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RISK-BASED DECISION MAKING GUIDELINES

A Proof-of-Principle Demonstration of a Preliminary Risk Analysis of Operations at the Port of Baltimore

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16. Abstract

This report documents a test of a preliminary risk analysis tool of selected activities at the Port of Baltimore. The preliminary risk analysis was performed using a mishap-based version of the coarse risk analysis. The purpose of the analysis was to test the application of the risk tool for the activity of establishing port priorities for Activities Baltimore (ACTBALT). This analysis was part of the development of a 2nd edition of RBDM Guidelines to support the U.S. Coast Guard's Office of Design & Engineering Standards' (G-MSE) strategy of developing a risk toolbox for marine safety activities.

For each port activity analyzed, the teams considered a set of mishaps that could occur while conducting that activity. For each mishap, the teams identified the most significant contributors (causes) that could lead to the mishap and assessed the mishap risk. The results established a partial risk baseline for ACTBALT activities. The Coast Guard's process of establishing port and waterway priorities associated with risk is based on customer alignment with port needs and program goals. In the past, no systematic formal risk process was used to help identify port priorities. The outcome of this new process is expected to be an improvement in resource allocation based on identified port risk priorities. A port-wide risk assessment will enhance the Captain of the Port's (COTP) understanding of the port's loss exposure and hazard priorities.

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EXECUTIVE SUMMARY

The Coast Guard's process of establishing port and waterway management priorities has been based on customer alignment with port needs and program goals. In the past, no formal risk basis was used to help identify port priorities.

A Preliminary Risk Analysis (PrRA) of selected activities (Water-side Activities Operations and Shore-side Activities Operations) was tested at Coast Guard Activities Baltimore (ACTBALT). The PrRA was performed using a mishap-based version of the coarse risk analysis methodology. The coarse risk analysis was developed as part of the Coast Guard's Integrated Risk Assessment process for risk analysis of Coast Guard internal operational risk. ACTBALT personnel served as subject matter experts for the analysis. The purpose of the analysis was to test the application of the PrRA technique from the 2nd edition of the Risk-based Decision-making (RBDM) Guidelines for establishing port priorities for ACTBALT. The development of the 2nd edition of RBDM Guidelines is part of a project to support the Office of Design & Engineering Standards' (G-MSE) strategy of developing a risk toolbox for marine safety activities.

For each port activity analyzed, the teams considered a set of mishaps that could occur while conducting that activity. For each mishap, the teams identified the most significant contributors (causes) that could lead to the mishap, and assessed the frequency with which each of three consequence severity categories would be expected to occur. Based on this information, calculations were performed to determine a Risk Index Number (RIN) for each mishap. The RIN is a relative measure of the overall risk associated with the mishap analyzed. The PrRA technique provided results in the form of identification of high-risk mishaps, high-risk activities, expected time between mishaps, risk by venue, i.e., high-level risk breakdown between water-side and shore-side activities, and risk matrices. The analysis produced over 30 risk reduction recommendations specific to these operations. The results established a partial risk baseline for activities at the Port of Baltimore.

In general, ACTBALT staff felt that the PrRA approach was simple to use, produced the right kind of risk information, generated easy to understand results, and they believed in its

scientific basis. However, they felt that implementation of the process to initially examine port-wide risks would be time-consuming and require considerable up-front staff commitment.

ACTBALT is considering the application of this new process, i.e., a port-wide risk assessment, in the spring as part of their unit-wide RBDM project. However, they will have to update the risk activity hierarchy to be consistent with their revised activity cost model. The R&D Center provided PrRA software to facilitate these updates. The software has a Facility Administrator module to help develop and maintain a meaningful hierarchical structure for a unit, a Preliminary Risk Analyzer module that helps the analyst perform and document the risk analysis, and a Risk Manager module that automatically performs quantitative risk calculations and can combine risk data from multiple analysis into aggregate risk levels.

