels in certain geographical areas to follow alternative regulation (in addition to the ASCPs discussed above), and other governing bodies, such as the National Institute for Occupational Safety and Health (NIOSH) and the Alaska Scallop Association, can suggest safety measures or create protocols within specific industries.

The halibut derby system is a prime example of how simply altering fishing regulations can save many lives. Before 1995, halibut fishing in Alaska was operated on a "derby" system, wherein fishermen were allocated 24-hour periods in which to catch as many fish as possible. The dates of the derbies were established months before the day of fishing and were not flexible to adjust for harsh weather conditions. Between the years of 1991 and 1994, there were 6 fatal events on commercial halibut vessels (Thomas & Conway, 1999).

However, in 1995, regulatory bodies implemented individual fishing quotas (IFQs) for halibut and sablefish, which allocated individual catch limits to each vessel. The fishermen were then allowed 8 months in which to fill their quota. This allowed fishermen greater flexibility of their hours, and it gave operators the ability to adjust their schedule based on weather conditions (Thomas & Conway). Since this change, there have not been any deaths on commercial halibut vessels. While this exact modification may not be feasible in the tender business, this example proves that sometimes a change in operational practices may help reduce accidents, too.

Similar changes in the crabbing industry have also helped alleviate workplace hazards. Overloading crabbing vessels with pots has, historically, created many dangers for the crabbing fleet and has caused vessels to capsize unnecessarily. However, some safety measures have helped mitigate these risks. In 1999, the USCG initiated the At the Dock Stability and Safety Compliance Check (SSCC) in the Bering Sea Aleutian Islands (BSAI), which required preseason dock examinations to ensure that fishermen will not overload their vessel. Also, in 2005, many of the BSAI crabbing fleets implemented Individual Fishing Quotas (IFQs) in a new “crab rationalization” program to alleviate issues that arise in a derby fishing system (Fina, 2004). This system is similar to that of the halibut regulation, and has also contributed to safety aboard crabbing vessels in Alaskan waters. These two changes in regulation, the USCG preseason dockside checks, and the crab rationalization program, have helped decrease the average annual fatality rate of employees in this industry by 60 percent. Between 1990 and 1999 there were an average of 8 deaths per year, and between 2000 and 2010 there was an average of less than 1 death per year. Further, of the 8 individuals who died between 2000 and 2010, 3 fell overboard, and 5 were lost from a capsizing event. The only vessel to capsize during this period did not complete the SSCC (Woodley, Lincoln, & Medlicott, 2009).

Other organizations, such as the National Institute for Occupational Safety and Health (NIOSH) have also developed technology and recommended policy to ensure that workers are protected at sea. Recently, NIOSH developed an emergency stop device that can be retrofitted to any winch, which helps deactivate a winch in case of personnel entanglement. NIOSH has also introduced a hatch and door monitoring system that prevents flooding on vessels. This system has been tested in the Bering Sea and is in the process of being licensed for the market (Lincoln & Lucas, 2013).

Lastly, associations within the fishing industry can, and have, helped reduce vessel casualties. As previously mentioned, falls overboard without flotation devices (especially in Alaskan waters) are one of the leading causes of fatalities. To address this problem, the Alaska Scallop Association and individual vessels in the crabbing industry recently established a 100 percent personal flotation device (PFD) policy for all crew on deck. By educating crews and requiring all crewmembers to wear PFDs, leaders in the development and implementation of this policy hope to reduce casualties due to individuals falling overboard.

The previous examples make clear that there are multiple ways to reduce vessel and worker casualties at sea. It is also important to note that the most effective regulations often involve a collaboration of entities to combine expertise. Therefore, understanding the dynamics between regulators and other interested parties will likely be the most effective way to create effective change in the tender industry.

Chapter 2: Methods

This report analyzes data of tender vessel casualties between the years 2000 and 2012 in the 17th Coast Guard District. When an accident or casualty occurs aboard a vessel in the commercial fishing industry, the owner is required by law to file a report with the USCG documenting the incident. The Coast Guard then records and stores the report, and oftentimes other federal organizations, such as NIOSH, have an agreement by which they may access the data and complete analyses. Due to privacy laws, the original data was not available for purposes of this study, but the NIOSH Alaska Pacific Office generously processed the data and removed its distinctive features so that it could be used in this report. The data of personnel fatalities encompasses the full 12-year time span from 2000 to 2012, while the vessel casualty data only analyzes events between 2000 and 2009. In the fall of 2013, the data for non-fatal tender events between 2009 and 2012 had not yet been processed by NIOSH, and it was therefore unavailable for the purposes of this study.

The Alaska Independent Tendermans Association (AITA) also provided valuable, important information for this report. Thirty-two current tendermen from across Alaska filled out a questionnaire regarding their operations, expenses, vessels, and more. Leaders at AITA then compiled these reports, removed distinctive features (so that the data may remain anonymous), and then granted access to the data to enhance the scope and breadth of this report. This made it easier to propose economically reasonable regulations.

Conversations with many other experts in the fields of occupational safety and health, Coast Guard regulations, and fishing operations helped enhance understanding throughout this report. Amy Duz, founder and CEO of iWorkWise, helped brainstorm potential regulations for the *Discussion* chapter, and she also provided general guidance for the direction of this thesis. Visits to multiple tender vessels at port in Bellingham, Washington and discussions of potential regulation and safety issues proved to be useful in broadening the scope of this report as well.

Chapter 3: Results

3.1 Fatal Events

Between 2000 and 2012, the NIOSH Alaska Pacific Office (APO) reported that there were 3 fatal events on tender vessels. These deaths occurred on separate vessels and were a result of three different causes. Overall, the vessels had an average year-built of 1971, an average crew size of 3, and an average length of 81 feet. All vessels were made of steel, two vessels were tendering salmon, and one was not tendering fish at the time of the fatality (Table 1).

One death occurred because the individual asphyxiated due to Freon™ exposure.

Another death occurred when an individual fell from the dock, intoxicated by alcohol.

