FAST RESCUE BOAT (FRB) INCIDENT INVESTIGATION REPORT

A. INTRODUCTION

A systematic incident investigation was conducted of the FRB incident which occurred on board a NOAA Ship. The purpose of the investigation was to determine the basic (root causes) and the corrective actions necessary to prevent the incident from ever happening again. The investigation process can be summarized as follows:

Fact Finding

- Gather basic information on the proper way to recover a Fast Rescue Boat (FRB)
- Conduct interviews with all applicable employees including the injured employee
- Re-enact the incident with those directly involved
- Review documentation such as operating procedures, equipment manuals, training records, etc.

Causal Analysis

- An event model was constructed to show causal relationships and to facilitate determining basic causes and correctable opportunities from a management system and operational control perspective
- Verify the event model with the ship captain, chief engineer, and acting chief bosun

Corrective Action Plan Development

- Facilitate an open discussion with the ship captain, chief engineer, and acting chief bosun to determine and agree upon corrective actions that will need to be implemented prior to sailing
- Determine longer term actions to address the management system correctable opportunities

The following sections of the report summarize the incident investigation findings and recommendations. At the end of the narrative report, six sketches/drawings and photos that were referenced in the report are presented.

B. INVESTIGATION REPORT

1. **LOCATION:** NOAA Ship; In port
2. **DATE OF INVESTIGATION:** Summer, 2011
3. **IDENTIFICATION:**
   - **3.1. Type of Incident:** Serious - Disabling (Lost Work Days); Struck By Rotating Manual Winch Handle
   - 3.2. **Date of Incident:** Summer 2011
   - 3.3. **Time:** 13:15 Local Time
   - 3.4. **Area Involved:** Fast Recovery Boat (FRB) Launch and Recovery Station
   - 3.5. **Exact Location:** Immediately adjacent to the winch motor on the inboard side
   - 3.6. **Employee Involved:** wage mariner
   - 3.7. **Job Title:** Skilled Fisherman
   - 3.8. **Equipment Involved:** Winch motor equipped with adaptor sleeve; sleeve cover, proximity limit switch, and manual crank arm

4. **LOSS:**
   - **4.1.** **Nature of Injury:** Compound fracture of upper right arm near elbow; bruised radial nerve
   - **4.2.** **Part of Body:** Right Arm
   - **4.3.** **Property/Equipment Damage:** Adaptor sleeve broken from winch motor; wiring to limit switch pulled out; winch motor shaft bent; winch motor needed to be sent to shop for rewire/repair
   - **4.4.** **Process Loss:** Employee transport to local hospital and air evacuated; ship could not sail until employee could be replaced, winch motor repaired, and incident investigation/corrective action completed.
5. **DESCRIPTION OF INCIDENT:**

The Fast Rescue Boat (FRB) returned to ship side after launching to conduct a man overboard drill as part of the Fleet Inspection process. A crew of four assembled to recover the FRB – the Acting Chief Bosun (ACB) manned the power control station, an AB Deck Hand manned the Bow Line, another AB Deck Hand manned the stern line, and the injured employee manned the manual winch crank station (see **Figure 1** for a sketch indicating the position of the crew and **Figure 2** for a photo showing the locations).

The bow and stern line were secured to the FRB by the deck hands and the fall line and brake release line (used for lowering the boat) were lowered and secured to the lift point on the FRB. The ACB asked for and received verbal feedback from each of the crew members that they were ready for recovery.

Just before jogging the power to remove slack from the fall system, the ACB observed that the lines were twisted. The ACB stopped the recovery at this point and had the fall lines straightened (approximately 30 seconds). The ACB then asked again for, and received verbal feedback that the deck hands were ready for recovery of the FRB. The ACB proceeded to jog the power to remove slack prior and ensure that all lines were secure. Immediately after applying power, there was a loud "bang" sound. The injured employee moved toward the ACB position with obvious arm injuries having been struck by the manual crank arm that rotated quickly when power was applied to the winch. The impact caused the adaptor sleeve and manual crank arm to break away from the winch motor and when it struck the deck caused the loud "bang" sound heard by all in the vicinity. (See **Figure 3** for position of manual crank arm and adaptor sleeve location immediately after the incident).

The operation was suspended at this point and medical care rendered to the injured employee.