The outcome of the new process, assuming that risk levels identified are effectively tied to activity costs, is expected to be an improvement in resource allocation based on identified port risk priorities. A port-wide risk assessment is expected to enhance COTP's understanding of the port's loss exposure and hazard priorities. The assessment will also improve the COTP's ability to see where he or she can influence those areas where there is some loss exposure of concern. A high-level risk profiling technique, combined with a risk Change Analysis (subject of another R&D proof-of-principle demonstration) of actual and proposed changes from routine port operations, present a powerful, continuous risk analysis capability for a port.

The analysis used preliminary data and consequence categories. Therefore, the results of this analysis should be interpreted as proof-of-principle only and should not be used for decision-making purposes at this time.

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1.0 INTRODUCTION

This report documents a preliminary risk analysis of selected activities at the Port of Baltimore. Activities Baltimore (ACTBALT) personnel familiar with these activities served as subject matter experts for the analysis. Table 1.1 lists the personnel involved in the analysis.

Table 1.1 Preliminary Risk Analysis Team Members.

Individual	Organization
LT Ann Bryant	USCG ACTBALT
LT Curt Farrell	USCG ACTBALT
SWO Dan Lawrence	USCG ACTBALT
LT Todd Offutt	USCG ACTBALT
LCDR Brian Poskaitis	USCG ACTBALT
Mr. Bert Macesker	USCG R&D Center
Dr. Brooke Schaab	USCG R&D Center
Mr. Vernon Guthrie	ABS Group
Mr. Chuck Mitchell	ABS Group
Mr. David Walker	ABS Group

The preliminary risk analysis provides 1) quantitative risk results for Water-side Activities Operations and Shore-side Activities Operations, and 2) recommendations for reducing risk (the analysis generated 31 risk reduction recommendations). The objective of the analysis was to test the application of a high-level risk profiling tool for the activity of establishing port priorities and to evaluate if , by establishing a baseline risk profile of selected ACTBALT operations, improvements could be achieved in understanding of the port's loss exposure.

2.0 SCOPE

To help ensure that ports are analyzed on a consistent basis, ACTBALT personnel proposed the hierarchy for port activities presented in Table 2.1. The level at which the analysis was performed is shown in bold letters. Activities not analyzed are highlighted in gray. The table identifies an entry by its venue, activity, asset type, and, if applicable, its package form and content form. In performing this analysis for the Port of Baltimore, the level at which issues

Table 2.1 Hierarchy of Port Activities.

Venue	Activity	Asset Type	Package Form	Content Form
Water-side	**Cargo Transportation**	**Deep Draft**	Container	Dry
				Liquid
				Compressed Gas
			Break Bulk	Dry
				Liquid
			Bulk	Dry
				Liquid
				Compressed Gas
		Barge	Container	Dry
				Liquid
				Compressed Gas
			Break Bulk	Dry
				Liquid
			Bulk	Dry
				Liquid
				Compressed Gas
		Supply Vessel	Container	Dry
				Liquid
				Compressed Gas
			Break Bulk	Dry
				Liquid
	Passenger Transportation	Crew/Support		
		Excursion		
		Traditional Ferry		
		High Speed Ferry		
	Recreational		Organized	Permitted
				Non-permitted
			Non-organized	
	Assist Providers	Tug/Tow	n/a	n/a
Shore-side	**Cargo Loading and Unloading**	All Types	**Bulk**	Dry
				Liquid
			Container	Dry
				Liquid
				Compressed Gas
			Break Bulk	
	Passenger Loading and Unloading	Crew/Support		
		Excursion		
		Traditional Ferry		
		High Speed Ferry		

were analyzed varied depending upon the nature of the activities performed, the information available, and the experience of the subject matter experts. For example, all package form and all content form entries were analyzed together when the team collected mishap information for the entry Venue: Water-side, Activity: Cargo Transportation, Asset Type: Deep Draft." However, for the entry "Venue: Shore-side, Activity: Cargo Loading and Unloading, Asset Mode: All Types, Package Form: Bulk, Content Form: Liquid" the mishap information was collected for the specific content form.