The third death (not in temporal order) occurred because a vessel was overloaded (Table 1).

Table 1. A description of all fatal events and vessels involved in fatal events on tender vessels ≥ 50 feet in length between 2000 and 2012 in the 17th Coast Guard District. Based on data from the NIOSH APO.

Vessel Description	Average	Range	
Length (feet)	81	60 - 108	
Crew Size	3	2 - 4	
Year Built	1971	1962 - 1979	
Types	Salmon tender and not fishing at the time		
Vessel Hull Material	**Total**		
Steel	3		
Event	**Total Fatalities**	**Number of Crew on Vessel**	**Cause**
Asphyxiation	1	2	Freon
Fall from Dock	1	Unknown	Alcohol
Vessel Disaster	1	4	Overloading

3.2 Non-Fatal Events

3.2.1 Overview

Between 2000 and 2009, the NIOSH Alaska Pacific Office reported that there were 21 tender vessel casualties that did not end in fatalities. The average vessel year-built was 1963 with a range from 1920 to 1998 (Table 2). The average crew size was 3 with a range from 1 to 6 individuals, and the average length was 81 feet, with a range of 50 to 165 feet (Table 2). Eighteen of these vessels were operating as salmon tenders, 1 was tendering herring, 1 vessel was fishing for sea cucumbers and transporting their catch and the catches of others to town,[1] and the operations of one vessel are unknown (Table 2).

Ten of the tenders involved in non-fatal events were made of steel, 8 were made of wood, and 3 were made of fiberglass (Fig. 1).

Table 2. A description of all vessels involved in non-fatal events on tenders ≥ 50 feet in length between 2000 and 2009 in the 17th Coast Guard District. Based on data received from the NIOSH APO.

Vessel Description	Average	Range
Length (feet)	81	50 - 165
Crew Size	3	1 - 6
Year Built	1963	1920 - 1998
Types	Salmon (18), Herring (1), Cucumber (1), and Unknown (1)	

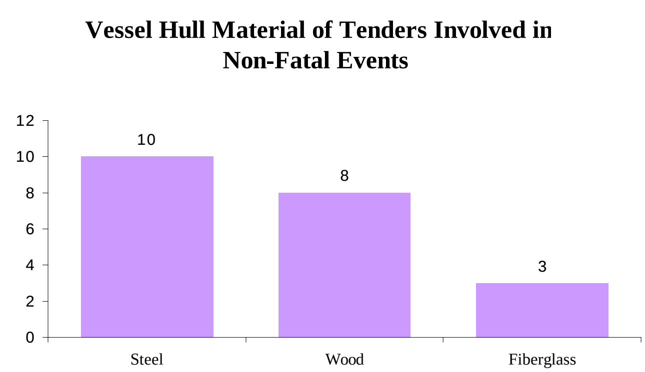

Figure 1. Vessel hull material of tenders involved in non-fatal events between 2000 and 2009. Based on data received from the NIOSH APO.

[1] This instance of “tendering” is different from the classic definition of a tender vessel. While they may have been tendering cucumbers in a broad sense, the activities aboard this vessel were not typical of the tenders in the Alaska Independent Tendermans Association (AITA).

3.2.2 Events

Striking rocks or the ocean floor was the most common occurrence in the non-fatal events and accounted for 8 out of 21 (≈38%) accidents. The second most common incident was fire or explosion, accounting for 5 (≈24%) events, while 4 (≈19%) vessels experienced flooding. Less predominant causes of non-fatal events included collision/allision (3 vessels, or about 14%) and being struck by a large wave (1 vessel, or about 5%) (Fig. 2).

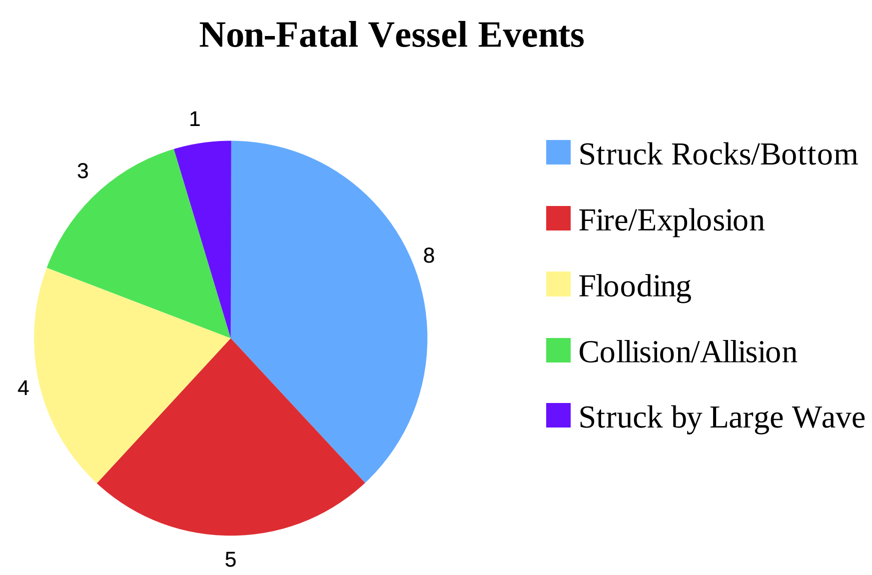

Figure 2. Events resulting in a non-fatal tender accident between 2000 and 2009. Based on data received from the NIOSH APO.

3.2.3 Human Error

Only 12 of the 21 non-fatal tender accidents reported a human error. Of these 12, 7 (≈58%) reported a human error of falling asleep at the helm, 3 (25%) reported drug use, and 2 (≈17%) reported a navigational error (Fig. 3).