6. **PERTINENT FACTS**
   - **6.1.** During normal powered operation, the manual winch handle should only be inserted into the adaptor sleeve onto the winch motor shaft when the FRB has been recovered to the deck cradle position and after the davit limit switch cuts power to the motor. Once the FRB reaches this position, the davit is manually cranked the final few inches to align the davit for insertion of a pin that secures the FRB davit. The crank should then be removed and stowed in position behind the winch motor. For this incident, the injured employee inserted the manual crank handle prior to starting to recover the FRB from the water to the deck position.
   - **6.2.** There is a limit switch mounted on the bottom of the crank handle adaptor sleeve. The opening of the adaptor sleeve is covered by a metal plate that is secured by a top and bottom threaded studs

and wing nuts. When ready to insert the manual crank handle, the cover plate is designed to be rotated downward to trigger the limit switch and kill power to the motor. (See **Figure 4** for a drawing of the winch motor showing limit switch/cover plate location and **Figure 5** for a sketch of the cover plate and limit switch configurations). For this incident, the cover plate was configured in the opposite direction where it did not activate the safety limit switch. (See **Figure 3** for a photo of the configuration immediately after the incident). The winch motor limit switch is a redundant safety control since the davit limit switch would be triggered first in normal operation when the FRB reaches position to be manually cranked into final position.

6.3. The lower stud did not have a wing nut and was painted over indicating that the plate was normally rotated up. The design of the cover plate and securing mechanism (two wing nuts) allows rotation and securing in the wrong position and there are no visual cues on the assembly to prompt a person to align properly. (It should be noted that the adaptor sleeve/limit switch/cover plate could not be examined as part of this investigation since it had been sent with the winch motor to a shop for repair).

6.4. After the incident and prior to removing the motor and crank arm adaptor for repairs, the limit switch on the adaptor sleeve was determined to be functional.

6.5. All members of the crew manning the positions for recovery of the FRB were experienced in launch and recovery of small boats including FRBs.

6.6. The person manning the power controls does not have a clear line of site to the winch motor/handle location. At the beginning of FRB recovery, the ACB observed that the manual winch handle was not inserted. It appears that the manual crank handle was inserted during the brief time when the lines were being straightened, just prior to applying power to the winch.

6.7. The procedure calls for five people to conduct the FRB recovery. In this case, four crew members were assigned. Interviews indicated that typically three people are used and the bow line deck hand will move to the crank position after the FRB is in the cradle position and cranks the winch manually to move the FRB davit into a final position where a pin can be inserted to secure the davit.

6.8. The injured employee had manned the bow line position on other FRB recoveries and was familiar with the manual cranking operation and davit functionality.

6.9. Nobody on the ship understood the functionality of the winch motor limit switch or the proper configuration for insertion of the winch handle.

6.10. The FRB recovery was conducted as a part of a man overboard drill for the Fleet Inspection Team operational readiness inspection.

7. CAUSAL ANALYSIS

7.1. A causal relationship model was constructed to facilitate determination of basic (root) causes and identify correctable opportunities from a management system perspective. The model is presented in **Figure 6**. Immediate and basic causes are summarized below.

8. INCIDENT CAUSES

8.1. Immediate Causes

8.1.1. Injured employee Inserted the manual crank arm onto winch motor prior to the FRB being recovered to the deck position and was struck by the crank arm when power was first applied to recover the FRB.

8.1.2. Injured employee did not configure the adaptor sleeve cover plate to engage the limit switch that would have ensured that power was cut to the winch motor.

8.2. Basic (Root) Causes

8.2.1. Procedures:

8.2.1.1. The operating procedure did not include controls to hazards and risks associated with the all aspects of operations including equipment operation and critical safety systems; e.g. controls to ensure safe manual crank operation and configuration of the winch motor limit switch.

8.2.1.2. The operating procedure did not provide details on roles and responsibilities for various crew members and oversight responsibilities.

8.2.1.3. The operating procedure did not include a process, including necessary manning, to provide oversight to safety critical functions.

8.2.1.4. The maintenance procedures, contained in document FRV40-224-093-010 Rescue Boat Handling System, did not have any details on the critical safety systems or their setup. Additionally, these procedures were not known to all personnel involved with the FRB launch/recovery or the davit system.

8.2.2. Equipment Design:

8.2.2.1. The design of the adapter sleeve/limit switch/cover plate did not ensure that the plate is configured in the correct position.

8.2.3. Training:

8.2.3.1. Operator training did not contain critical safety controls for all hazards and risks associated with the FRB recovery operation and associated equipment.

8.2.3.2. Operators and maintainers did not receive training in sufficient detail to understand how to test and maintain critical equipment.

8.2.4. Inspection, Testing, and Preventative Maintenance System (ITPMS):

8.2.4.1. The ITPMS (SAMMS) did not contain sufficient details or instructions to ensure that all safety critical equipment is functioning properly nor did it contain all manufacturer recommended ITPMS items.

8.2.5. Human Engineering:

8.2.5.1. There were no visual cues/instructions/checklists on the equipment or in use by the crew to facilitate remembering how to operate/configure critical safety controls.

8.2.6. Immediate Supervision:

8.2.6.1. The person in charge was unable to provide sufficient oversight due to configuration of equipment and duties that required focus in the direction of FRB vs. equipment and deck hands.