3.0 ANALYSIS APPROACH

The preliminary risk analysis was performed using a modified (mishap-based instead of deviation-based) version of the Integrated Risk Assessment's coarse risk analysis (*Integrated Risk Assessment [IRA] User's Manual*, available from the Research and Development Center). For this test application of the preliminary risk assessment methodology, four separate teams conducted analyses of selected port activities. Each team consisted of a facilitator (from the ABS Group Inc. Risk & Reliability Division [ABS Group] who was familiar with the analysis process, and one or more ACTBALT personnel members who were subject matter experts for the activity being analyzed. Personnel from the United States Coast Guard (USCG) Research and Development (R&D) Center also participated on some of the analysis teams.

For each port activity analyzed, the teams considered a set of mishaps that could occur while conducting that activity. For each mishap, the teams identified the most significant contributors (causes) that could lead to the mishap and assessed the frequency with which each of three consequence severity categories would be expected to occur as well as a confidence level in their estimates. The frequency category estimates for each consequence severity category provide perspective about the level of risk that each potential mishap poses in ACTBALT activities. These estimates may be mathematically combined into one metric, called a risk index number (RIN) that describes the total risk for the mishap in one number. This RIN is calculated using the following equation:

$$RIN_{Annual} = \frac{16.5 \times 10^{\text{Frequency Score for Severity Category 1}} + 0.165 \times 10^{\text{Frequency Score for Severity Category 2}} + 0.00165 \times 10^{\text{Frequency Score for Severity Category 3}}}{10{,}000}$$

The specific mishaps included in the analysis are presented in Table 3.1. Table 3.1 also identifies the type of effect associated with the mishap. This association is used in Section 4, "Results," to estimate the risk for each type of effect.

By using the midpoint values of each frequency and severity category, the RIN can be correlated to an annualized loss rate. Using this approach with the categories described in Table 3.2 and Figure 3.1, one unit of the RIN is approximately equal to $10,000 of loss per year (i.e., a RIN of 1.6 reflects a loss potential of $16,000 per year).

Table A.1 in Appendix A documents the analysis. This table describes the team's assessment of the various causes of mishaps. The risk index numbers (RINs) characterizing the risk associated with each mishap are also listed in Table A.1.

4.0 RESULTS

This section provides risk analysis results from the Water-side Activities Operations and Shore-side Activities Operations preliminary risk analysis. The following is a list of results included in this section:

- Risk by venue
- Risk matrix
- High risk mishaps
- Overall frequency analysis results of mishaps
- Risk of activities
- High risk activities
- Risk associated with types of effects
- High risk types of effects

Table 3.1 Mishaps and Associated Types of Effects.

Mishaps	Types of Effects			
	Economic	**Mission**	**Environmental**	**Safety**
1. Capsizing	X			
2. Collision with another vessel	X			
3. Collision with a fixed object	X			
4. Collision with a floating object	X			
5. Grounding	X			
6. Sinking	X			
7. Fire/explosion	X			
8. Person overboard				X
9. Non-conformance leading to loss of commerce		X		
10. Acute hazard exposure: public				X
11. Acute hazard exposure: workers				X
12. Environmental impact			X	

Table 3.2 Criteria for the Consequence Severity Categories.

Consequence Severity Category	Types of Effects			
	Safety	**Environmental**	**Economic**	**Mission**
1	One or more deaths or permanent disability	Releases that result in long-term disruption of the ecosystem or long-term exposure to chronic health risks	> $3M	> $3M
2	Injury that requires hospitalization or lost work days	Releases that result in short-term disruption of the ecosystem	>$10K and <$3M	>$10K and <$3M
3	Injury that requires first aid	Pollution with minimal acute environmental or public health impact	> $100 and <$10K	> $100 and <$10K