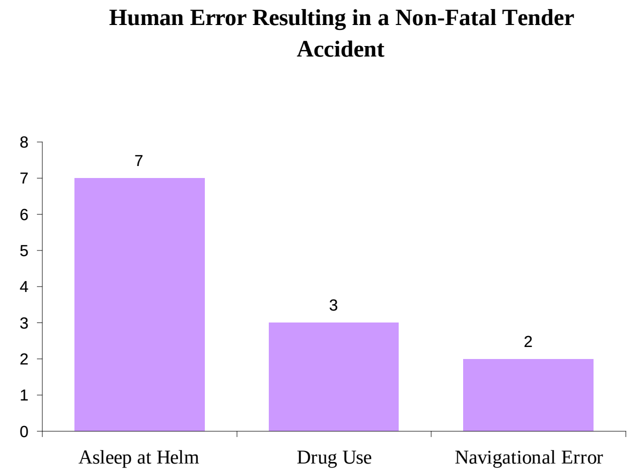

Figure 3. Human error resulting in non-fatal tender accidents in Alaska between 2000 and 2009. Based on data received from the NIOSH APO.

3.2.4 Human Error and Resulting Event

In 5 out of 12 (≈42%) human errors, the operator fell asleep at the helm and struck rocks or the ocean floor. The 3 instances of drug use (25%) also led to the vessel striking rocks or bottom, as did 1 navigational error (≈17%). There were also 2 events (≈17%) where the operator fell asleep at the helm, which resulted in a collision or allision event (Fig. 4). Therefore, all of the reported human error events resulted in the vessel striking something, causing boat damage.

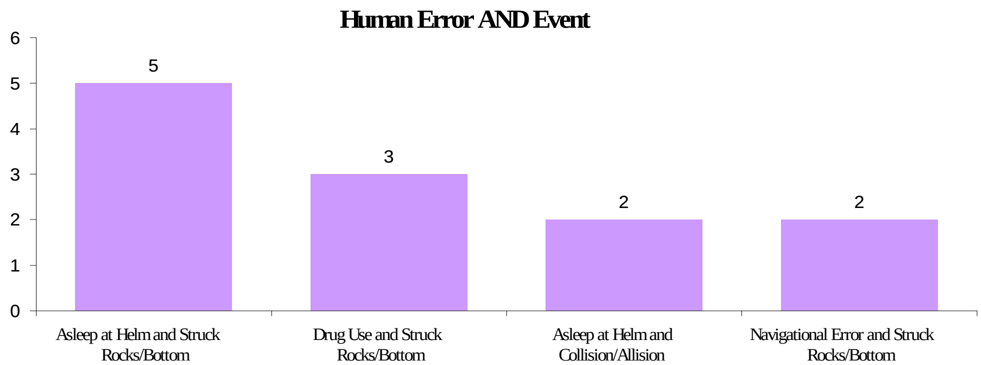

Figure 4. Reported human error and the subsequent event aboard tender vessels between 2000 and 2009. Based on data received from the NIOSH APO.

3.3 Current Tender Operations and Expenses

3.3.1 Tender Dimensions and Operations

Thirty-two tenders across Alaska generously provided information regarding their current expenses and practices. These vessels had an average year-built of 1956, with a median of 1946 and a range of 1918 to 1987 (Table 3). The average vessel length was 89.2 feet, with a median of 83.5 feet and a range of 54 to 124.6 feet. Also, the average *maximum* crew size was 4.6 individuals with a median of 4 and a range of 3 to 8 people (Table 3).

The majority of vessels were made of steel (20, or 62.5%), while 11 (34.4%) were made of wood, and 1 was made of fiberglass (3.1%) (Table 3).

These tenders spent an average of about 89 percent of their total yearly operations tendering, with 99 percent as the median time. The most common reported percentage for this variable was 100, and values ranged from 25 to 100 percent (Fig. 5).

Table 3. Reported data from 32 current tenders regarding vessel dimensions and materials (2013). Based on data received from AITA.

Vessel Description	Average	Median	Range
Length (feet)	89.2	83.5	54 - 124.6
Maximum Crew Size	4.6	4	3 - 8
Year Built	1956	1946	1918 - 1987
Vessel Hull Material	**Total**		
Steel	20		
Wood	11		
Fiberglass	1		

Tender operators also reported other uses for their vessels, including commercial fishing, hauling freight, and surveys.[2] Nine out of 32 tenders reported fishing commercially. These 9 tenders spent an average of 35 percent of their time commercial fishing, with a median of 10 percent. Additionally, 8 out of 32 tenders reported hauling freight throughout the year, with an average time spent hauling freight of 7.8 percent and median time of 5 percent. One tender reported spending 2 percent of their year completing surveys (Table 4).

Table 4. Average time spent by tenders on other activities as reported by 32 AITA tenders in 2013. 100% equals the full year. Based on data received from AITA.

Activity	Number of Vessels	Average Time (%)	Median Time (%)
Commercial Fishing	9	35	10
Hauling Freight	8	7.8	5
Surveys	1	2	2

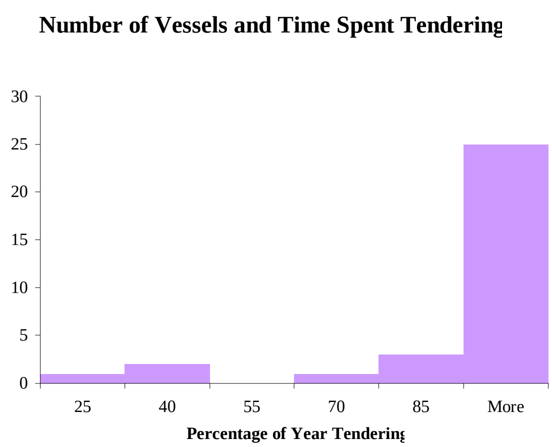

Figure 5. Reported time spent tendering of tender vessels in Alaska in 2013 (100%=total operational time, n=32) (25=0-25%, 40=26-40%, more=86% or more, etc.). Based on data received from AITA.

[2] A survey is generally when a company or agency charters the vessel to do research. Fish and wildlife agencies often do this to learn about sea life populations to accurately set fishing quotas for the coming year (Duz, 2014).

3.3.2 Income and Expenses

Twenty-seven vessels reported their gross income from tendering operations. They reported an average of $258,777 and a median of $250,000. These gross incomes ranged from $21,000 to $600,000 (Table 5).