8.2.7. Communication:

8.2.7.1. There was no pre-operational briefing or huddle to do a quick safety overview of the recovery process including the roles/responsibilities of crew members and to ensure that all positions were manned by trained personnel.

8.2.8. Management Systems:

8.2.8.1. A system was not in place to ensure that operators and maintainers understood the content, location, etc. of procedures.

8.2.8.2. A training system was not in place to ensure that all employees associated with the operation received adequate training and proficiency to conduct the operation and to do ITPM procedures.

8.2.8.3. The training system in place did not contain adequate content to cover safety controls to all hazards and risks.

8.2.8.4. A system was not in place to ensure that key personnel that write procedures and supervise operations had sufficient knowledge of safety equipment operation.

9. CORRECTIVE ACTION PLAN

9.1. Develop a comprehensive operating procedure that is based upon a thorough hazard and risk analysis and a review of the operation of all equipment/functions. The procedure should include minimally: proper crew size, configuration, and roles and responsibilities; oversight process; and how the procedure will be monitored to ensure that it is followed. The procedure should contain instructions and a requirement for testing the davit and winch motor limit switches monthly during FRB launch/recovery exercises. **(Addresses 8.2.1.1, 8.2.1.2, 8.2.1.3, 8.2.6.1)**

9.2. Develop a maintenance procedure for all equipment associated with the FRB recovery process. **(Addresses 8.2.1.4)**

9.3. Develop a procedure to require a pre-operations review immediately prior to any FRB recovery operations. This can be a brief "safety huddle" type review with a checklist to remind of critical safety controls. **(Addresses 8.2.7.1)**

9.4. Design the adaptor sleeve/cover plate/limit switch so that it rotates only in the correct direction**. (Addresses 8.2.2.1)**

9.5. Move the manual crank arm location from next to the motor to the push button control station so that the power operator has control of the crank arm until the FRB has been recovered to the deck position. The person operating the manual winch crank arm will need to obtain it from the person at the controls. **(Addresses 8.2.6.1)**

9.6. Revise the SAMMS ITPM system to include details on how to test and maintain the all equipment to manufacturer's requirements. **(Addresses 8.2.4.1)**

9.7. Provide visual reminders at the FRB recovery location to assist operators in remembering key safety functions. This could include laminated checklists, instructions, visuals, etc. affixed with wire or plastic ties. **(Addresses 8.2.5.1)**

9.8. Retrain all applicable crew members on the procedures and conduct exercises to ensure proficiency. **(Addresses 8.2.8.1, 8.2.8.2, 8.2.8.3)**

9.9. Train all operators and maintainers on how to complete ITMP (SAMMS) duties. **(Addresses 8.2.8.2)**

9.10. Develop a training process to ensure that all personnel are aware of the location, structure, and content of operating and maintenance procedures. **(Addresses 8.2.8.1, 8.8.8.3)**

9.11. Develop a training process to ensure that newly assigned personnel are proficient in operations and maintenance duties called for in the procedures.

9.12. Consider having manufacturer representative, fleet experts, or others assist management personnel in understanding all aspects of operating systems and equipment prior to conducting risk assessments and procedure development. **(Addresses 8.1.8.4)**

C. ADDITIONAL RECOMMENDATIONS

During the course of this investigation, additional potential contributing factors were noted. While there was insufficient evidence to directly correlate the factors with the specific incident being investigated, these factors indicate possible system issues that could lead to incidents and operational inefficiencies. It is recommended that OMAO leadership conduct further evaluation of these factors.