Frequency Scoring Categories

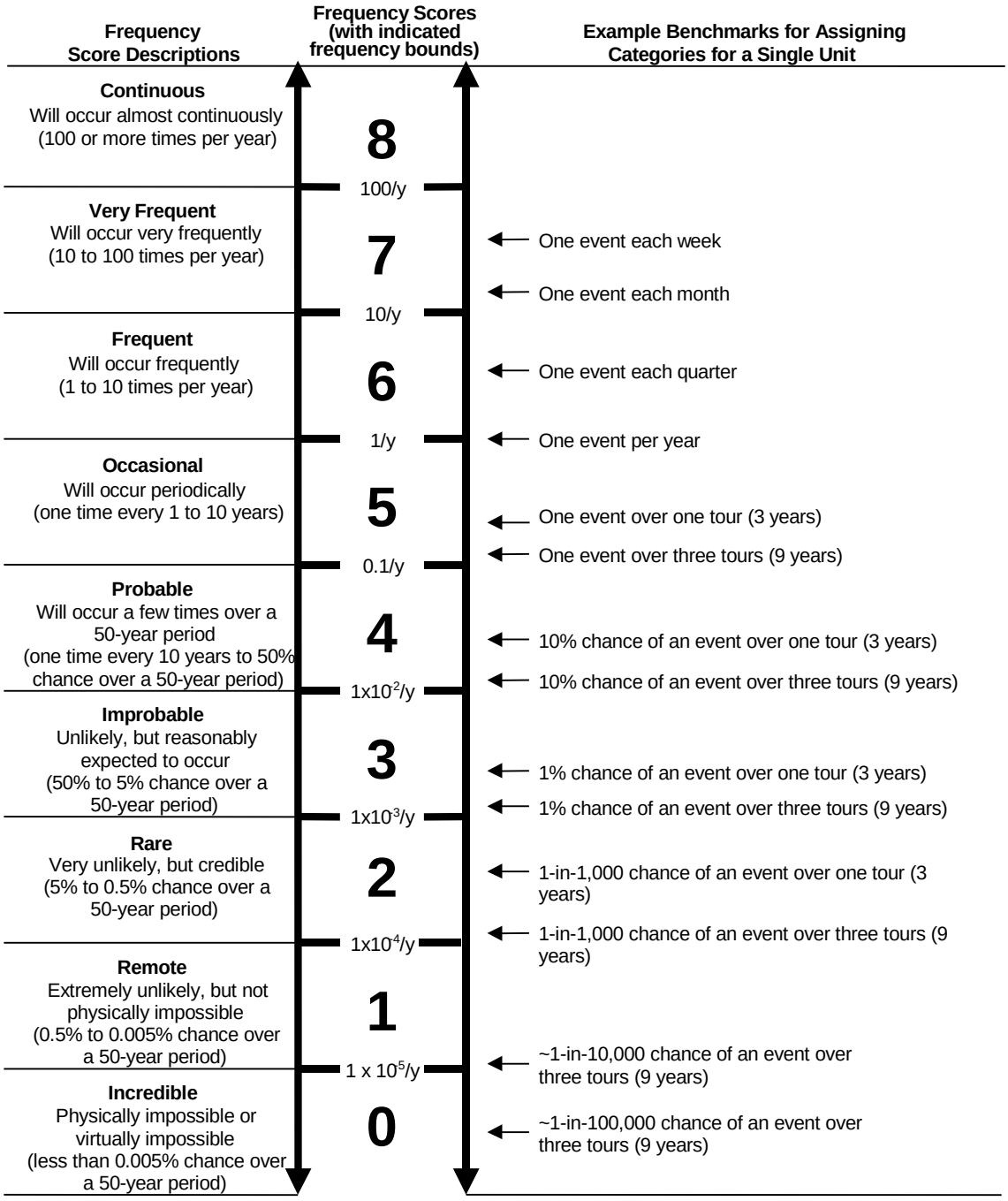

Figure 3.1 Frequency Scoring Categories

The total RIN for the activities of the Water-side Activities Operations and Shore-side Activities Operations within the scope of this analysis is approximately 2,265. If all of the potential losses were economic then a RIN of 2,265 translates to an expected loss of $22,650,000/yr at $10,000/yr per RIN. This section provides detailed information about the risk.