Thirty vessels also reported their annual maintenance budget.[3] Of these vessels, the average budget was approximately $51,200, with a median of $50,000 and a range of $15,000 to $120,000 (Table 5).

Table 5. Reported gross incomes from tendering operations (n=27) and annual maintenance budgets (n=30) of current tender vessels in Alaska (in dollars). Based on data received from AITA.

	Average	**Median**	**Range**
Gross Income	258,777	250,000	21,000 - 600,000
Maintenance Budget	51,200	50,000	15,000 - 120,000

[3] Some vessels reported a range of values. In these cases, the average of the values was used to compute the average and median. For example, if a vessel reported a maintenance budget of $30,000 to $50,000, $40,000 was used to compute the averages.

Chapter 4: Discussion

The deaths and vessel casualties aboard tenders arose from many different problems, and this chapter proposes individual solutions for each type of casualty category. First, solutions and potential regulation for the fatal events are proposed, followed by the non-fatal events, taking into consideration the AITA survey data completed by individuals in the fleet. The AITA data (Section 3.3) indicate that most tenders spend the vast majority of their year tendering, and also that their incomes (and associated maintenance budgets) from these operations are usually quite limited. This means that the economic burden of each regulation was assessed before the regulation was recommended in this report.

Finally, the current Alternative Compliance and Safety Agreement implemented in the catcher/processor fleet is reviewed, taking into consideration the feasibility and usefulness of this regulation as it relates to the tender fleet. Ultimately, the events and accidents experienced by tenders are very different from other fleets, and the proposed solutions therefore reflect the individualistic nature of the issues at hand.

Throughout this entire analysis, it is important to remember the financial situation of most tender operators. While tenders and regulators understand that safety is a primary goal, regulation that puts many tenders out of business should also be a primary concern. Since tender vessels are usually older vessels that have been repurposed for tendering, they are generally already in poorer condition than vessels in other fleets. The new alternative regulations should therefore find a balance between increasing safety and allowing operations to continue despite minor hazards.

Additionally, the alternative compliance measures should not be subjective measures in which a member of the Coast Guard dictates what they feel is best in a specific instance, but an objective system that tenders can budget for year by year. This will help tenders allocate time and money to certain projects without being surprised by new, expensive repairs at inconvenient times. An untimely and unexpected repair could easily cost a tender operator more than their business is worth, and it is therefore important that regulators and the writers of regulation adhere to a structured, predictable, step-by-step plan that all tenders can allocate resources towards. This will greatly reduce the potential for economically devastating impacts of the new regulation.

4.1 Fatal Events

Between 2000 and 2012, there were only 3 reported deaths aboard tender vessels in Alaska. This number is relatively low, considering that there were 107 total deaths aboard fishing industry vessels in Alaska between 2000 and 2009 (Lincoln & Lucas, 2011). Also between 2000 and 2009, the Bering Sea Aleutian Islands (BSAI) fleet experienced 12 fatalities and the Alaska salmon industry experienced 39 fatalities (Lincoln & Lucas, 2011). While other fleets, such as the Bering Sea Aleutian Islands (BSAI) crab fleet, have already undergone substantial changes in their safety policies because of their very high death rates, the relatively infrequent deaths in the tender fleet have helped slow the charge toward alternative regulation. Yet alternative regulation is imminent, and the new regulations should therefore reflect the real threats in this unique segment of the industry. It is important to remember that these deaths were preventable, and simple, cost-efficient measures should be taken to significantly reduce these risks in the future.

4.1.1 Freon™ Exposure

Freon™ is a type of refrigerant used aboard most tender vessels to keep fish cold during their journey from the fishing vessel to the processing plant. Freon™ is a chlorofluorocarbon (CFC) trademarked by DuPont that comes in many molecular structures, the most common of which aboard fishing industry vessels is currently R-22 (Chlorodifluoromethane) (Duz, 2014).[4] Freon™ is a heavy gas that displaces oxygen when it enters a space, leading to heart arrhythmia or asphyxiation if an individual remains in the contaminated area. Unfortunately, death due to Freon™ exposure can happen in many different industrial workplaces, often when an individual enters a confined space without proper protection or without knowing that the area is contaminated. The Center for Disease Control (CDC) reported 12 deaths in the 1980s due to Freon™ exposure on land (Miller, 1989), and this refrigerant is a persistent threat in the fishing and fish processing industries (Duz, 2013).

In the AITA survey, 27 out of 32 vessels reported using some type of Freon™ and only one reported using ammonia. Although Freon™ can be lethal, simple measures can be taken to significantly reduce the risk of harmful exposure. Freon™ detectors can be installed in at-risk areas with a readout panel in a remote location to warn employees and operators when there is a dangerous leak. These devices can be installed for $600 to $900

[4] Although DuPont has trademarked Freon™, other companies manufacture refrigerants with the same molecular formula and market them under different names. Freon™ is used in this report for readability and because it is the nickname for all of these types of refrigerants in the industry.

per sensor, and the readout panels cost around $1,300 (Duz, 2013). Compared to other repairs and expenses, these detectors are quite affordable, and they are a very effective way of reducing the risk of Freon™ exposure.

Although many tenders may not have these detectors already installed, the detectors are a simple solution to a deadly threat. Freon™ exposure is a serious issue in many industrial workplaces, and the risk of death should therefore be taken seriously. Freon™ detectors aboard tender vessels will surely prevent future deaths, and they should be required in all tenders that use Freon™ as a refrigerant.

4.1.2 Fall from Dock, Intoxication

One individual in this study died because they fell from the dock, intoxicated by alcohol. Unfortunately, regulating alcohol consumption by commercial and recreational fishermen is an extremely complex topic and cannot be adequately addressed in this report. The Occupational Safety and Health Administration (OSHA) (and in some cases state occupational safety and health agencies) generally regulates safety on docks. However, alcohol consumption usually occurs during non-working hours and is thus outside the scope of occupational safety regulators' enforcement. Proposing specific regulations for the tender fleet related to incidents of this type is therefore unproductive, as the nature of this death is beyond the scope of this analysis.

