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RISK-BASED DECISION MAKING GUIDELINES:

A Detailed Hazard Analysis of Lifeboat Inspection/Drill Activities On Foreign-Flagged Deep Draft Vessels

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16. Abstract

Performing U.S. Coast Guard (USCG) inspections and drills on lifeboats of foreign flagged deep draft vessels requires inspection, launching, and recovery of a vessel's small boats. Situations are encountered where the crew is not well trained in lifeboat operations. In these situations, the USCG officer must assess the risks of conducting boat operations. This assessment can include factors such as urgency of the drill, wind, visibility, temperature, experience of the lifeboat crew and deck personnel, fatigue, and potentially changing weather conditions. Due to the many variables involved, absolute standards governing lifeboat inspection/drill decisions do not exist.

The Coast Guard inspection area was selected by Coast Guard Activities Baltimore (ACTBALT) to be examined with a risk tool from the 2nd edition of the Risk-Based Decision-Making (RBDM) Guidelines. The development of a 2nd edition of RBDM Guidelines supports the Office of Design & Engineering Standards' (G-MSE) strategy of developing a risk toolbox for marine safety activities. A detailed hazard analysis used for this activity combined the use of two assessment methods. The two methods used for this study were the Worker and Instruction Safety Evaluation (WISE) and Human error (error-likely situation) review.

Based on the results and insights gained from performing this detailed hazard analysis, the team identified ways to improve personnel and equipment safety during lifeboat operations. The opportunities identified for reducing risk include both procedural and physical design changes. Although there was not a lot of new information created from this analysis, it was effective in generating: 1) a better understanding than what could have been achieved from a higher-level risk screening tool, and 2) specific risk reduction opportunities that would not have been identified from a higher-level risk screening tool.

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risk, risk assessment, hazard analysis, lifeboat drills, lifeboat inspections, risk-based decision-making

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EXECUTIVE SUMMARY

Performing U.S. Coast Guard (USCG) inspections and drills on lifeboats of foreign-flagged deep draft vessels requires inspection, launching, and recovery of a vessel's small boats. Situations are encountered where the crew is apparently not well trained in lifeboat operations. In these situations, the USCG officer must assess the risks of conducting boat operations. This assessment can include factors such as urgency of the drill, wind, visibility, temperature, experience of the lifeboat crew and deck personnel, fatigue, and potentially changing weather conditions. Due to the many variables involved, no absolute standards exist governing lifeboat inspection/drill decisions.

The lifeboat inspection/drill activity was selected by Coast Guard Activities Baltimore (ACTBALT) as an area to be examined with a detailed risk assessment technique. This application area was chosen for study because there are no written procedures for conducting lifeboat inspections/drills for the wide diversity in the types of lifeboat systems. The activity is one that has been done for many years where USCG marine inspectors draw upon their training, experience, and refer to regulations to assess the condition of the lifeboats and crew drills.

Techniques were chosen from the 2nd edition of the Risk-based Decision-making (RBDM) Guidelines. The validation of the 2nd edition of the RBDM Guidelines supports the Office of Design & Engineering Standards (G-MSE) strategy of developing a risk toolbox for marine safety activities.

A good approach for any field unit embarking on developing a risk management strategy is to begin by identifying and prioritizing risks at a high level in their zone. This can be accomplished by performing a high-level port-wide risk analysis of some fashion. This was done as part of another R&D evaluation of a risk tool at ACTBALT, and was in the form of a proof-of-principle mishap-based Preliminary Risk Analysis (PrRA) technique. The PrRA technique is a high-level screening tool that will capture sufficient information for most activity decision-making. However, it may not always characterize the risk of some activities well enough for Coast Guard decision-makers. For those activities that require a better understanding/resolution

of the risk contributors, an appropriate detailed technique would need to be applied. This report documents an examination of the use of a detailed risk analysis tool on an example activity seen as needing better risk resolution.

This risk analysis combined the use of two risk assessment methods. The two methods used for this study were the Worker and Instruction Safety Evaluation (WISE) and human error review (error-likely situation) review. The WISE technique integrates human factor aspects of process hazard analysis and job hazard (task) analysis.

Based on the results and insights gained from performing this detailed risk analysis, the risk team identified ways to improve personnel and equipment safety during lifeboat operations. The suggestions include both procedural and physical design changes.

The risk tools provided a more focused review of lifeboat inspection/drill activities, and thus developed recommendations that the PrRA would not have produced (nor should have produced due to the level of resolution needed from a PrRA). Although there was not a lot of new information created from this analysis, it did prove effective in generating: 1) a better understanding than what could have been achieved from a higher-level risk screening tool, and 2) specific risk reduction opportunities that would not have been identified from a higher-level risk screening tool. This risk tool application was viewed by ACTBALT participants as a fairly difficult process that produced marginal improvements in risk understanding. This stresses the importance of spending more front-end time in framing the decision or types of information needed before proceeding with what can potentially be a resource/time consuming detailed risk analysis. However, the study participants did agree that the general application of a detailed risk tool can provide USCG marine inspectors an ability to take a step back to systematically review the inherent hazards and risks of an activity.

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1.0 INTRODUCTION

Performing U.S. Coast Guard (USCG) inspections and drills on lifeboats of foreign flagged deep draft vessels requires inspection, launching, and recovery of a vessel's small boats. The USCG officer in charge must carefully assess the benefits and risks involved.

Lifeboat operations require a high degree of skill, training, and coordination on the part of the bridge officers, deck crew, and boat crew. Situations are encountered where the crew is apparently not well trained in lifeboat operations. In these situations, the USCG officer must assess the risks of conducting boat operations. This assessment can include considering factors such as urgency of the drill, wind, visibility, temperature, experience of the lifeboat crew and deck personnel, fatigue, and potentially changing weather conditions. Due to the many variables involved, no absolute standards exist governing lifeboat inspection/drill decisions.

2.0 OBJECTIVES

Activities Baltimore (ACTBALT) personnel identify lifeboat inspections/drills as one of the perceived high-risk activities conducted by ACTBALT. Objectives for this proof-of-principle demonstration of a detailed hazard analysis tool are described as follows:

- Objectives related to the R&D project of developing the 2nd edition of the RBDM Guidelines were to evaluate the applicability and effectiveness of applying a detailed hazard analysis tool for a particular type of prevention and inspection planning decision-making activity (i.e., inspection of lifeboat and lifeboat drill activities on foreign flagged deep draft vessels) and to generate results that would provide a worked-out example for inclusion in the 2nd edition of the Risk-based Decision-making Guidelines.
- Objectives specific to the application analyzed were to 1) understand and identify the contributors to a high risk operation that lead to consequences of interest; to 2) recommend ways for reducing the risks associated with the identified hazards; and to 3) document the hazards and potential accidents that can occur associated with lifeboat inspection/drill

activities so this information can be included in USCG training efforts for new personnel conducting these operations.

3.0 SCOPE

The detailed analysis covered bridge functions, deck level functions, bridge-to-deck communications, and bridge-to-boat communications during lifeboat inspections and launch/recovery evolutions.

4.0 SYSTEM DESCRIPTION

The lifeboat inspection/drill activities conducted by ACTBALT personnel involve many different types of deep draft vessels and associated lifeboat systems. Therefore, a description of specific systems and hardware would be unique for a particular vessel and is not provided as part of this analysis. Rather, the following is a brief summary of the general activities and hardware types that may be encountered during a typical inspection/drill activity.

4.1 Lifeboats

Generally, lifeboats are highly capable boats whose rugged construction contributes to the ability to withstand adverse weather conditions.