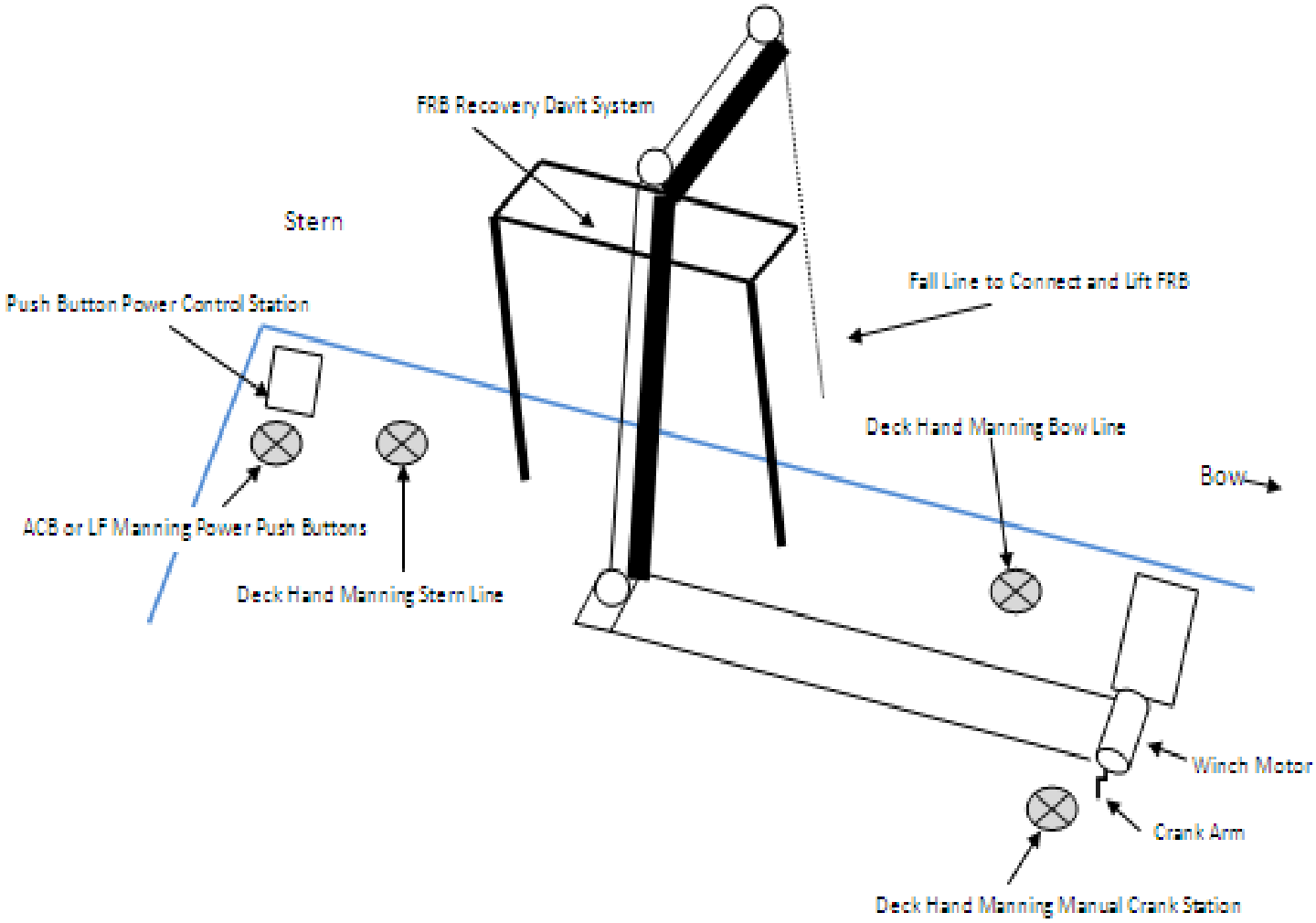
- Staffing/Turnover – concern was expressed relative to base level of training of individuals coming to the ships, time to train on ship specific procedures, use of "augmenters", sourcing of competent staff, etc. Indications were that ships struggle to maintain minimum safe levels of experience manning.
- Burnout – concern was expressed relative to not getting sufficient leave/relief time resulting in burn out and turnover. This factor is related to one above.
- Officer Evaluation/Promotion Criteria – The perception exists that Officer performance is primarily measured by two criteria – days at sea and evaluations by scientists. This provides system pressure on command to sail or conduct operations in at-risk situations.
- SAMMS System/Maintenance Procedures – concerns were expressed that there is a limited understanding of the expectations for the SAMMS, knowledge of use of the system, and lack of resources/time on the ships to properly deploy the system with sufficient content detail.
- Inconsistent Standards between Ships – concerns were expressed that some ships standards and procedures relative to safe conduct of operations are different across the fleet. This may be related to number three above.
- Culture of "Optionality" – some ships fully deploy required safety processes, others may elect not to.
- Fleet Inspection Scheduling – in some cases (as with this ship), the readiness inspection is done as soon as the ship comes off a mission without sufficient time to rest, prepare, see family, etc.
- Overloaded scheduling – since there are limited windows of opportunity to implement fleet-wide programs, they are often done in condensed time frames. For example, on the day of the incident investigated in this report, multiple activities were being conducted such as fall protection training, multiple drills, inspections, securing the shore station, etc. One person described an atmosphere of "controlled chaos".

Addressing these factors from a cultural standpoint would lead to improved operational efficiency and safety as well as reducing maintenance issues.