4.1 RISK BY VENUE

Table 4.1 shows the distribution of risk between the venues analyzed and shows the mishaps that contribute to the majority of the risk associated with each venue.

4.2 RISK MATRIX

The risk matrix for the Water-side Activities Operations and Shore-side Activities Operations is shown in Figure 4.. The number in each cell of the matrix is the number of mishaps, with the frequency score and consequence severity category represented by the cell. The risk matrix can serve as a risk management starting point to begin acting on risk levels identified. The field unit would need to establish risk level acceptance criteria that is consistent with their business plan/ unit goals. The risk matrix could be employed by establishing threshold levels above which the frequency of occurrence and severity levels are unacceptable. Supplemental analysis could be needed to better understand high risk mishaps or perhaps those mishaps with risk levels that were developed with low confidence, e.g., no data were believed to be available to substantiate findings. The field unit could begin by implementing risk reduction opportunities that offered risk reductions to acceptable levels.

4.3 HIGH RISK MISHAPS

Table 4.2 presents a list of the high risk mishaps (80% of total risk) for the Water-side Activities Operations and Shore-side Activities Operations as indicated by their associated RINs and risk contribution to total risk.

Table 4.1 High Risk Venues and Associated Mishaps.

Venue	Percent of Total Risk	Mishaps Contributing to 70% of Total Venue Risk[1]	Percent of Venue Risk
Water-side	79.56%	Cargo Transportation/Deep Draft/ All Package Forms/All Content Forms *Acute hazard exposure: workers*	19.23%
		Cargo Transportation/Deep Draft/ All Package Forms/All Content Forms *Non-conformance leading to loss of commerce*	18.31%
		Cargo Transportation/Deep Draft/ All Package Forms/All Content Forms *Fire/explosion*	10.08%
		Passenger Transportation/Excursion *Person overboard*	9.26%
		Cargo Transportation/Deep Draft/ All Package Forms/All Content Forms *Grounding*	9.25%
		Cargo Transportation/Deep Draft/ All Package Forms/All Content Forms *Collision with another vessel*	9.25%
Shore-side	20.44%	Cargo Loading and Unloading/All Asset Types/Container/All Content Forms *Acute hazard exposure: workers*	74.85%

[1] Port activities are shown in regular font, and mishaps are italicized. Each port activity is described by at least two elements "Activity/Asset Type" and where appropriate two additional elements "Package Form/Content Form" are included.

Frequency Categories	Consequence Severity Categories 1	2	3
Continuous (8)	**0**	**0**	**5**
Very Frequent (7)	**0**	**4**	**8**
Frequent (6)	**0**	**9**	**10**
Occasional (5)	**7**	**15**	**9**
Probable (4)	**10**	**6**	**3**
Improbable (3)	**7**	**3**	**1**
Rare (2)	**10**	**4**	**3**
Remote (1)	**12**	**7**	**5**

Figure 4.1 Risk Matrix.

Table 4.2 High Risk Mishaps.

RIN	Percent of Total Risk	Mishaps Contributing to 80% of Total Risk[1]
346.5	15.30%	Water-side/Cargo Transportation/Deep Draft/All Package Forms/ All Content Forms *Acute hazard exposure: workers*
346.5	15.30%	Shore-side/Cargo Loading and Unloading/All Asset Types/Container/All Content Forms *Acute hazard exposure: workers*
330.0	14.57%	Water-side/Cargo Transportation/Deep Draft/All Package Forms/ All Content Forms *Non-conformance leading to loss of commerce*
181.7	8.02%	Water-side/Cargo Transportation/Deep Draft/All Package Forms/ All Content Forms *Fire/explosion*
166.8	7.36%	Water-side/Passenger Transportation/Excursion *Person overboard*
166.6	7.36%	Water-side/Cargo Transportation/Deep Draft/All Package Forms/ All Content Forms *Collision with another vessel*
166.6	7.36%	Water-side/Cargo Transportation/Deep Draft/All Package Forms/ All Content Forms *Grounding*
165.0	7.28%	Water-side/Passenger Transportation/Excursion *Non-conformance leading to loss of commerce*

[1] Port activities are shown in regular font, and mishaps are italicized. Each port activity is described by at least three elements "Venue/Activity/Asset Type," and where appropriate two additional elements "Package Form/ Content Form" are included.

