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Preventing fatal winch entanglements in the US southern shrimp fleet: A research to practice approach

Jennifer M. Lincoln, * Chelsea C. Woodward, Grant W. King, Samantha L. Case, Devin L. Lucas, Theodore D. Teske

Western States Division, National Institute for Occupational Safety and Health, Centers for Disease Control and Prevention, USA

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ABSTRACT

Introduction: During 2000–2011, 35 injuries (8 fatal) involving winches were reported to the Coast Guard in the Southern shrimp fleet. Injuries involving the main winch drums had a higher risk for fatal outcomes compared to injuries involving the winch cathead (RR = 7.5; 1.1–53.7). The objective of this study was to design effective solutions to protect deckhands from entanglement hazards posed by winches found on the vessels in the Southern shrimp fleet. *Methods:* Based on injury characteristics, site visit observations, and input from vessel owners, NIOSH determined that the design and implementation of effective main-winch guarding was a feasible first-step in mitigating the entanglement hazard. Design considerations for stationary guards favor systems that are simple, affordable, durable, unobtrusive, and will not interfere with normal fishing operations. In addition, an auxiliary-stop method was tested to prevent entanglements in try-net winches. *Results:* Standardized passive guards were designed for three commonly found main winch models. Initial prototype guards have been sea-tested. The design of six additional guards is underway, for a total of three iterations for each winch model identified. These will incorporate features found to be valued by fishermen, will be more efficient, and will reduce the overall cost of fabrication and maintenance. Sea testing of these iterations continues. The auxiliary-stop circuit control prototype system was designed to prevent entanglements in the try-net winch and is currently being sea tested. *Discussion:* NIOSH has completed initial designs for stationary-winch guards. Through collaborations with shrimper associations and safety groups, the successfully tested winch guard and auxiliary stop designs will be made available to qualified welders and craftsmen to use. This approach has proven effective in preventing other types of winch injuries. *Practical applications:* Injury epidemiologic methods and industry input are an effective way to identify workplace hazards and to design effective safety interventions to control hazards.

1. Problem

In August 2012, a 15 year old boy died when his clothing became caught in a rotating deck winch on a shrimp vessel in the Gulf of Mexico. This fatality received widespread press coverage and led to an epidemiologic investigation of winch hazards on shrimp vessels by the National Institute for Occupational Safety and Health (NIOSH) Commercial Fishing Safety Research and Design Program. NIOSH found that during 2000–2011, 35 injuries (8 fatal) involving winches in the southern shrimp fleet were reported to the United States Coast Guard (USCG). Injuries involving the main winch drums had a higher risk for fatal outcomes compared to injuries involving the winch cathead (RR = 7.5; 1.1–53.7). Fatal outcomes were also associated with being alone on the vessel (RR = 5.8; 2.1–15.9) (Centers for Disease Control and Prevention [CDC], 2013). The findings highlighted the need for action to reduce the risk of entanglement on board fishing vessels.

Workers in the commercial fishing industry continue to have one of the highest occupational fatality rates in the United States, nearly 25 times higher in 2014 than the rate for all U.S. workers (Bureau of Labor Statistics [BLS], 2015). During 2000–2014, 693 fishermen were killed in the U.S. fishing industry, most commonly by drowning as a result of vessels sinking (344, 50%) and falls overboard (210, 30%). Another 12% of fatalities (81 deaths) were caused by injuries sustained onboard vessels, such as entanglement in machinery. Entanglement fatalities of deckhands in the United States occurred most often in the Gulf of Mexico (Commercial Fishing Incident Database [CFID], 2016). Additionally, NIOSH has shown that most (67%) severe nonfatal injuries occur on deck during the deployment and retrieval of fishing gear (Thomas, Lincoln, Husberg, & Conway, 2001).

Commercial fishing vessels are uninspected vessels. The U.S. Coast Guard (USCG) has authority over the safety of employees onboard these vessels. The Occupational Safety and Health Administration

* Corresponding author at: 4230 University Drive, Grace Hall – Suite 310, Anchorage, AK 99508, USA.
E-mail address: Jxw7@cdc.gov (J.M. Lincoln).

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(OSHA) only has jurisdiction out to three miles from shore and is precluded from enforcement with respect to working conditions regulated by other federal agencies. The USCG does have regulations requiring machine guarding (footnote), but the extent to which these are enforced is limited as evidenced by the lack of guarding on most deck equipment found on commercial fishing vessels.

The Southern shrimping fleet operates in the Gulf of Mexico and off the South Atlantic coast from Florida to North Carolina. A review of the literature found one other study that described entanglement injuries in the shrimp fleet. The study reviewed 19 patients who had been treated at a Texas hospital during 1986–2006, with injuries involving shrimp winches (Schroeder, Viegas, & Carmichael, 2008). All of the injuries were nonfatal, ranging in severity from crushed fingers to transhumeral amputations, and 17 of the 19 injuries were to the upper extremities.