4.2 Deck Responsibilities

The deck personnel have key functions during lifeboat operations, especially in the lowering/recovery segments.

4.3 Launch and Recovery Systems

Each lifeboat has a dedicated launch/recovery system. Deck personnel are responsible for manning and operating the launch/recovery systems. Engineering personnel are responsible for maintaining mechanical and electrical systems on the lifeboats and on the launch/recovery systems.

5.0 APPROACH

As part of the 2nd edition of the Risk-based Decision-making (RBDM) Guidelines document being prepared for the Marine Safety Office (MSO), the USCG is exploring the possibility of applying system safety concepts, including risk/hazard assessment techniques, to marine safety activities. Because of the wide diversity in the types of lifeboat systems, there are no written procedures for conducting lifeboat inspections/drills. The USCG Foreign Freight Vessel Examination Book contains checklists that provide guidance on key items to inspect and monitor during the activity (available from the Coast Guard upon request). The analysis techniques used for this evaluation focus on what hazards exist at each particular step in a procedure or work instruction. Therefore, because detailed procedures do not exist, the analysis team drafted a procedure of major steps taken during a typical lifeboat inspection/drill activity. Appendix A is a copy of the procedure drafted by the team.

Combining two assessment methods supported the detailed hazard analysis. Each method provides a somewhat different means for systematically identifying hazards and developing meaningful risk reduction recommendations. The two methods used for this study were:

- Worker and Instruction Safety Evaluation (WISE) review
- Human error (error-likely situation) review

A multidisciplinary team was assembled to identify and evaluate lifeboat hazards. The team was comprised of personnel with backgrounds in vessel operations, research and development, and risk/hazard analysis. The analysis was conducted in two ½-day sessions and was conducted on typical deep draft vessels that transit the Port of Baltimore. Team members are listed in Table 1.

Table 1.0 Detailed Hazard Analysis Team Members and Their Organizational Affiliation

Team Member	Organization
LT Ann Bryant	USCG ACTBALT
PO1 Dan Ruggiero	USCG ACTBALT
PO1 Pete Bullard	USCG ACTBALT
Mr. Chuck Mitchell	ABS Group Inc. Risk & Reliability Division
Mr. Bert Macesker[1]	USCG R&D Center

[1] Part-time participant in analysis

5.1 WISE Review

The team used the WISE technique as one means for systematically identifying and evaluating evolution hazards. The WISE approach integrates the human factor aspects of process hazard analysis and job hazard (task) analysis. A WISE analysis involves three steps:

(1) perform a task analysis to identify the required operator actions and their sequence,
(2) identify operator and evolution hazards associated with each step, and
(3) investigate ways to reduce or eliminate hazards, reduce their likelihood of occurrence, or mitigate their potential consequences.

The key elements of the WISE review are defined by the following terms:

Items - distinct action item steps

Deviations - departures from the intended action

Causes - reasons why deviations might occur

Consequences - potential effects of the deviations

Safeguards - features or human actions designed to prevent the causes or mitigate the consequences of the deviations

Actions - recommendations for design or procedural changes

The WISE technique uses a set of guide words (WISEguides) as deviations. Table 2 lists the guide words along with descriptions of their meanings. Although the guide words were developed for application within the petroleum and chemical processing industries, they are still applicable to USCG operations. The team's WISE review of deep draft vessel lifeboat inspection/drill activities is summarized in Appendix B.

Table 2.0 WISE Deviations

WISEguide	Meaning
Missing	The written procedure does not describe an action taken during, or immediately before, the step being examined.
Skip/part of	The worker skips this step (or some part of it) and performs the rest of the procedure correctly. Example: The worker skipped Step X (open lube oil valve), so the compressor burned up when it was started in Step Y.
More	The worker does too much of the specified action or does it too quickly. Example: The worker opened the valve too quickly, causing a water hammer that ruptured the steam line.
Less	The worker does too little of the specified action or does it too slowly. Example: The worker added too little catalyst (Step X), so pressure built up when feed was added in Step Y, over pressurizing the reactor with unreacted feed material.
Out of sequence	The worker performs the steps in a different order than specified by the procedure, possibly as a short cut. Example: The worker added both reactants before starting the mixer.
Other than/reverse	The worker performs some action other than the one specified in the procedure, usually because of confusion or haste. Examples: When reaching for the Valve X control switch, the operator grasped and actuated the adjacent switch for Valve Y. After reinstalling the motor, the electrician wired it to run in reverse.
Caught in/on/by/ between	The equipment entangles a body part or clothing, often because the machine guards are missing or inadequate. Example: The worker's arm was broken when it was caught on the spinning coupling.
Struck by/contact by	The equipment or process material hits the worker. Examples: A forklift ran into a worker or a box toppled off a forklift onto a worker. Acid splashed out of a vat into a worker's eyes.
Contact with/ struck against	The worker inadvertently touches or hits the process. Examples: The pipe fitter hit an unprotected light bulb and was electrocuted. The worker hit his head on a low pipe.
Slip/trip/fall	The worker loses his/her grip or footing. Example: The worker dropped a wrench that punctured the top of the fiberglass tank.
Stress/strain/fatigue	The worker is poorly positioned with respect to the equipment, must frequently repeat a motion, or is overloaded. Example: The worker must carry 50-pound bags up a ladder and empty them into a tank.
Exposure to	The process or location creates an acutely or chronically dangerous work environment — fumes, vibration, noise, heat, radiation, etc. Example: The worker may be exposed to fumes when taking a sample.

Table 2.0 WISE Deviations (continued)

WISEguide	Meaning
Process upset/ malfunction	The process experiences an abnormal condition during this step of the procedure. Examples: The relief valve on Tank X discharges while the worker is checking the level on adjacent Tank Y. The belt breaks while the machine is being threaded.
Layout/traffic/siting	The worker cannot approach or evacuate the area because of permanent or temporary obstructions. Example: The operator was run over as she sprinted from the control room to close an emergency isolation valve.
Tools/equipment	The worker cannot perform the required actions because the necessary tools and equipment (including personal protective equipment [PPE]) are not available. Example: The workers could not promptly isolate the release because the PPE cabinets were engulfed in the cloud.

5.2 Human Error (Error-likely Situation) Review

When contemplating ways to improve human performance, there are two basic types of errors that managers/supervisors must address: 1) errors whose primary causal factors are individual human characteristics unrelated to the work situation and 2) errors whose primary causal factors are related to the design of the work situation. The latter of these two items contributes in creating error-likely situations in the work environment. It has been found that approximately 80 to 85% of human errors result from the design of the work situation (the tasks, equipment, and environment), which managers/supervisors directly control.

To ensure broad coverage of human factors issues, the team consulted the information documented in *A Manager's Guide to Reducing Human Errors* (Chemical Manufacturers Association). This publication describes a number of work situations that influence creation of error-likely situations. Not all are applicable to every work environment. Each applicable work situation was characterized by identifying 1) key areas of applicability within lifeboat operations, 2) strengths and weaknesses in current practices, and 3) recommendations, if any, to address the weaknesses. Appendix C summarizes the assessment of error-likely situations. Table 3 lists the error-likely situations.