4.1.3 Overloading

Overloading, which resulted in one death in this study, is another preventable issue. Overloading occurs when a vessel carries too much weight or carries too much weight above the waterline, which destabilizes the vessel and significantly increases the risk of capsizing and downflooding. These events are usually a result of a human error when an operator makes poor decisions and knowingly destabilizes the vessel. Thus, the most important and useful way to avoid overloading is to limit unwise management decisions made by operators. However, other measures may also be taken to reduce the risk of overloading and encourage safe practices. Some of these potential regulations are described below, but it is important to keep in mind that the best decisions will involve the ideas and efforts of many parties.

In other fishing fleets, vessels are required to undergo stability analyses, in which an outside party calculates the amount that the vessel can safely load onto their vessel without significantly increasing the risk of capsizing. However, these stability tests are extremely expensive. A single test can cost $25,000, which is almost half of the average yearly maintenance budget as reported by AITA tenders. While 20 out of 32 vessels in the AITA survey reported having completed a roll or stability test, more than half of those tests occurred before 1991. Usually, new stability tests are required whenever a vessel undergoes a significant modification, and since some tenders have made significant changes to their vessel, many existing stability tests are likely inapplicable now. Thus, even though about two-thirds of reporting tenders have completed a stability analysis at some point in the past, most will need to complete new one, and many current owners will not be able to do so because of the test’s associated economic burden.

Putting tenders out of business as a result of requiring stability tests would be detrimental to both the tender fleet and those who depend on tenders for their services (including fishing vessels and processors). Therefore, if the Coast Guard decides that some type of stability test is necessary, it should seek to create an alternative to the traditional stability test. This test should be cost-effective, and it should provide some leniency in operations for tenders. It may prescribe how much a tender vessel can load on board, but it should not require the full mathematical analysis required for other fleets. Rather than being an extremely rigid, strict system, the analysis should leave some room for operations to continue despite small hazards on vessels.

It is also important that the requirements are implemented over a long time period to allow tenders to adjust to the new regulations. Implementing a stability test in a matter of two years (a very short time frame) would cause unnecessary burden on tenders, and this burden is unwarranted because of the relatively few instances of overloading disasters aboard the vessels. Although some sort of stability test may be inevitable, the test's design should take into account the economic challenges faced by the fleet.

Another alternative to a traditional stability tests might be regulation that dictates where tender vessels can operate without a stability test. One of the longest and most dangerous voyages that tenders undergo is the trip across the Gulf of Alaska, a large body of water near the southeast corner of the state (Duz, 2014). This is an especially dangerous crossing because of its length and exposure, as other vessels may not be available to come to the rescue if problems arise.

Regulating tender voyages across this body of water may help reduce the risks associated with overloading, and there are many options for increasing safety here without requiring costly tests and analyses. First, the Coast Guard could require tenders without a current stability report to make this crossing without loads on deck, thus improving stability. Alternatively, they could require tenders to either make this crossing simultaneously with another vessel or operate within a designated distance from shore. These measures might allow tenders to continue to operate in safer, more protected waters without costly regulation. Of course, dangerous waters are still a serious threat along shorelines and a vessel may still encounter trouble in these areas, but the increased protection, as well the closer proximity to rescue personnel, make coastlines somewhat safer for voyages.

The Coast Guard could enforce these rules by accessing a vessel's Automatic Identification System (AIS), which tracks the vessel and allows others to view its location. Since all tender vessels either already have AIS systems or will be required to use them in the near future (Lee, 2014), this would not be an added cost to tender operators, making this type of regulation both effective and cost-efficient.

Again, while the suggestions described above may help avoid overloading disasters, the most important factor in these accidents is the human factor. The ultimate solution to avoiding overloading casualties and fatalities is proper decision making on behalf of the operator, and their knowledge and experience is key. Even though solutions with a price tag are often appealing when forming regulation, it is important to remember that the operator is truly the most important variable when analyzing these issues.

4.2 Non-Fatal Events

The hurdles experienced by the Alaskan tender fleet are much different than those of the entire fishing vessel population. Data of all non-fatal vessel losses in Alaska and the West Coast between 2000 and 2010 indicate that 6 out of 129 (27%) of the disasters that led to non-fatal events aboard Alaskan fishing vessels were a result of being struck by a wave (Lincoln *et al.*, 2012), whereas only 1 (5%) of the vessels in the non-fatal events for tenders occurred because a vessel was struck by a wave (Fig. 2). Similarly, instability was a factor in 11 out of 129 (9%) non-fatal events in Alaska fisheries at large (Lincoln *et al.*), whereas this was not a factor in non-fatal events on tenders. Finally, 35 out of 126 (27%) non-fatal events on fishing vessels occurred because the vessel struck bottom or rocks (Lincoln *et al*.), whereas this occurred in 8 out of 21 (38%) events aboard tenders.

Thus, it is clear that tenders require specific regulations that will help mitigate issues that pertain directly to this fleet. Applying the current ACSA program or the regulations that are used in the BSAI crabbing fleet would be ineffective and fiscally burdensome for tender operators, and the subsequent sections seek to propose realistic and helpful solutions to the issues faced by tender vessels. Solutions for each type of vessel casualty are discussed individually (striking rocks/ocean floor, fires/explosions, flooding, collision/allision, and struck by large wave), as well as the human errors that resulted in casualties (falling asleep, drug use, and navigational error).

4.2.1 Striking Rocks or the Ocean Floor

The largest proportion of vessel accidents occurred because a vessel struck rocks or the bottom of the sea floor (8 out of 21, or 38%). These types of incidents are usually due to human error, and solutions to these issues are proposed in the *Human Error* section on page 50 under *Falling Asleep At Helm*.

4.2.2 Fire and Explosion

The second most common type of vessel casualty was fire or explosion, accounting for 5 out of 21 (≈24%) events. These serious events often exhibit warning signs before occurring, and although the data in this report do not show the cause of these incidents, fires and explosions are often due to human errors of neglect and poor maintenance, which generally have simple solutions.