To prevent these types of injuries, experts have recommended that vessel machinery be redesigned or retrofitted with safety features (Burgess, 2001; Husberg, Lincoln, & Conway, 2001). In 2005, NIOSH collaborated with the Northwest fishing industry to address the hazard of winch-related entanglements on fishing vessels that use a purse seine and a hydraulic capstan winch (Lincoln, Lucas, McKibbin, Woodward, & Bevan, 2008). An emergency-stop button located strategically on the winch was determined to be the most effective means for reducing the risk of winch entanglements posed by hydraulic capstan winches. The "e-stop" device was developed, tested, and licensed to a manufacturer for installation on new winches and for retrofitting on existing winches. A similar approach appears to be needed to develop viable prevention solutions to the hazards winches present on shrimp vessels.

The emergency-stop device created for capstan winches typically used in purse-seine fisheries, controls oil flow to and from a hydraulic winch motor (Lincoln et al., 2008). The emergency-stop circuitry when activated, arrests the oil flow which locks the capstan drums and prevents them from turning. However, hydraulically driven main winches for the shrimp fisheries are not widely adopted in the fleet due to cost limitations. NIOSH determined that this proven safety intervention for the Northwest capstan winches was not suitable for the mechanically-driven winches in use in the Gulf of Mexico shrimp fishery.

The objective of this study was to design effective solutions to protect deckhands from entanglement hazards posed by winches found on the vessels in the Southern shrimp fleet.

2. Background information on winches

There are two types of winches commonly used on commercial side-trawl shrimp boats to deploy and retrieve the nets; the main winch, and a try-net winch. To better understand the entanglement hazards associated with winch use, the following operation and physical descriptions are provided.

Side-trawl shrimp vessels typically employ multi-drum main winches mounted in the same frame located on the aft deck (see supplement, Fig. 1). These winch drums each wind a single wire rope that is bridled to multiple strands of wire cable that attach to the main trawl nets. The main winch drums are typically connected mechanically and are driven through a single power-take-off linkage system from the vessel's main engine. To engage or disengage the power to the main winch, one of two winch operators swings a bar or pushes a knobbed control cable. A cathead spool mounted on the end of each winch shaft spins when the power-take-off mechanism is engaged. Each winch operator is required to manually guide the retrieved cable evenly onto the drum with a pivoting lever. Guiding the cable requires the operator to exert considerable force pushing and pulling the pivoting lever. Typically, inadequate or no machine guards are present to prevent the worker from falling into or becoming entangled in moving machinery or the cable.

A smaller winch, the try-net winch, is similarly located on the aft deck under the house roof and adjacent to the main-winches. The try-net winch spools a lighter wire rope that drags a small net used to sample the expected catch of the main trawls (see supplement, Fig. 2). Unlike the longer retrieval frequency interval of the main winches, the try-net winch is used to check the small trawl net every 20 to 30 min while the larger trawl nets are out. The catch in the small net provides an estimate of what the larger trawl nets may contain. A try-net winch is commonly driven by an electric motor, whereas the main winch drums are mechanically driven. The electric motor start/stop controls for the smaller winch are ordinarily mounted above the winch on the house roof (see supplement, Fig. 3). The main shaft of the try-net winch also has a cathead solidly mounted. The operator stands near the winch and reaches up to the winch motor controls mounted on the house roof to switch the electric motor on. The try-net main shaft and cathead spin whenever the motor is energized. The operator partially rotates a clutch arm to engage the try-net winch spool to the spinning shaft and starts the wire rope to be retrieved. While the clutch arm is maintained engaged, the operator pivots a bar that has captured the wire rope to wind the line evenly onto the spool. The clutch and level-winding operation is similarly used in the operation of the main-drum winches. To turn off the power to the try-net winch, the operator again stands near the spinning cathead to reach the control switch mounted on the house roof.

3. Methods

This study identified ways to reduce the risk posed by these two types of winches commonly used on commercial side-trawl shrimp boats, the main winch and a try-net winch.

3.1. Design for stationary guards for the main deck winches

Since the main deck winches are associated with fatal injuries, the initial focus of the project was to design effective guarding for the main deck winches. Utilization of machine guarding, similar to that used in other industries, would reduce the risk of worker entanglement. Design considerations for stationary guards favor systems that are simple, affordable, durable, unobtrusive, applicable to various winch models, will not disable other vessel functions, nor interfere with normal fishing operations.

In the Fall of 2013, NIOSH awarded a contract to Tool Inc. of Marblehead, MA to conduct a dockside survey of side-trawl shrimp vessels to identify the three most common main winch types and to design standardized passive guards for each type.

The first iteration of the passive guard designs for each of the three models were then built and tested at sea. These sea trials were performed on working commercial shrimp boats. Owners and crewmen working on these subject vessels provided ongoing evaluations of design features that they saw as beneficial, as well as those features that proved to be cumbersome, non-robust, or interfered with fishing or maintenance operations. The information collected during sea trials was then used to improve the second design iterations of prototype guarding.

3.2. Design for auxiliary stop for the try-net winch

NIOSH engineers considered multiple safety interventions to prevent entanglements, and to reduce the severity of injuries while operating a try-net winch. The try-net winch motor start/stop controls are mounted on the house roof so workers cannot reach the controls to shut down power to the winch if entangled. The severity of injury to an entangled worker would be reduced if the power to the winch could be readily turned off. The development of an emergency-stop device required retrofitting an electric braking system on the winch motor

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