Table 3.0 Error-likely Situations

• Deficient procedures	• Violations of population stereotypes
• Inadequate, inoperative, or misleading instrumentation	• Overly sensitive controls
• Insufficient knowledge	• Excessive mental tasks
• Conflicting priorities	• Opportunities for error
• Inadequate labeling	• Inadequate tools
• Inadequate feedback	• Sloppy housekeeping
• Policy/practice discrepancies	• Extended, uneventful vigilance
• Disabled equipment	• Computer control failure
• Poor communication	• Inadequate physical restrictions
• Poor layout	• Appearance at the expense of functionality

6.0 APPLICATION RESULTS

The USCG uses several safeguards in its lifeboat inspection/drill activities that either 1) prevents mishaps of concern from occurring or 2) limit the severity of mishaps of concern. Numerous elements positively affecting operator safety are found in the design of lifeboats and launch/recovery systems and in lifeboat procedures and practices. However, lifeboat operations still are considered among the higher risk evolutions performed by ACTBALT.

Based on the results and insights gained from performing this detailed hazard analysis, the team identified ways to improve personnel and equipment safety during lifeboat operations. The suggestions include both procedural and physical design changes. Documentation for this report's core analyses is found in the Appendices

7.0 APPLICATION RECOMMENDATIONS FOR SYSTEM IMPROVEMENT

The following are recommendations that could further reduce personnel and equipment risk incurred during lifeboat inspection/drill activities. No significance should be placed on the order in which the recommendations appear. These recommendations are strictly the suggestions of the analysis team. Past USCG studies may already address the identified risks.

Recommendation 1 — Consider standardizing the lifeboat inspection and drill requirements for each type of lifeboat equipment.

Throughout the analysis, the team noted significant differences in the way that different crews conducted tests for similar types of lifeboat equipment. In one case, the team noted that the crew preferred to lower the boarding ladder only after the lifeboat is in the water. In this situation, if the ladder came loose when it was lowered, the lifeboat and crew are in the water with no way to board the ship if the lifeboat lift fails. The team recommends lowering the ladder before the lifeboat is lowered to ensure that the ladder is secure and offers an escape route if needed.

By standardizing inspection/drill activities, the team believes that lessons learned from previous incidents can be incorporated into the drill activities to lower the overall risk of the activity. The team also notes that standardizing the inspection/drill activities would require involvement of International Maritime Law organizations because the USCG does not have the authority to enforce "good marine practice" into the conduct of their drills.

Recommendation 2 — **Consider providing new USCG trainees with a checklist or procedure that outlines the lifeboat inspection/drill activities, similar to the procedure developed by the team as provided in Appendix A, for them to follow when initially observing inspections/ drills.**

USCG personnel participating in the analysis observed that much of the information being collected as part of the hazard analysis would be useful for new trainees in the USCG.

These materials could be used by the trainees both as a briefing tool prior to assisting with inspection/drill activities and as a training aid while observing the conduct of these activities.

8.0 OBSERVATION FROM THE DETAILED HAZARD ANALYSIS APPLICATION

Lifeboat inspection/drill activities are among the higher risk operations performed by ACTBALT personnel and foreign flagged deep draft vessels. In spite of its dangers, the USCG has repeatedly demonstrated its capability to conduct such evolutions efficiently and safely. Nevertheless, it was believed that some safety improvement could be realized.

The detailed hazard analysis team used multiple, systematic methods to evaluate lifeboat inspection/drill activities from operations, and human error perspectives. These methods allowed complete coverage of lifeboat issues while analyzing distinct elements in lifeboat operations. Furthermore, the methods are not unnecessarily complex, nor are the results, and should be understandable to personnel not trained in risk/hazard assessment techniques. The team ultimately developed two recommendations for reducing risk, which are presented to the USCG for review and consideration.

9.0 RISK-BASED DECISION-MAKING PROCESS IMPROVEMENT EVALUATION

The following discussion of process improvement is based on an ACTBALT follow-up visit by the R&D Center several months after the proof-of-principle test.

The inspection activity chosen for the analysis is one that has been institutionalized in the Coast Guard for many years. Coast Guard marine inspectors draw upon their training, experience, and refer to regulations to assess the condition of the lifeboats and crew drills. This activity can be generally classified as prevention and inspection planning for monitoring of port and waterway operations.

The results from this study do not significantly change the findings from the preliminary risk assessment conducted for Port of Baltimore activities as part of another R&D study. Overall, the preliminary risk assessment was a good first pass at assessing port risks, especially considering the level of resolution needed at that phase. Implementing all of the recommendations generated from the preliminary risk assessment should lower these risks. The results of this detailed study provided a more focused review of lifeboat inspection/drill activities and thus developed recommendations that the preliminary risk assessment would not have produced (nor should have produced due to the level of resolution needed from a preliminary risk assessment).

Although there was not a lot of new information created from this analysis it was effective in generating 1) a better understanding than what could have been achieved from a higher-level risk screening tool and also 2) specific risk reduction opportunities that would not have been identified from a higher-level risk screening tool. Even though there was an improved understanding of the risks associated with this activity it was seen by ACTBALT participants as a fairly difficult process that produced marginal benefit. The application of the detailed risk tools to a different activity might have produced more significant findings. This stresses the importance of spending more front-end time in framing the decision or types of information needed before proceeding with what can be a resource consuming detailed risk analysis. The analysis has served as an example analysis for inclusion in the draft 2nd edition of the RBDM Guidelines.

The objectives specific to the application analyzed were met in that there was 1) a better understanding of the contributors to a perceived high risk operation, 2) a set of recommendations generated for reducing risk, and 3) a more structured view of steps and risks in each step for this activity that could serve as a training template for less experienced USCG inspectors.

Two other risk tools were tested at the same time as the detailed risk analysis tool. A risk change analysis on the upcoming OPSAIL 2000 marine event and the PrRA, already discussed. Appendix D provides a hypothetical discussion on how the different risk tools analyzed as part of the ACTBALT proof-of-principle tests can be tied together to form a risk management strategy for a port. In the short term, ACTBALT staff do not feel they have much use for detailed risk assessments before performing a broad-brush look at port risks, activity costs, and areas where the COTP has influence.

Based on this proof-of-principle test and the other tests at ACTBALT, some general observations can be made:

- Activity-based cost models must correlate with risk models to demonstrate value added by Coast Guard prevention and response activities.
- Detailed risk analysis must be prudently selected to avoid overly complex analysis that provides marginal additional value to decision-makers.
- ACTBALT staff interviewed felt comfortable with the qualitative implementation of these techniques and their added value to existing decision-making processes.

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APPENDIX A

Lifeboat Inspection/Drill Procedure
Foreign-flagged, Gravity-davit, Open Lifeboat Inspection/Drill Procedure

Pre-briefing

1. Review appropriate documents, check logs, etc.

Pre-drill inspection

2. External davit inspection
3. External lifeboat inspection
4. lifeboat inspection
5. Internal support equipment inspection

Lifeboat drill operations

6. Sound alarm from bridge
7. Crew arrives with lifeboat equipment and PPE
8. Check muster list
9. Two persons board lifeboat, prepare boat for lowering, and depart boat
10. Bracing (gripes) removed
11. Release safety ladder
12. Lower boat to embarkation deck
13. Lower safety lines
14. Deploy frapping lines
15. Engineer, and others as necessary, board lifeboat
16. Release tricing pendants
17. Release frapping lines
18. Deploy forward and aft sea painters, start engine, perform radio check
19. Lower lifeboat to water
20. Release hooks, engage engine, release sea painters
21. Reverse engine, pull away from ship, and return to ship

Lifeboat recovery operations

22. Re-deploy painters, engage hooks, untangle cables
23. Secure engine
24. Raise lifeboat to embarkation deck
25. Install frapping lines
26. Disembark all personnel
27. Perform brake test
28. Board and install tricing, and depart
29. Raise lifeboat into davit and test limit switch

30. Manually crank lifeboat into permanent storage position
31. Reinstall bracing (gripes)
32. Raise embarkation ladder
33. Dismiss personnel and secure drill

APPENDIX B

Lifeboat Inspection/Drill WISE Worksheets

The proceedings of the WISE review were recorded in Table C.1. The table comprises six columns: **Item Number**, **Deviation**, **Causes**, **Consequences**, **Safeguards**, and **Recommendations**.