The Coast Guard could therefore implement simple, cost-effective regulations that should mitigate the risk of fires and explosions aboard vessels. These requirements may include an annual inspection of the sleeving on fuel hoses, hydraulic hoses, and fittings on these hoses to reduce the risk of fire. The regulation may also require proper storage of flammable materials, (for example, away from the engine) the use of metal flooring on steel vessels (as opposed to wood, which ignites easily, especially when soaked with oil), and/or a visual inspection of electrical wiring and equipment. Evidently, these are all general maintenance procedures that necessitate proper attention.

Additionally, most tenders must already undergo periodic surveys as required by their insurer. This means that the vessels are already being inspected for some issues, and requiring additional inspections would be feasible. Twenty-six out of 32 tenders in the

AITA questionnaire replied that their insurer required periodic surveys, while only 6 responded that surveys were not required. Most of the tenders were required to complete a survey every 2 to 4 years, with a range of frequency from 1 to 5 years. While an inspection every 5 years may be insufficient, tenders are already accustomed to the process, and regulators should therefore consider implementing additional inspections or broadening the scope of the current inspections to reduce fire and explosion risks.

Although fires and explosions can likely be avoided by paying attention to general maintenance without serious financial burden, extra measures may be necessary if these options prove inadequate. Subsequent regulation could require some crewmembers or operators to participate in basic fire prevention and fire fighting classes to enhance fire safety knowledge, and these classes would be a relatively inexpensive solution. While these classes are often helpful, it will also be important to specify who must be trained, because it would likely be impractical to require every member aboard the vessel to complete a training course. As with other fishing fleets, many crewmembers arrive in the summer from far away to work. They usually do not have time to participate in a fire safety class before boarding a vessel, and the classes are often not offered near their hometown or at necessary times. Thus, requiring every member aboard the vessel to complete a course would place a logistical and economic burden on the tender. It may be more feasible, then, to require certain key operators or managers to complete a course so that their knowledge can be applied to the vessel. Therefore, while fire safety classes could be a helpful solution to tenders’ issues, it would be important to specify who must complete the training.

More advanced systems are also available if fires persist. Fixed systems, which generally put out a fire in a closed space by filling the room with a gas or chemical extinguishing agent, are a more sophisticated type of fire fighting equipment that require airtight spaces to be effective (United States Department of Labor, 2014). Indeed, some tenders have already implemented this technology. In the AITA survey, half (16) of tenders reported having fixed fire systems.

However, fixed systems have serious drawbacks, and since installing a fixed system can cost an operator thousands of dollars, other regulatory standards should be implemented before resorting to these measures. When a fixed system is activated, the entire vessel must be shut down without power for hours, leaving it adrift in the ocean until the engine room may be safely accessed again, posing new hazards to the vessel and crew. Furthermore, fixed systems may not be effective when a fire occurs. Ultimately, these systems should not be the first line of defense in fire prevention or fire fighting aboard tender vessels. Smaller preventive actions, such as routine maintenance procedures and the use of appropriate construction materials, are generally much more effective.

Thus, the Coast Guard should implement a compliance checklist for tenders to follow to reduce their risk of fires and explosions. The associated inspection should be at clear time intervals with very little room for inspector interpretation or subjectivity, and if the vessel does not comply with the checklist they should be given time to perform the maintenance to bring them into compliance. If this type of regulation is not effective in reducing fires and explosions after multiple years, the Coast Guard and operators could consider extra measures such as additional fire prevention courses, fire fighting training, or the installation of fixed systems. In general, however, many fire prevention strategies are not very costly, and both tender operators and regulatory agencies should consider implementing simple solutions as a way to significantly limit vessel casualties in a cost-efficient manner.

4.2.3 Flooding

Four out of 21 (≈19%) tender vessel casualties involved flooding. While flooding can have disastrous consequences for both the vessel and those aboard, there are many simple steps that owners and operators can take to significantly reduce their chances of experiencing a flooding event. Similar to the previous section on fires and explosions, the Coast Guard could effectively use a checklist of general maintenance procedures to increase vessel safety.

Tender vessels generally flood as a result of downflooding, in which an initiating event, such as a failed watertight hatch, a rogue wave, or improper through hull fittings leads to water entering one or more of the ships compartments (Duz, 2014). Water from that flooded area then enters other spaces on the vessel, ultimately leading to a large flooding disaster. Luckily, there are simple, routine maintenance procedures that can help reduce the risk of flooding. The Coast Guard, along with other involved parties, should therefore formulate a checklist much like the one proposed for the *Fires and Explosions* section (Section 4.2.2). This checklist would include inspecting the vessel's hull materials for watertight integrity, and it should also ensure that fittings are not corroded and safe for use. Again, this checklist should be an objective list that tenders can follow year by year, and it should also have steps to be implemented over a substantial period of time (multiple years) to reduce financial burden.

Since tenders are often older vessels converted from previous fishing boats, they may use something called a "doubler" to reinforce the hull of their vessel, which may also pose a flood risk. A doubler is often installed when a piece of steel on the hull of the vessel becomes rotten and weak. Instead of replacing the steel with a new piece, some operators layer a piece of steel on top of the old one to enhance the hull. In general, this is not the safest solution to these issues, but it is much more cost-effective for operators who may be under financial stress. In the AITA survey, there were 20 steel tender vessels. Of those boats, 11 reported using doublers. When polled about what percentage of their hull was covered in doublers, values varied greatly, ranging from 1 percent to 80 percent.