ATTACHMENTS

The following figures are attached:

Figure 1. Sketch showing approximate positioning of crew involved in recovery of the FRB


FRB Recovery Davit System
Stern
Fall Line to Connect and Lift FRB
Push Button Power Control Station
Deck Hand Manning Bow Line
Bow
ACB or LF Manning Power Push Buttons
Deck Hand Manning Stern Line
Winch Motor
Crank Arm
Deck Hand Manning Manual Crank Station

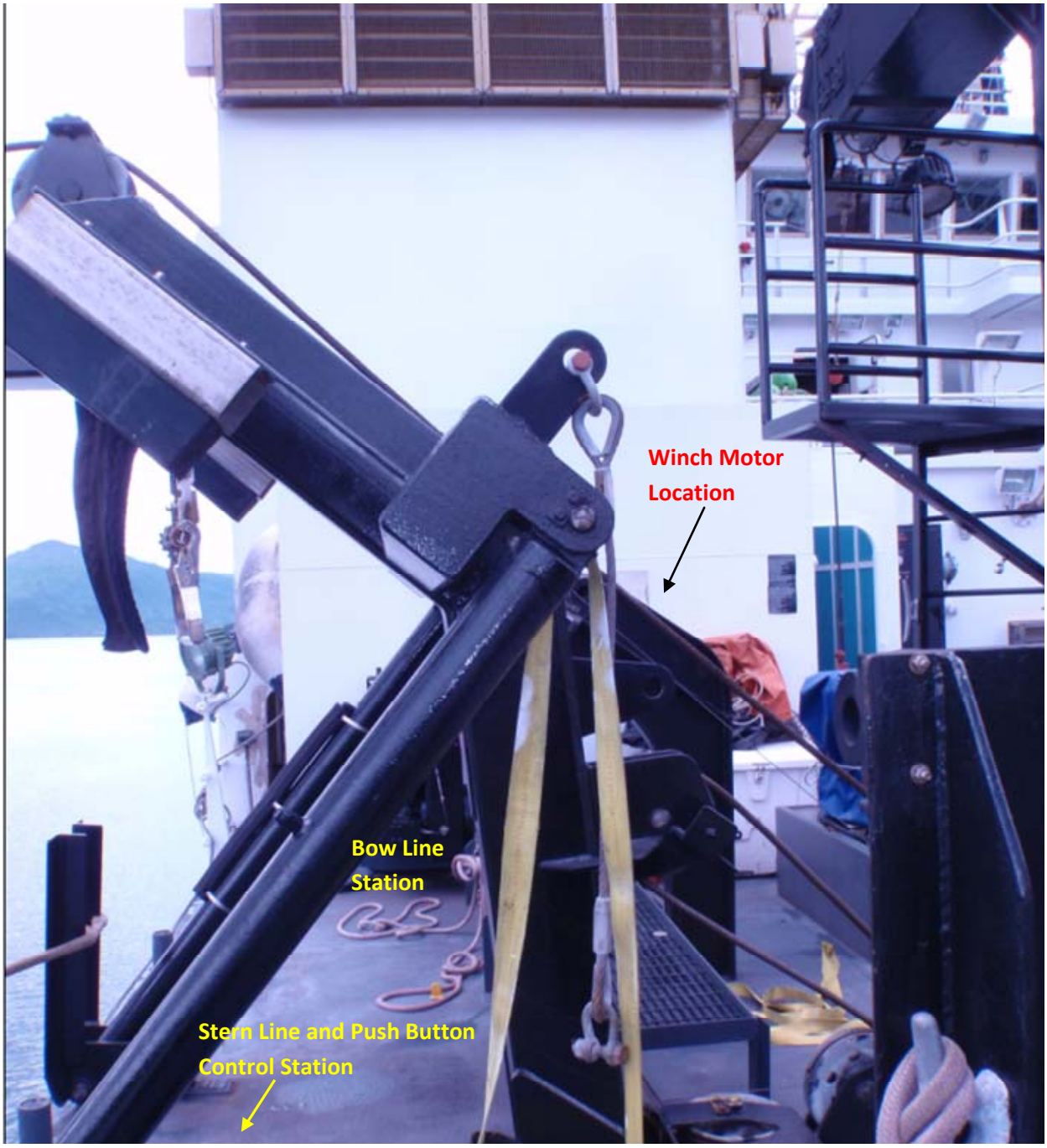


Figure 2. View of Davit System looking from the push button power control station toward the winch motor.

Figure 3. Photo of Winch Motor and Manual Hand Crank Assembly Immediately after Incident. (Note: Adaptor sleeve broke away from the winch motor upon impact with the injured employee).