The first column, **Item Number**, represents a distinct action item step in the inspection/drill evolution. The procedure, which was developed by the analysis team and is presented in Appendix B, was broken down into distinct steps so that each step could be evaluated in detail.

The second column, **Deviation**, is defined as an upset from normal operations. The WISE technique uses a set of guide words to facilitate evaluation of potential upset conditions/situations. Table 2 in the body of this report lists and defines the guide words. Although the guide words were developed for application within the petroleum and chemical processing industries, they are still applicable to USCG operations.

Causes of each deviation are listed in the third column of the worksheet. Generally, only functional failures, human errors, single equipment failures, or external conditions (winds, seas) were considered because these typically are the most significant causes of deviations.

The **Consequences** column identifies the mishaps of interest associated with a particular deviation. If the team found no applicable mishaps or no mishaps at all stemming from a deviation, "No consequences of interest" was entered into the table. The one exception was in the "Missing" deviation, in which "No missing steps identified" was entered.

Safeguards (column 5) are equipment features, procedural steps, or operator actions intended to (1) reduce the likelihood of one or more causes producing consequences or (2) reduce the severity of the given consequences.

The last column in the worksheet, **Recommendations**, refers to specific suggestions that are described as recommendations in the report. The suggestions were developed based on analysis team discussions and include hardware additions, procedural upgrades, documentation reviews, and policy/guidance changes. These recommendations are strictly the suggestions of the analysis team. Past USCG studies may already address the identified risks. More effective ways may also exist for protecting against hazards, and some recommendations may not be practical or cost-effective.

TABLE B.1 WISE Worksheets

Item Number	Deviation	Causes	Consequences	Safeguards	Recommendations
1.0 STEP - REVIEW APPROPRIATE DOCUMENTS, CHECK LOGS, ETC.					
1.1	Missing		No missing steps identified		
1.2	Skip	Communication barriers with foreign languages Multiple inspection agencies being on board (immigrations, customs) that do not allow adequate time to communicate expectations Time constraints on vessels trying to leave port quickly with pressure to quickly perform inspection/test	Potential to skip later steps because USCG expectations not communicated to crew with the potential for accident/injury or loss of commerce Potential for inexperienced crew to be performing test with the potential for accident or injury later in the test Potential for loss of commerce due to delay in passing the inspection/drill Vessel may be held to an inappropriate standard (i.e., drill is not conducted for the correct vessel)	Flexibility of USCG to work with portions of the crew, so other portions of the crew can work with other agencies Standardized USCG expectations that are conducted/communicated very frequently Minimum of two USCG inspectors are present with at least one being well trained	
1.3	Part of		Same as skip		
1.4	More		No consequences of interest		

Item Number	Deviation	Causes	Consequences	Safeguards	Recommendations
1.5	Less		Same as skip		
1.6	Out of sequence		Same as skip if performed after the drill		
1.7	Other than/ reverse		No consequences of interest		
1.8	Caught in/on/by/ between		No consequences of interest		
1.9	Struck by/ contact by		No consequences of interest		
1.10	Contact with/ struck against		No consequences of interest		
1.11	Slip/trip/fall		No consequences of interest		
1.12	Stress/strain/ fatigue		No consequences of interest		
1.13	Exposure to		No consequences of interest		
1.14	Process upset/ malfunction		No consequences of interest		
1.15	Layout/traffic/ siting		No consequences of interest		
1.16	Tools/equipment		No consequences of interest		

Item Number	Deviation	Causes	Consequences	Safeguards	Recommendations
			2.0 STEP - PERFORM EXTERNAL INSPECTION OF LIFEBOAT DAVIT		
2.1	Missing		No missing steps identified		
2.2	Skip	Fatigue Neglect	Potential to drop the lifeboat during the drill because defective equipment (sheaves, cables) not discovered prior to lowering the boat injuring one or more members of the crew Potential for boat to drop during internal inspection, injuring USCG personnel	USCG awareness of the importance of the equipment integrity to the safety of the drill	
2.3	Part of		Same as skip		
2.4	More		No consequences of interest		
2.5	Less		Same as skip		
2.6	Out of sequence		No consequence of interest if performed prior to internal inspections; otherwise, same as skip		
2.7	Other than/ reverse		Same as skip		
2.8	Caught in/on/by/ between		No consequences of interest		

Item Number	Deviation	Causes	Consequences	Safeguards	Recommendations
2.9	Struck by/ contact by		No consequences of interest		
2.10	Contact with/ struck against		No consequences of interest		
2.11	Slip/trip/fall	Hydraulic leak from motors Leakage from drums stored on deck in vicinity of lifeboats	Person overboard Slip on hydraulic fluid	PPE (hard hats, gloves, steel-toed boots, personal flotation devices [PFDs]) worn by inspectors	
2.12	Stress/strain/ fatigue		Same as slip/trip/fall		
2.13	Exposure to	Adverse (inclement) weather	Person overboard Exhaustion Frostbite	PPE (PFDs, insulated coveralls)	
2.14	Process upset/ malfunction		No consequences of interest		
2.15	Layout/traffic/ siting		No consequences of interest		
2.16	Tools/equipment		No consequences of interest		

Item Number	Deviation	Causes	Consequences	Safeguards	Recommendations
			3.0 STEP - PERFORM EXTERNAL INSPECTION OF LIFEBOAT		
3.1	Missing		No missing steps identified		
3.2	Skip	Fatigue Neglect	Potential for lifeboat to sink when placed in the water if hull integrity was not intact	Crew has increased awareness of importance of lifeboat integrity and will generally repair hull damage before inspections	
3.3	Part of		Same as skip		
3.4	More		Same as skip		
3.5	Less		No consequences of interest		
3.6	Out of sequence		Same as skip		
3.7	Other than/ reverse		No consequences of interest		
3.8	Caught in/on/by/ between		No consequences of interest		
3.9	Struck by/ contact by		No consequences of interest		
3.10	Contact with/ struck against		No consequences of interest		

Item Number	Deviation	Causes	Consequences	Safeguards	Recommendations
3.11	Slip/trip/fall	Hydraulic leak from motors Leakage from drums stored on deck in vicinity of lifeboats	Person overboard Slip on hydraulic fluid	PPE (hard hats, gloves, steel-toed boots, PFDs) worn by inspectors	
3.12	Stress/strain/ fatigue		No consequences of interest		
3.13	Exposure to		No consequences of interest		
3.14	Process upset/ malfunction		No consequences of interest		
3.15	Layout/traffic/ siting		No consequences of interest		
3.16	Tools/equipment		No consequences of interest		

Item Number	Deviation	Causes	Consequences	Safeguards	Recommendations
			4.0 STEP - PERFORM INTERNAL INSPECTION OF LIFEBOAT		
4.1	Missing		No missing steps identified		
4.2	Skip	Fatigue Neglect	Potential for boat to drop during internal inspection, injuring USCG personnel	Visual inspection of integrity of hooks prior to entering lifeboat Visual inspection of locking pin on release lever prior to entering lifeboat USCG awareness of the importance of the equipment integrity to the safety of the drill	
4.3	Part of		Same as skip		
4.4	More		No consequences of interest		
4.5	Less		Same as skip		
4.6	Out of sequence		Same as skip		
4.7	Other than/ reverse		Same as skip		