Replacing these doublers with new hull plating would be extremely expensive. Seattle shipyards typically charge $2,000 to repair a small 12 inch by 12 inch section, and a full sheet of steel may cost as much as $50,000 to replace (Duz, 2014). The prices vary greatly based on the location and condition of the vessel structural members, too. For example, if fuel tanks must be gas freed,[5] or if equipment must be removed and reinstalled, prices increase. These potential repairs have very high costs that would likely put many tenders out of business, considering that the median annual maintenance budget for tenders is about $50,000. Yet some regulators might suggest that tenders replace their doublers to reduce their chances of flooding. However, the casualty data do not show that

[5] Before performing repairs around or near a confined space, especially a fuel tank, the space must be cleared of all combustible gases and liquids. These procedures become very expensive rather quickly, as the tanks are usually drained, cleaned, and then filled with an inert gas so that the welder does not cause an explosion.

tenders need to undergo such an expensive process, as there were no cases of doubler failure reported in the data of tender casualties. Simpler maintenance may be just as beneficial.

Thus, similar to the issues posed in the *Fires and Explosions* section, simple, cost-effective measures should help decrease the number of vessel casualties aboard tenders, and these issues should therefore be given first priority. Furthermore, expensive repairs, such as replacing doublers, would be cost prohibitive for many operators and the expense would place an undue burden on the fleet. Thus, there are many solutions to the problems faced by tenders that will allow vessels to increase safety and also continue operations, and those solutions should be the primary interest of regulators and operators.

4.2.4 Collision and Allision

There were 3 vessels (≈14%) that experienced collision or allision (an instance where one vessel strikes a fixed object) events. Collision and allision often arise due to the same issues in the *Striking Rocks or Ocean Floor* and *Navigational Errors* sections, and the same solutions are therefore proposed. These suggestions can be found in the *Human Error* section (Section 4.3.1) under *Falling Asleep at the Helm* on page 50 and the *Navigational Error* section (Section 4.3.3) on page 54. Solutions that keep watchpeople awake and alert and solutions that enhance navigational knowledge are likely the same solutions that would help reduce these collision and allision events, and they should therefore be strongly considered to prevent tender accidents in the future.

4.2.5 Struck by Wave

There was one instance in this report where a vessel was struck by a large wave. While this may be considered a "freak accident" and there may not be a realistic, helpful solution to addressing this isolated incident, there are simple measures that vessels can take to reduce their risk of harm if they were to be struck by a wave. These solutions have already been discussed in this report, and they are discussed in more depth in the *Overloading* subsection (Section 4.1.3) of the *Fatal Events* section on page 39. While these solutions may not have helped this particular incident of being struck by a wave, they nevertheless would increase tender vessel safety and would be realistic solutions to the pervading problems at hand.

4.3 Human Error

4.3.1 Falling Asleep at the Helm

Falling asleep at the helm was the most commonly reported human error (7 out of 12 instances). These errors resulted in the vessel either striking rocks or the bottom (5 out of 7) or a collision or allision event (2 out of 7). Therefore, to prevent many of the non-fatal events that occur, finding a way to keep individuals alert and awake at the helm would be a very advantageous solution. Generally, operators in the tender fleet are especially susceptible to falling asleep at the helm because of the long hours and limited staff on board. Tenders often spend all day and night receiving fish deliveries and traveling from one location to the next, and when the crew size is small (2-3 individuals), the long, monotonous hours and rolling seas can lull even the most caffeinated individual to sleep. Luckily, there are many cost-effective solutions to keep tender operators awake at the helm.

Watch alarms, also called bridge alarms or bridge navigational watch alarm systems, are one of the most effective ways to ensure that operators remain alert. These inexpensive pieces of equipment generally display a local signal (often in the form of a flashing light) at designated time intervals where the operator is located. The operator must then switch off the alarm, usually by pressing a button or moving his arm in front of the sensor, indicating that he or she is alert and awake. If he or she does not switch the alarm off, however, a louder alarm will sound, waking him and/or other vessel employees. Safety of Life at Sea (SOLAS), an international maritime safety treaty to ensure basic vessel safety, recently required that watch alarms be used in passenger and cargo ships (with a phase-in period ending in 2018) to address similar issues aboard different vessels (Germanischer Lloyd, 2013). While the price of these systems varies, they generally cost about two thousand dollars for the equipment, which is a relatively low cost for the longevity and utility of these safety systems.

Yet tenders do not frequently report using watch alarms. In the AITA survey, only 5 out of 32 vessels reported using such systems, a surprisingly low number for the issues that they prevent. Because the data show that tender watchstanders are falling asleep at the helm, mandating the installation and use of watch alarms would be an advantageous solution for tenders. Additionally, it may be beneficial to require these alarms to be linked to the vessel’s autopilot and general alarm systems. Since the risk of falling asleep is the greatest when the vessel is running on autopilot, keeping tender operators awake during this critical time would minimize the instances of needless accidents. Further, connecting the alarm to the general alarm system would help notify all other crewmembers of potential emergencies before they have serious consequences.

Since striking rocks or the ocean floor accounted for the largest proportion of all vessel disasters (35%), and of the recorded human errors, falling asleep accounted for over half (≈58%) of these striking-rock incidents (and also all of the collision events), keeping tender operators from falling asleep would likely be one of the most effective solutions to reducing vessel casualties in the tender fleet. The tender fleet and USCG should seriously consider requiring the use of watch alarms to help mitigate tender disasters, especially because they are very cost-effective.

4.3.2 Drug Use

Drug use accounted for 3 out of 12 (25%) reported human errors, and all 3 instances resulted in the vessel striking rocks or the ocean floor.

Unfortunately, the data studied in this thesis are insufficient to reach a conclusion and propose solutions for reducing errors related to drug use, and the nature of tenders exacerbates this challenge. The data do not distinguish between types of drugs used, including the distinctions between illegal substance abuse and alcohol consumption, which would be an important differentiation to make when proposing drug-related regulation. Additionally, tenders face other logistical challenges, including a limited number of employees onboard and lack of administrative oversight or support. This suggests that proposing drug use regulation, even if this data better described the incidents, would be a great logistical challenge. Essentially, the shortcomings of the data set and realities of tendering make any potential regulation an ineffective use of resources, and other methods would likely be more beneficial.