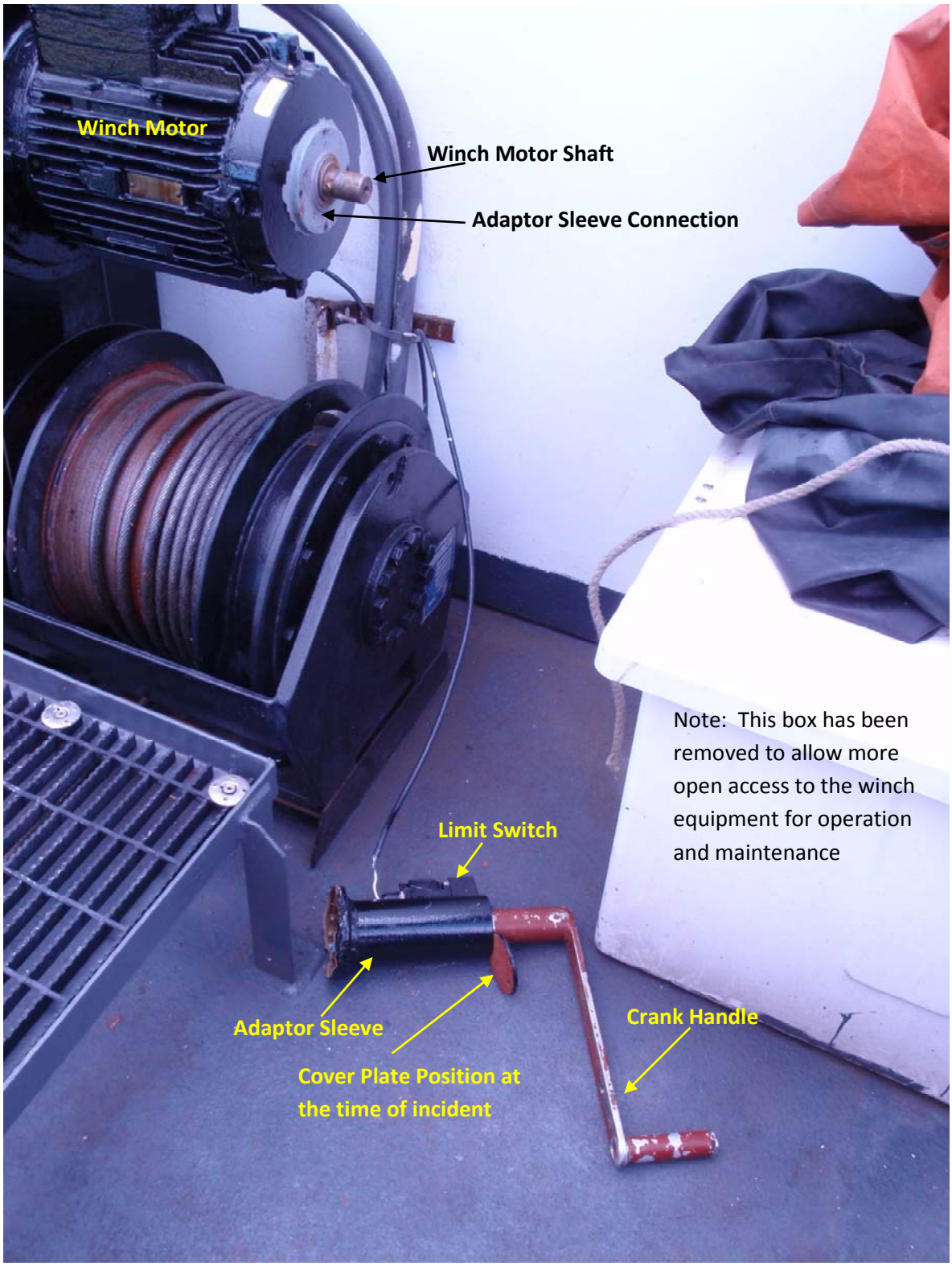


Figure 4. Side views of manual crank handle assembly and