Item Number	Deviation	Causes	Consequences	Safeguards	Recommendations
4.8	Caught in/on/by/ between	Shaft/prop left engaged after last test	Potential for injury to personnel during test of lifeboat engine on the lifeboat that will not be lowered (only the engine is tested at this time on the boat that is not lowered during the drill)	Engine operating instructions for safe engine operation and shutdown during previous test	
4.9	Struck by/ contact by		No consequences of interest		
4.10	Contact with/ struck against		No consequences of interest		
4.11	Slip/trip/fall	Water accumulation, icing, etc., due to leaking covers	Personnel injury	Drain plug is not installed in the hull, which allows continuous draining to prevent water accumulation in the hull	
4.12	Stress/strain/ fatigue		No consequences of interest		
4.13	Exposure to		No consequences of interest		
4.14	Process upset/ malfunction		No consequences of interest		
4.15	Layout/traffic/ siting		No consequences of interest		

Item Number	Deviation	Causes	Consequences	Safeguards	Recommendations
4.16	Tools/equipment		No consequences of interest		

5.0 STEP - PERFORM INTERNAL INSPECTION OF LIFEBOAT SUPPORT EQUIPMENT (This step was not evaluated because there is no impact on port risk. The only impact would be that crew could not survive if the lifeboats were used at sea [i.e., it is not a port risk issue].)

Item Number	Deviation	Causes	Consequences	Safeguards	Recommendations
6.0 STEP - SOUND ALARM AND CREW ARRIVES AT MUSTER STATION (Steps 6 - 8)					
6.1	Missing		No missing steps identified		
6.2	Skip		No consequences of interest		
6.3	Part of		No consequences of interest		
6.4	More		No consequences of interest		
6.5	Less		No consequences of interest		
6.6	Out of sequence		No consequences of interest		
6.7	Other than/ reverse		No consequences of interest		
6.8	Caught in/on/by/ between		No consequences of interest		
6.9	Struck by/ contact by		No consequences of interest		
6.10	Contact with/ struck against		No consequences of interest		
6.11	Slip/trip/fall		Minor potential for slips, trips, and falls while crew is gathering at the muster station		
6.12	Stress/strain/ fatigue		No consequences of interest		
6.13	Exposure to		No consequences of interest		
6.14	Process upset/ malfunction		No consequences of interest		

Item Number	Deviation	Causes	Consequences	Safeguards	Recommendations
6.15	Layout/traffic/ siting		No consequences of interest		
6.16	Tools/equipment		No consequences of interest		

Item Number	Deviation	Causes	Consequences	Safeguards	Recommendations
7.0 STEP - TWO PERSONS BOARD LIFEBOAT, PREPARE TO LOWER BOAT, AND EXIT BOAT (Steps 9 - 11)					
7.1	Missing		No missing steps identified		
7.2	Skip		Same as part of		
7.3	Part of	Communication error or inattention to detail - crew member does not release davit Failure to install drain plug	Only one davit released, damaging equipment and delaying drill and eventual transit of the vessel Lifeboat will take on water if plug is not installed, potentially capsizing or sinking the lifeboat	Drill leader ensures that both davits are released and that plugs are installed before lowering the boat	
7.4	More		No consequences of interest		
7.5	Less		No consequences of interest		
7.6	Out of sequence		Some vessels may board lifeboat after the boat is in the water, in accordance with that ship's policy		1
7.7	Other than/ reverse				

Item Number	Deviation	Causes	Consequences	Safeguards	Recommendations
7.8	Caught in/on/by/ between	Caught in safety ladder when boarding or departing the boat	Potential for crew member to be thrown overboard	All crew members are wearing PFDs	
7.9	Struck by/ contact by	Untrained crew members in vicinity of swinging gripes Attempting to perform drill too fast	Crew struck by swinging equipment when removing gripes	Crew training and experience USCG personnel monitoring drill are aware of the hazards and will inform inattentive crew members	
7.10	Contact with/ struck against		No consequences of interest		
7.11	Slip/trip/fall	Slip while boarding lifeboat Lifeboat shifts when gripes removed	Potential for personnel injury	PPE (hard hats, gloves, steel-toed boots, PFDs) worn by inspectors	
7.12	Stress/strain/ fatigue		No consequences of interest		
7.13	Exposure to		No consequences of interest		
7.14	Process upset/ malfunction		No consequences of interest		
7.15	Layout/traffic/ siting		No consequences of interest		

Item Number	Deviation	Causes	Consequences	Safeguards	Recommendations
7.16	Tools/equipment		No consequences of interest		

Item Number	Deviation	Causes	Consequences	Safeguards	Recommendations
		8.0 STEP - PREPARE LIFEBOAT FOR LOWERING TO WATER (Steps 13 - 18)			
8.1	Missing		No missing steps identified		
8.2	Skip		Same as part of		
8.3	Part of	Frapping lines not installed	Lifeboat will swing when tricing pendants are released, potentially throwing a crew member who is in the lifeboat overboard	Trained USCG personnel monitoring drill	
8.4	More	Brake not operated properly	Lifeboat will swing and could hit vessel, damaging lifeboat (no personnel should be in the lifeboat at this time)	Trained USCG personnel monitoring drill	
8.5	Less		No consequences of interest		
8.6	Out of sequence	Tricing pendants released too soon	Lifeboat will swing and could hit vessel while lowering to the embarkation deck, potentially throwing a crew member overboard	Trained USCG personnel monitoring drill	
8.7	Other than/ reverse		No consequences of interest		

Item Number	Deviation	Causes	Consequences	Safeguards	Recommendations
8.8	Caught in/on/by/ between	Engine engaged too soon	Potential for personnel injury	Trained USCG personnel monitoring drill	
8.9	Struck by/ contact by		No consequences of interest		
8.10	Contact with/ struck against		No consequences of interest		
8.11	Slip/trip/fall		No consequences of interest		
8.12	Stress/strain/ fatigue		No consequences of interest		
8.13	Exposure to		No consequences of interest		
8.14	Process upset/ malfunction		No consequences of interest		
8.15	Layout/traffic/ siting		No consequences of interest		
8.16	Tools/ equipment		No consequences of interest		

Item Number	Deviation	Causes	Consequences	Safeguards	Recommendations
		9.0 STEP - LOWER LIFEBOAT TO WATER (Step 19)			
9.1	Missing		No missing steps identified		
9.2	Skip		No consequences of interest		
9.3	Part of		No consequences of interest		
9.4	More	Improper operation of brake	Lifeboat hits water at high rate of speed, potentially injuring crew in the boat	Increased awareness of potential for injury Trained crew member operating brake	
9.5	Less		No consequences of interest		
9.6	Out of sequence		No consequences of interest		
9.7	Other than/ reverse		No consequences of interest		
9.8	Caught in/on/by/ between		No consequences of interest		
9.9	Struck by/ contact by		No consequences of interest		
9.10	Contact with/ struck against		No consequences of interest		
9.11	Slip/trip/fall		No consequences of interest		
9.12	Stress/strain/ fatigue		No consequences of interest		

Item Number	Deviation	Causes	Consequences	Safeguards	Recommendations
9.13	Exposure to		No consequences of interest		
9.14	Process upset/ malfunction		No consequences of interest		
9.15	Layout/traffic/ siting		No consequences of interest		
9.16	Tools/equipment		No consequences of interest		