It would be much more advantageous to enforce more realistic measures, such as requiring watch duties to be performed with an effective watch alarm. Watch alarms, which keep an individual alert and notify others if that individual has failed to do their duty, will likely significantly reduce the risk of the most common type of incidents that tenders face. The limited knowledge we have of drug use aboard vessels and the logistical challenges associated with tenders makes the aforementioned solutions the most effective.

4.3.3 Navigational Error

There were 2 instances (≈16% of the total human errors) of navigational errors in this data set, both of which led to the vessel striking rocks or bottom. This is a much less predominate type of human error in the fleet, but simple measures can be taken to reduce the risk of navigational errors. For instance, the USCG could require some operators or watchmen to complete navigational classes to increase their knowledge of general operational procedures and navigation techniques. Similar to the discussion on firefighting and fire prevention classes on page 45, it would not be feasible to require *all* employees aboard a tender vessel to complete courses in navigation because of their temporary employment and place of residence. However, it is important that at least some members of the crew have a thorough understanding of proper navigational practices. If some operators have completed a course and are competent in their skills, it would be beneficial for them to train other individuals on the vessel to increase general safety.

Navigational errors were only reported twice in this data set, but navigational classes for some specific employees would be a simple, effective solution to reducing these errors.

4.4 Current Alternative Compliance and Safety Agreement

The current Alternative Compliance and Safety Agreement (ACSA), used by the catcher/processor (C/P) fleet, is a lengthy document with many requirements. While some of the regulations may be helpful for increasing safety and staff competency, many of the measures are very expensive and would not adequately address the issues faced by the tender fleet as identified in this data set. It would therefore be very ineffective and foolish to simply implement this program in the tender fleet.

Applying the current ACSA to tenders would put many operators out of business. The catcher/processor fleet has a much greater income than the tender fleet (Duz, 2013), and C/P vessels and owners can therefore afford to make many of the changes required by the agreement. In order for tenders to remain in business, however, they must be allowed to use the least extensive changes necessary for safety, yet ACSA often calls for the most comprehensive maintenance procedures. This would impose an insurmountable financial burden without much benefit.

Furthermore, ACSA would not even address many of the issues faced by tenders. One of the predominant causes of vessel casualties in this data set was hitting rocks or the ocean's floor. The expensive maintenance required by ACSA would do little to address this issue, and the problems should therefore be solved with more effective, affordable solutions. The regulations proposed in this chapter would be more worthwhile for all involved parties, and regulators should therefore look towards a different type of alternative regulation for the tender fleet rather than modifying the current ACSA document.

Chapter 5: Conclusion

While this analysis lays a foundation for the future regulation of the tender fleet, the best regulations will arise out of a collaborative process between operators, owners, captains, regulators, inspectors, safety experts, and other individuals with a connection to the tender segment of the fishing industry. The regulations proposed in this thesis should therefore be understood as *recommendations* or a *starting point* for a discussion, with an understanding that the actual compliance agreement should be reached through a much greater dialogue between various parties.

However, this report's findings do lead to some important conclusions concerning the direction of the new regulation. After analyzing the data, communicating with regulators, safety experts, and tendermen, and reading websites, books, and legal documents, it remains abundantly clear that the current ACSA would not be an advantageous solution to the problems that tenders face. In many cases, it would ruin individuals' businesses and destroy family incomes, and it would be much more beneficial to implement simpler, more cost-effective measures that focus on alleviating the actual risks that have been documented in this report. In general, these new regulations should keep in mind a few main issues, including:

1. The **limited income** of tenders. Tenders have a very limited gross income and maintenance budget when compared to other fleets. Regulators should therefore consider the cost of any potential regulation,

2. The **timetable** in which maintenance is required. Regulations should have a clear, objective timetable of repairs and maintenance to perform. This will allow tenders to budget for maintenance expenses with minimal surprise, *and*,
3. The **objectivity** of inspections and maintenance procedures. Inspectors and regulators *must* remain objective when carrying out inspections. Regulations should not be subject to change based on an individual inspector's opinions, which could create unforeseen financial burdens for operators.

In addition to these general considerations, and based on the data of past tender casualties, the following specific regulations are proposed as a *starting point* to increase worker and vessel safety aboard tenders in the United States while also allowing most tenders to continue operations. The solutions are arranged from less expensive to more expensive, but they should all be considered to address the accidents that tenders have already experienced. The potential regulations include:

1. An alternative regulation to the stability test, which *might* include one or more of the following: Requiring **vessels without a current stability report** to make **long crossings in pairs and/or stay within a designated distance from shore and/or make crossings without loads on deck,** especially when crossing the Gulf of Alaska.
2. Install **watch alarms** that are linked to both the vessel's autopilot and general alarm systems,
3. Require some vessel operators to complete a **navigational course** before operating the vessel,

4. Create a **routine compliance checklist** to ensure that the vessel is not at risk of **fires and explosions** (to be carried out at designated intervals by a surveyor or an individual from the United States Coast Guard),
5. Create a **routine compliance checklist** to ensure that the vessel is not at risk of **flooding** (to be carried out at designated intervals by a surveyor or an individual from the United States Coast Guard), *and,*
6. Install **refrigerant leak detectors** in spaces that have refrigeration equipment.

Expensive repairs and maintenance, such as replacing doublers or installing fixed firefighting systems, would be financially burdensome for most, if not all, tenders. Therefore, the less expensive compliance measures should be implemented first and given time to take effect. If the initial proposed regulations do not adequately address tendermen's issues and the same problems persist, then other measures may be considered.

Lastly, it is important to remember that tendermen can spend large sums of money on expensive and time consuming repairs, but unless the small, simple issues are addressed (such as keeping operators awake at the helm), progress toward safer operations will ultimately be slow, if not impossible. The greatest return on any investments in tender vessel safety will come from the small, operational changes that are implemented, which will both keep tenders in business and maximize their safety at sea. It is therefore of the utmost importance that operators, regulators, and other involved parties work together toward an effective, objective, and cost-efficient regulatory plan for tenders, ensuring that the regulations are the best course of action for all involved parties.

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