limit switch

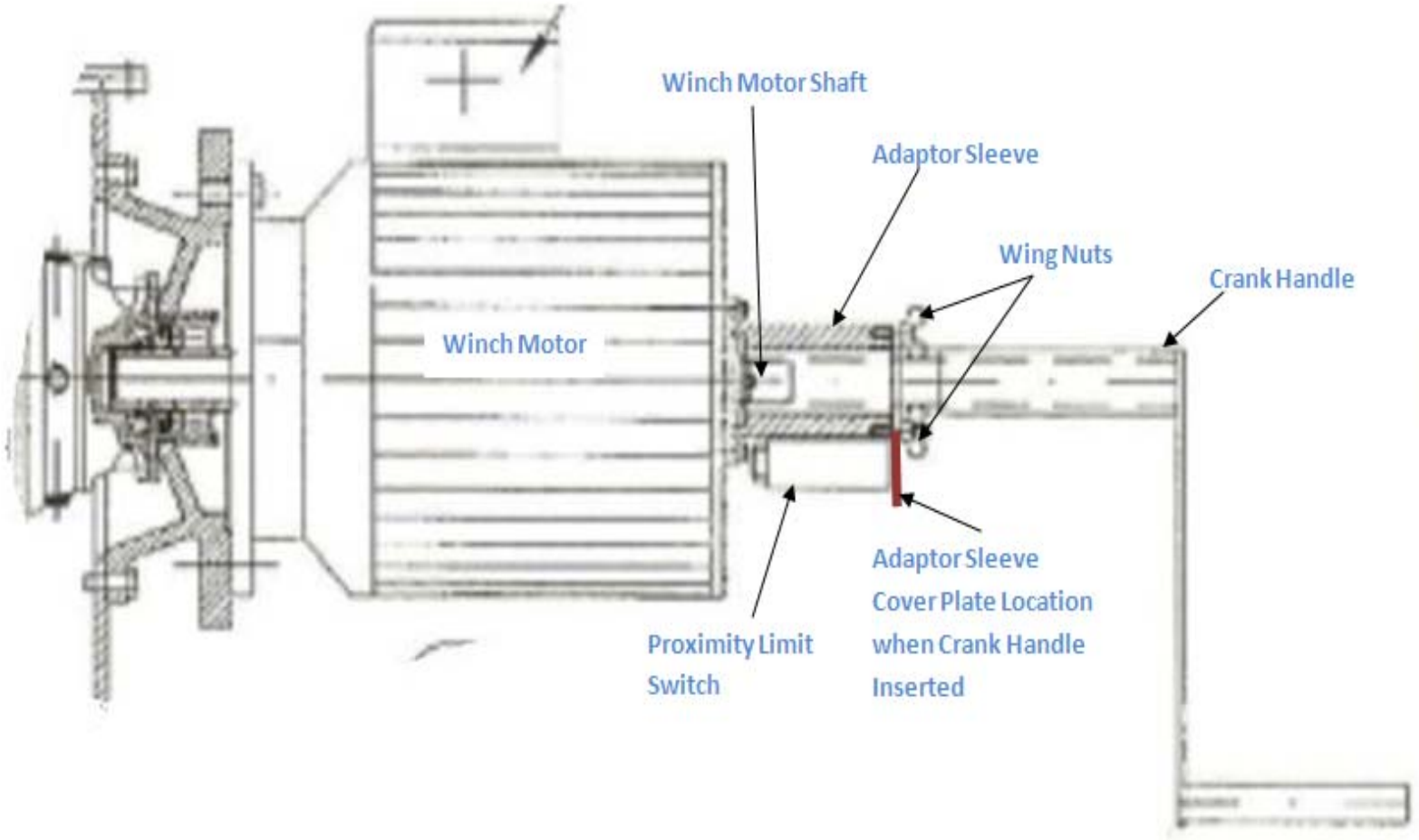
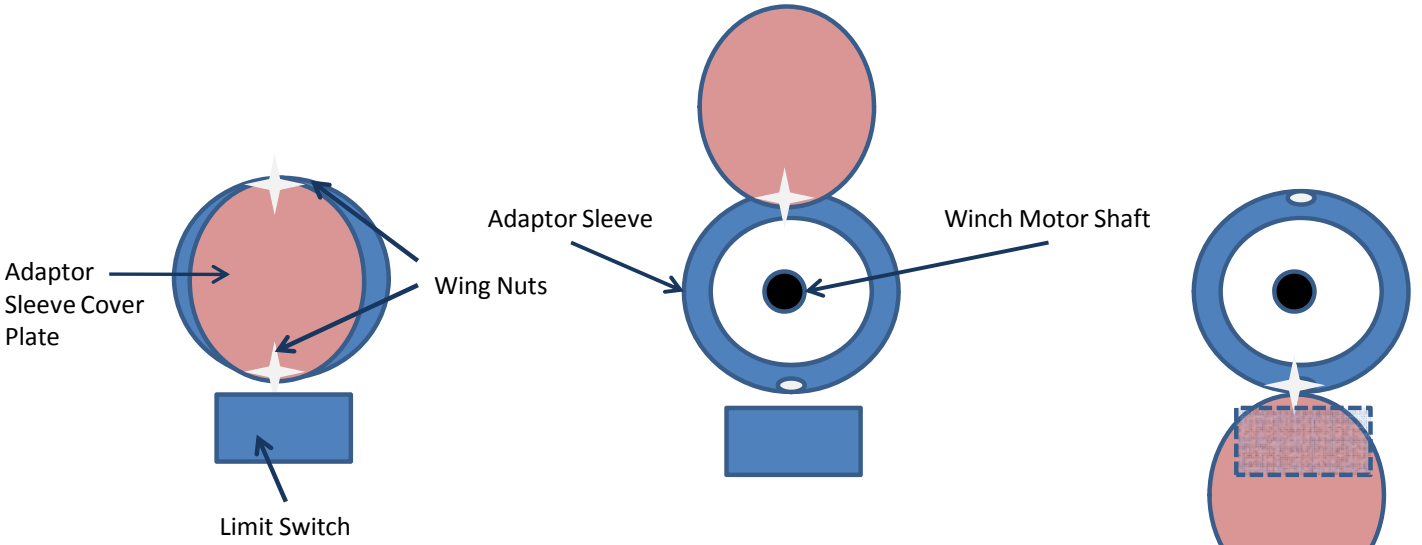