Item Number	Deviation	Causes	Consequences	Safeguards	Recommendations
	10.0 STEP - RELEASE HOOKS, ENGAGE ENGINE, AND RELEASE SEA PAINTERS (Step 20)				
10.1	Missing		No missing steps identified		
10.2	Skip		No consequences of interest		
10.3	Part of	One hook released too soon	Potential to swamp boat if only one is released with boat above the water line, potentially leading to one or more people falling overboard	PFDs worn by all crew members	
10.4	More		No consequences of interest		
10.5	Less		No consequences of interest		
10.6	Out of sequence	Hooks released before boat reaches water	Hazardous exposure - contact injury	Hard hats worn by all crew members	
			Potential to swamp boat if only one is released with boat above the water line, potentially leading to one or more people falling overboard		
10.7	Other than/ reverse		No consequence of interest		
10.8	Caught in/on/by/ between	Sea painters released at incorrect time (too early or too late)	No consequences of interest — rope caught in propeller		

Item Number	Deviation	Causes	Consequences	Safeguards	Recommendations
10.9	Struck by/ contact by	Swinging hook near boat Sea painter snaps	Personnel injury when hit by swinging hook or sea painter	Hard hats worn by all crew members	
10.10	Contact with/ struck against		No consequences of interest		
10.11	Slip/trip/fall		No consequences of interest		
10.12	Stress/strain/ fatigue		No consequences of interest		
10.13	Exposure to		No consequences of interest		
10.14	Process upset/ malfunction		No consequences of interest		
10.15	Layout/traffic/ siting		No consequences of interest		
10.16	Tools/equipment		No consequences of interest		

Item Number	Deviation	Causes	Consequences	Safeguards	Recommendations
	11.0 STEP - REVERSE ENGINE, PULL AWAY FROM SHIP, RETURN TO SHIP (Step 21)				
11.1	Missing		No missing steps identified		
11.2	Skip		No consequences of interest		
11.3	Part of		No consequences of interest		
11.4	More		No consequences of interest		
11.5	Less		No consequences of interest		
11.6	Out of sequence		No consequences of interest		
11.7	Other than/ reverse		No consequences of interest		
11.8	Caught in/on/by/ between		No consequences of interest		
11.9	Struck by/ contact by		No consequences of interest		
11.10	Contact with/ struck against		No consequences of interest		
11.11	Slip/trip/fall		No consequences of interest		
11.12	Stress/strain/ fatigue		No consequences of interest		
11.13	Exposure to		No consequences of interest		

Item Number	Deviation	Causes	Consequences	Safeguards	Recommendations
11.14	Process upset/ malfunction		No consequences of interest		
11.15	Layout/traffic/ siting		No consequences of interest		
11.16	Tools/equipment		No consequences of interest		

Item Number	Deviation	Causes	Consequences	Safeguards	Recommendations

12.0 STEP – REDEPLOY PAINTERS, ENGAGE HOOKS, AND SECURE ENGINE (Steps 22 - 23) (These steps were not evaluated because they are essentially identical to Steps 20 - 21 [Sections 10 - 11 above].)

Item Number	Deviation	Causes	Consequences	Safeguards	Recommendations
13.0 STEP - RAISE LIFEBOAT TO EMBARKATION DECK (Step 24)					
13.1	Missing		No missing steps identified		
13.2	Skip		No consequences of interest		
13.3	Part of		No consequences of interest		
13.4	More		No consequences of interest		
13.5	Less		No consequences of interest		
13.6	Out of sequence		No consequences of interest		
13.7	Other than/ reverse		No consequences of interest		
13.8	Caught in/on/by/ between		No consequences of interest		
13.9	Struck by/ contact by	Air line on deck ruptures Hook does not hold or prematurely releases	Swinging air line with potential for injury Lifeboat will fall from lift system, potentially leading to one or more persons overboard	Boat will likely fall when initially lifted from water but will not fall a great distance PFDs	
13.10	Contact with/ struck against		No consequences of interest		
13.11	Slip/trip/fall		No consequences of interest		

Item Number	Deviation	Causes	Consequences	Safeguards	Recommendations
13.12	Stress/strain/ fatigue		No consequences of interest		
13.13	Exposure to		No consequences of interest		
13.14	Process upset/ malfunction		No consequences of interest		
13.15	Layout/traffic/ siting		No consequences of interest		
13.16	Tools/equipment		No consequences of interest		

Item Number	Deviation	Causes	Consequences	Safeguards	Recommendations
14.0 STEP - INSTALL FRAPPING LINES, DISEMBARK, PERFORM BRAKE TEST, AND INSTALL TRICING (Steps 25 - 28)					
14.1	Missing		No missing steps identified		
14.2	Skip		No consequences of interest — there is a minimal potential for injury because no one is aboard the lifeboat during these steps except to install tricing		
14.3	Part of		No consequences of interest		
14.4	More		No consequences of interest		
14.5	Less		No consequences of interest		
14.6	Out of sequence		No consequences of interest		
14.7	Other than/ reverse		No consequences of interest		
14.8	Caught in/on/by/ between		No consequences of interest		
14.9	Struck by/ contact by		No consequences of interest		
14.10	Contact with/ struck against		No consequences of interest		
14.11	Slip/trip/fall	Slip when installing tricing	Potential for personnel injury	PPE (hard hats, gloves, steel-toed boots, PFDs) worn by inspectors	

Item Number	Deviation	Causes	Consequences	Safeguards	Recommendations
14.12	Stress/strain/ fatigue		No consequences of interest		
14.13	Exposure to		No consequences of interest		
14.14	Process upset/ malfunction		No consequences of interest		
14.15	Layout/traffic/ siting		No consequences of interest		
14.16	Tools/equipment		No consequences of interest		

Item Number	Deviation	Causes	Consequences	Safeguards	Recommendations
		15.0 STEP - TEST LIMIT SWITCH, CRANK LIFEBOAT TO PERMANENT STORAGE POSITION, INSTALL GRIPES (Steps 29 - 31)			
15.1	Missing		No missing steps identified		
15.2	Skip		No consequences of interest		
15.3	Part of		No consequences of interest		
15.4	More	Limit switch fails	Potential for the lifeboat to continue to lift beyond the upper limit, potentially damaging the lifeboat	Inspectors and crew watching the lifeboat can manually stop the lift	
15.5	Less		No consequences of interest		
15.6	Out of sequence		No consequences of interest		
15.7	Other than/ reverse		No consequences of interest		
15.8	Caught in/on/by/ between		No consequences of interest		
15.9	Struck by/ contact by	Personnel lose hold of gripes when reinstalling	Potential for injury from swinging gripes	PPE	
15.10	Contact with/ struck against		No consequences of interest		
15.11	Slip/trip/fall		No consequences of interest		

Item Number	Deviation	Causes	Consequences	Safeguards	Recommendations
15.12	Stress/strain/ fatigue		No consequences of interest		
15.13	Exposure to		No consequences of interest		
15.14	Process upset/ malfunction		No consequences of interest		
15.15	Layout/traffic/ siting		No consequences of interest		
15.16	Tools/equipment		No consequences of interest		

Item Number	Deviation	Causes	Consequences	Safeguards	Recommendations

16.0 STEP - RAISE EMBARKATION LADDER, DISMISS PERSONNEL, AND SECURE DRILL (Steps 32 - 33) (No hazards identified)

APPENDIX C

Human Factors (Error-likely Situations) Review Worksheets

The error-likely situations described in *A Manager's Guide to Reducing Human Errors* (Chemical Manufacturers Association, 1990) are reviewed in this appendix for applicability to lifeboat operations.