4.4 OVERALL FREQUENCY ANALYSIS RESULTS OF MISHAPS

Table 4.3 summarizes the mishap frequency bounds for Consequence Severity Categories 1, 2, and 3 for the Water-side Activities Operations and Shore-side Activities Operations. This information indicates 1) the expected frequency ranges in which mishaps will occur and 2) the expected time between mishap events for each consequence category. The mishap frequency bounds were determined using the information from Figure 4.1 and the upper and lower frequency bounds for each mishap frequency category.

Table 4.3 Frequency Analysis Results.

Subject	Frequency Bounds for Mishaps (per year)			Expected Time Between Mishap Events		
	Consequence Severity Categories			Consequence Severity Categories		
	1	2	3	1	2	3
Water-side Activities Operations and Shore-side Activities Operations	0.8081 to 8.081	50.56 to 505.6	590.9 to 5,909	2 months to 1 year	17 hours to 1 week	1 hour to 15 hours

4.5 RISK OF ACTIVITIES

Figure 4.2 displays the percent of the total risk for each activity assessed in the preliminary risk analysis. Based on the partial analysis performed the Waterside/Cargo Transportation/Deep Draft/All Package Forms/All Content Forms presents the highest risk levels to the Port of Baltimore.

4.6 HIGH RISK ACTIVITIES

Table 4.4 displays the activities responsible for 80% of the total risk. The table shows the activity's percentage of total risk, the mishaps that are responsible for 100% of the activity's risk, and the mishap's percentage of total activity risk.

4.7 RISK ASSOCIATED WITH TYPES OF EFFECTS

Figure 4.3 displays the risk associated with the types of effects assessed in the preliminary risk analysis. Safety mishaps dominate the risk profile because of the high frequency of occurrence recorded by the analysis team for types of effects in categories 2 and 3.

4.8 HIGH RISK TYPES OF EFFECTS

Table 4.5 displays the types of effects responsible for 80% of the total risk. The table shows the type of effect's percentage of total risk, the mishaps that are responsible for 100% of the type of effect's risk, and the mishap's percentage of total type of effect risk.