Figure 5. Sketch of Winch Motor Adaptor Sleeve Cover Plate Configurations



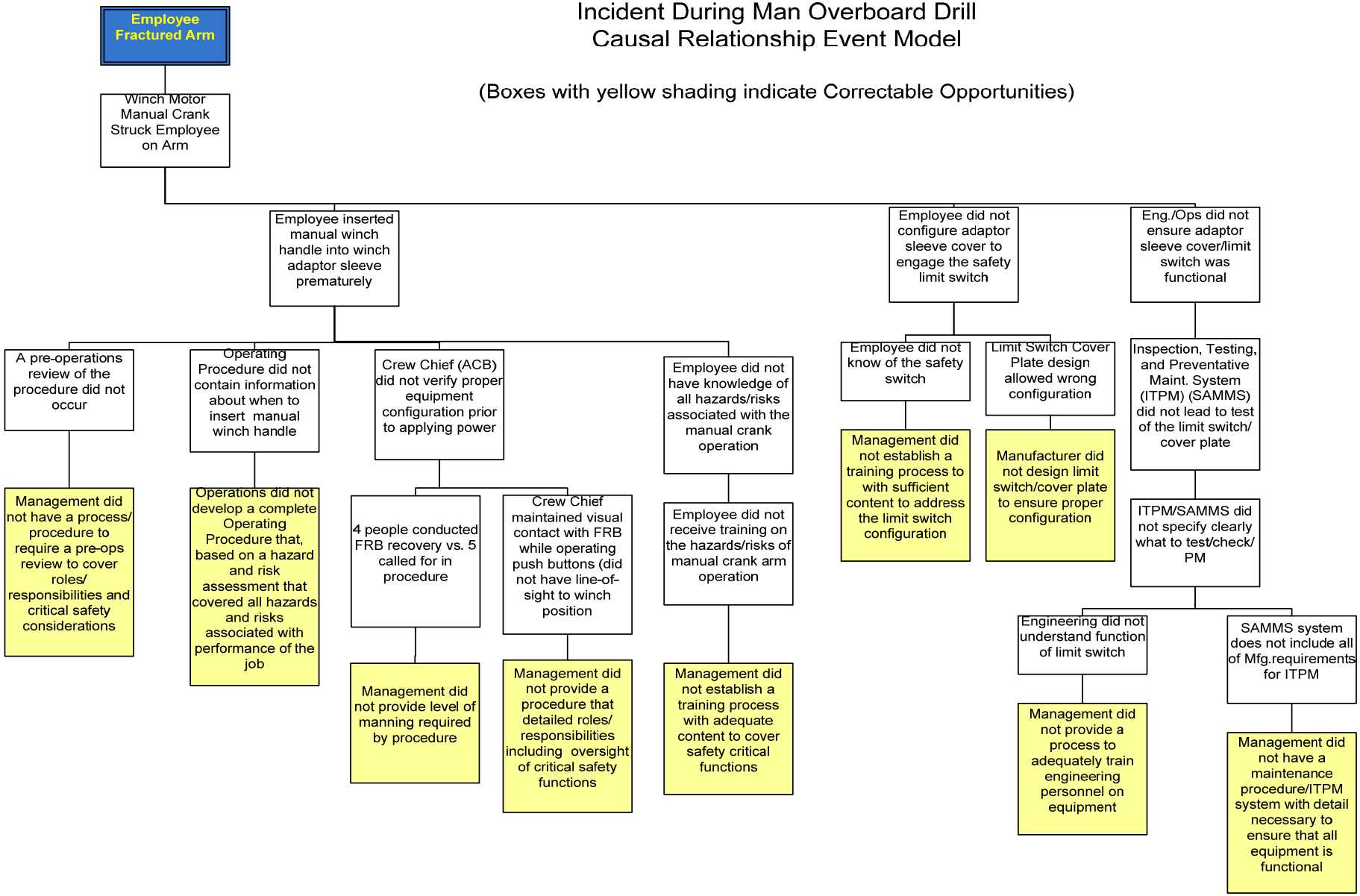
Winch Motor Adaptor Sleeve Cover - Normal Operating Position when Using Power to Winch Unit

Winch Motor Adaptor Sleeve Cover - Rotated to Allow Insertion of the Manual Crank Arm – <u>Wrong Position</u>

Winch Motor Adaptor Sleeve Cover - Rotated to Allow Insertion of the Manual Crank Arm – <u>Proper Position</u> to Activate the Limit Switch that Kills Power to the Winch Unit

Incident During Man Overboard Drill
Causal Relationship Event Model

(Boxes with yellow shading indicate Correctable Opportunities)



End of Report