Table C.1 Human Factors Issues for Lifeboat Inspections and Drills on Deep Draft Vessels

Error-likely Situation	Key Areas of Applicability	Strengths in Current Practices	Weaknesses in Current Practices	Actions
Deficient Procedures			No procedures are used	1
Inadequate, Inoperative, or Misleading Instrumentation	Not applicable			
Insufficient Knowledge	Vessel crew USCG inspectors	USCG certification process for deck inspectors	No important weaknesses identified	
Conflicting Priorities	Scheduling inspections/drills	USCG will excuse a vessel from performing a drill if weather contributes to the risk Flexibility of extent of USCG inspection to perform more or less extensive inspections based on vessel history and observed crew performance MSIS system to initially rank vessels before entering port provides indication of priority of performing inspections	No important weaknesses identified	

Table C.1 Human Factors Issues for Lifeboat Inspections and Drills on Deep Draft Vessels (cont'd)

Error-likely Situation	Key Areas of Applicability	Strengths in Current Practices	Weaknesses in Current Practices	Actions
Inadequate Labeling	Lifeboat capacity Vessel name Releasing gear	Required by international law Inspected during pre-drill	All members of multinational crews may not be able to read the labeling	
Inadequate Feedback	Raising/lowering lifeboat	Clear visual contact between drill captain and crews conducting the drill	When English is not used, USCG may not be aware of upcoming actions and does not have an opportunity to help correct a problem	
Policy/Practice Discrepancies	Raising/lowering lifeboat	Pre-drill briefing to describe the overall approach for conducting the drill	Different crews train differently so USCG cannot tell if there is variation	1
Disabled Equipment	Throughout lifeboat drill	Pre-drill inspection will identify issues important to safety and drill will not be conducted if impacted by disabled equipment	No important weaknesses identified	
Poor Communication	First mate and crew of different nationalities Captain and crew of different nationalities USCG and crew if they speak different languages	Use of international hand signal to stop drill if safety issues are observed Crew performing the drill is in contact by radio and/or hand signals	No important weaknesses identified	

Table C.1 Human Factors Issues for Lifeboat Inspections and Drills on Deep Draft Vessels (cont'd)

Error-likely Situation	Key Areas of Applicability	Strengths in Current Practices	Weaknesses in Current Practices	Actions
Poor Layout	Deck area around davits Congested areas	Visual contact achievable throughout drill	Trip hazards from exposed cables/lines	
Violations of Population Stereotypes	None identified	None identified	No important weaknesses identified	
Overly Sensitive Controls	None identified	None identified	No important weaknesses identified	
Excessive Mental Tasks	Throughout lifeboat drill	USCG personnel can recognize crews that are not trained and will stop drill if there are safety issues	No important weaknesses identified	
Opportunities for Error	Throughout lifeboat drill	Equipment is designed for intended use and can be operated safely if personnel are adequately trained	Lack of crew training	
Inadequate Tools	None identified	None identified	No important weaknesses identified	
Sloppy Housekeeping	Davits Lifeboats Lifts	Pre-drill inspection will identify unsafe conditions and poorly maintained equipment	No important weaknesses identified	
Extended Uneventful Vigilance	Not applicable			

Table C.1 Human Factors Issues for Lifeboat Inspections and Drills on Deep Draft Vessels (cont'd)

Error-likely Situation	Key Areas of Applicability	Strengths in Current Practices	Weaknesses in Current Practices	Actions
Computer Control Failure	Not applicable			
Inadequate Physical Restrictions	Crew strength	Crew members must meet physical fitness requirements Drills are not conducted in adverse weather conditions, which could pose safety hazards	No important weaknesses identified	
Appearance at the Expense of Functionality	Not applicable			

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APPENDIX D
TYING THE TOOLS TOGETHER

Coast Guard field unit managers can enhance their decision-making by performing risk assessments to better understand the general nature of risks in their area of responsibility. These risk assessments are often viewed as non-routine activities to address some immediate decision-making activity. However, an enterprise-wide risk management strategy with ties to field unit business plans could be developed using a combination of risk tools. Although, the risk tool tests at ACTBALT were evaluated as separate partial applications and considered proof-of-principle, there is a common thread that can tie them together into a simple continuous improvement strategy. The three risk applications, documented in separate R&D Center reports, were a Preliminary Risk Analysis (PrRA) of the Port of Baltimore, a risk Change Analysis of a hypothesized marine event, and detailed hazard analysis of lifeboat inspection/drill activities on foreign-flagged deep draft vessels.

Pockets in the Coast Guard may have difficulty obtaining and defending resources for controlling risks because relative priorities of risks across the organization are not available to managers making these resource allocation decisions. A high-level technique like the PrRA can be used to provide some risk management standardization across field units and still be flexible enough to reflect a meaningful risk structure to the individual unit activity. The PrRA is a high-level, systematic, mishap-based, “What-if” type of technique that can generate a risk profile for selected and/or all activities in a port. It is a common approach used by other agencies and industry to characterize a wide range of diverse risks such as safety/health, environmental, property loss, and business interruption or mission loss.

The PrRA activity hierarchy was defined to be consistent with the ACTBALT activity cost hierarchy structure, as it was at the time of this study. By constructing a risk activity model in this way, direct links can be made to activity costs so that unit activities can be driven by well-defined risk priorities. Risk levels can be accounted for as well as the costs of the activities to manage these risks. A PrRA type of approach could support a strategy to provide both routine and strategic risk management information to a port. However, the port is indeed a dynamic enterprise that will see changes and sometimes issues that require a more narrowly focused risk understanding.

A high-level risk profiling technique, combined with a risk Change Analysis of actual and proposed changes from routine port operations, present a powerful continuous risk capability for a port. The Change Analysis process was tested on a hypothesized marine event, OPSAIL 2000, to examine the potential loss exposure that might be introduced to the port. To illustrate this concept, a COTP might want to know how one significant marine event might affect the overall loss exposure to the port. Figure B.1 provides a side-by-side overview of some of the results from the partial PrRA and risk Change Analysis of a marine event performed at ACTBALT. Using the partial analysis information from the ACTBALT studies, the total risk to the port including the risk associated with the one-day marine event can be derived by,

$$Risk_{total} = Risk_{port}\,(364/365) + Risk_{marine\ event}$$
$$Risk_{total} = 2265\ RIN\ (364/365) + 8.3\ RIN$$
$$Risk_{total} = 2267\ RIN\ (\$22{,}670{,}000.00)$$

In this example, the ports loss exposure would only increase by about 0.1% with the approval of this one marine event. However, ten similar marine events in the same year would increase loss exposure by more than 3%, which might not be as tolerable to port stakeholders if it were presented to them in this way. On a different scale, the COTP might be concerned with mishaps associated with the presence of temporary floating piers in a marine event. Using the partial analysis information from the ACTBALT studies, the change in mishap risk can be derived by,

$$(Mishap_{marine\ event\ RIN} - Mishap_{PrRA\ RIN}\,(1/365)) \,/\, Mishap_{PrRA\ RIN}$$

In this example, there would be more than a 50% increase in loss exposure associated with a collision with a floating object compared to normal port risks with this mishap type. The COTP could make a risk informed choice about approving the use of temporary floating piers knowing how the relative risk levels have changed and having at his or her disposal a set of risk control strategies generated from the Change Analysis, i.e., both prevention and surveillance options. In the spirit of continuous improvement, the PrRA could be updated with the risk levels determined in the Change Analysis if the activity is permitted.

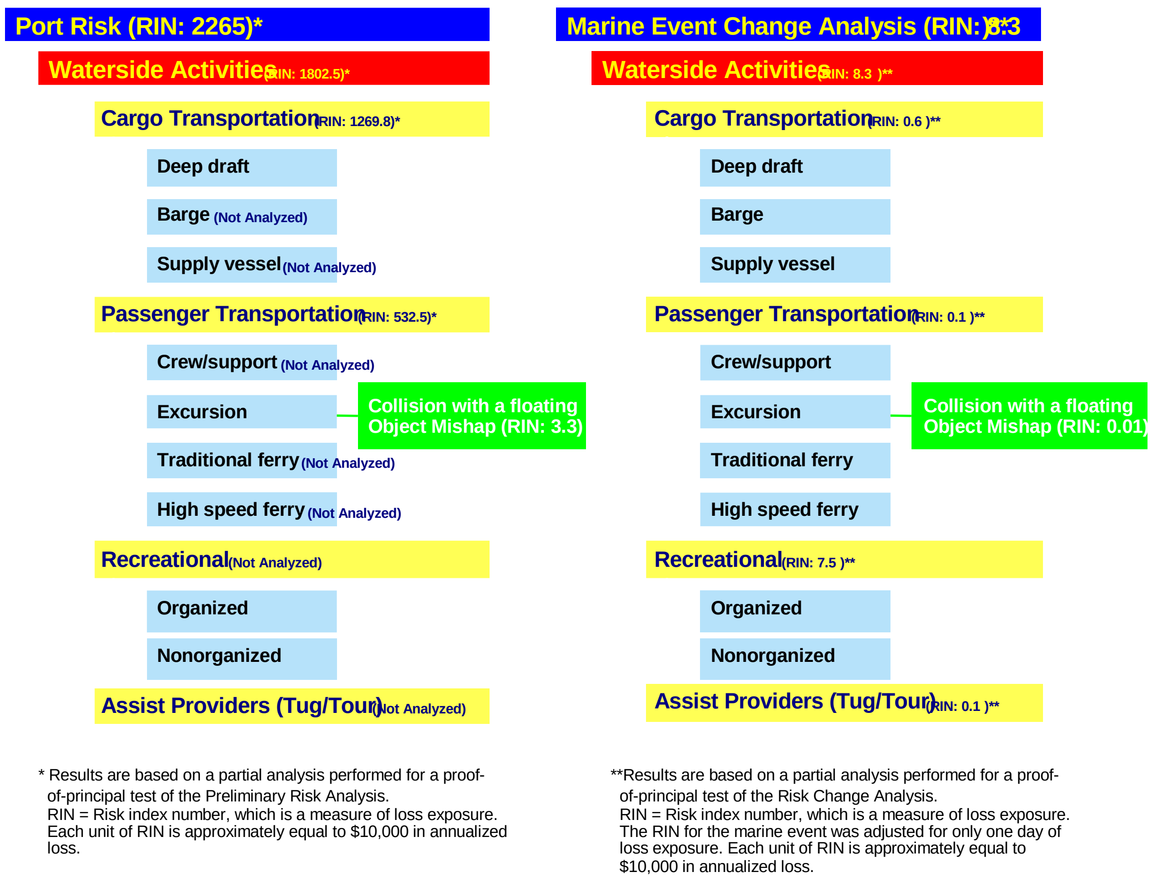

Figure D.1 Connection between Preliminary Risk Assessment and Change Analysis

Certainly, the Preliminary Risk Assessment represents a good first pass at assessing risk levels of port activities and will be sufficient for most port risk-based decision-making. However, there may be instances where more resolution is needed on an issue or particular activity, e.g., confidence in the mishap analyzed during the PrRA was low, a risk reduction recommendation could not be generated at the PrRA resolution level, or the mishap itself could not be well defined. In these instances, a narrowly focused detailed analysis may be needed to develop a better risk model/ improve the detail of information. The proof-of-principle detailed hazard analysis of lifeboat inspection/drill activities on foreign-flagged deep draft vessels at ACTBALT could have been an instance where there was low certainty in evaluating the Acute hazard exposure: workers mishap associated with the **Waterside/Cargo Transportation/Deep Draft/ All Package Forms/All Contents** activity analyzed in the PrRA. The low certainty could have been due to a question about the specific kinds of hazards and risks associated with lifeboat inspection and drill activities. The two methods used in the ACTBALT detailed risk study were the:

Worker and Instruction Safety Evaluation (WISE) review

Human error (error-likely situation) review

These tools facilitated a more structured look at risks to ship personnel in performing these activities. The results provided a better understanding of these hazards and risks that could have been used to refine their frequency and severity estimates in the PrRA model. It also generated risk reduction recommendations that probably would not have been identified without the detailed analysis. Figure B.2 illustrates this connection.

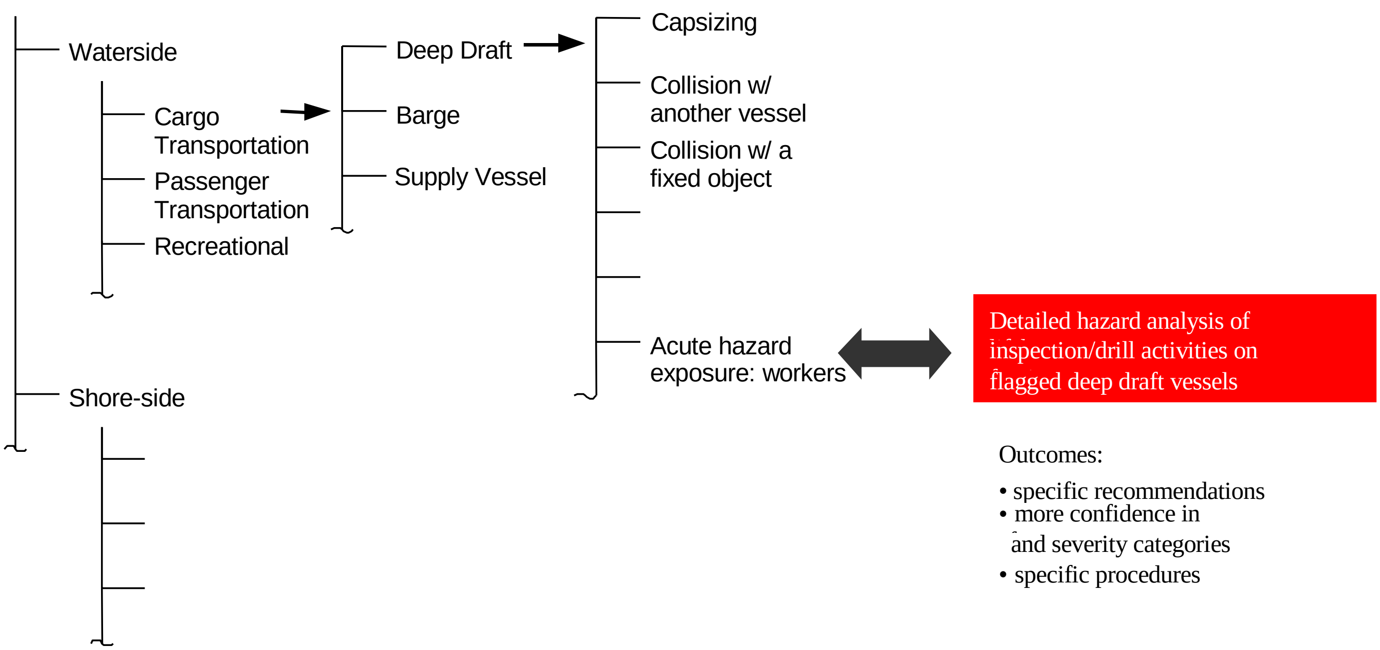

Figure D.2 Connection between Narrowly Focused Detailed Analysis and Preliminary Risk Assessment