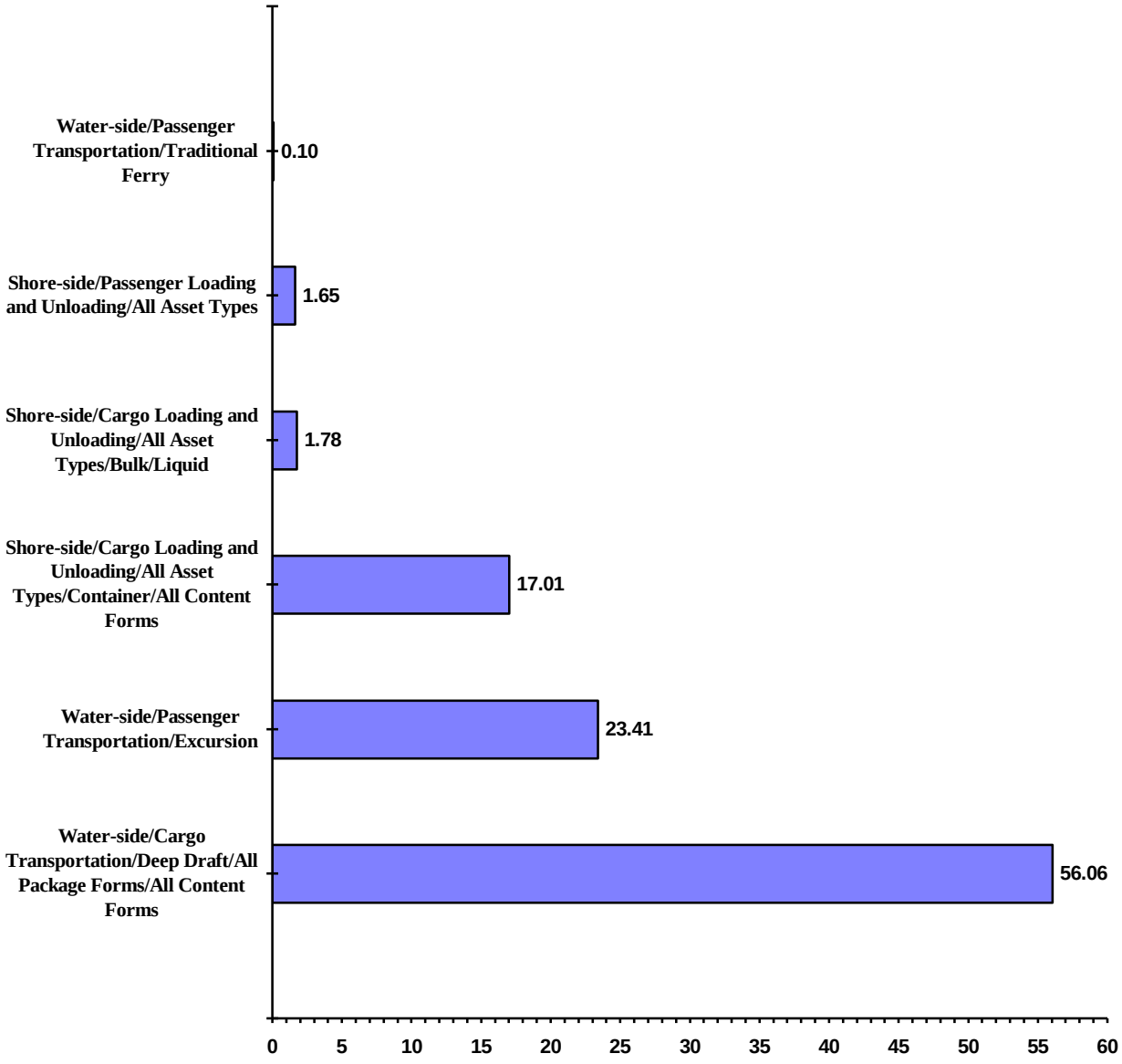

Figure 4.2 Percent of Total Risk for Activities.*

* Only activities analyzed are shown.

Table 4.4 High Risk Activities.

Activities Contributing to 80% of Total Risk	Percent of Total Risk	Mishaps Contributing to 100% of Activity Risk	Percent of Activity Risk
Water-side/Cargo Transportation/Deep Draft/All Package Forms/All Content Forms	**56.06%**	*Acute hazard exposure: workers*	27.29%
		Non-conformance leading to loss of commerce	25.99%
		Fire/explosion	14.31%
		Grounding	13.12%
		Collision with another vessel	13.12%
		Collision with a fixed object	1.44%
		Acute hazard exposure: public	1.44%
		Collision with a floating object	1.44%
		Person overboard	1.43%
		Environmental impact	0.39%
		Capsizing	0.01%
		Sinking	0.01%
Water-side/Passenger Transportation/ Excursion	**23.41%**	*Person overboard*	31.46%
		Non-conformance leading to loss of commerce	31.12%
		Acute hazard exposure: public	6.53%
		Acute hazard exposure: workers	6.53%
		Collision with a fixed object	3.73%
		Collision with another vessel	3.45%
		Sinking	3.43%
		Fire/explosion	3.43%
		Capsizing	3.43%
		Grounding	3.15%
		Environmental impact	3.11%
		Collision with a floating object	0.63%
Shore-side/Cargo Loading and Unloading/All Asset Types/Container/All Content Forms	**17.01%**	*Acute hazard exposure: workers*	89.93%
		Collision with a fixed object	8.56%
		Person overboard	0.86%
		Non-conformance leading to loss of commerce	0.43%
		Fire/explosion	0.13%
		Environmental impact	0.05%
		Acute hazard exposure: public	0.04%
		Capsizing	0.00%

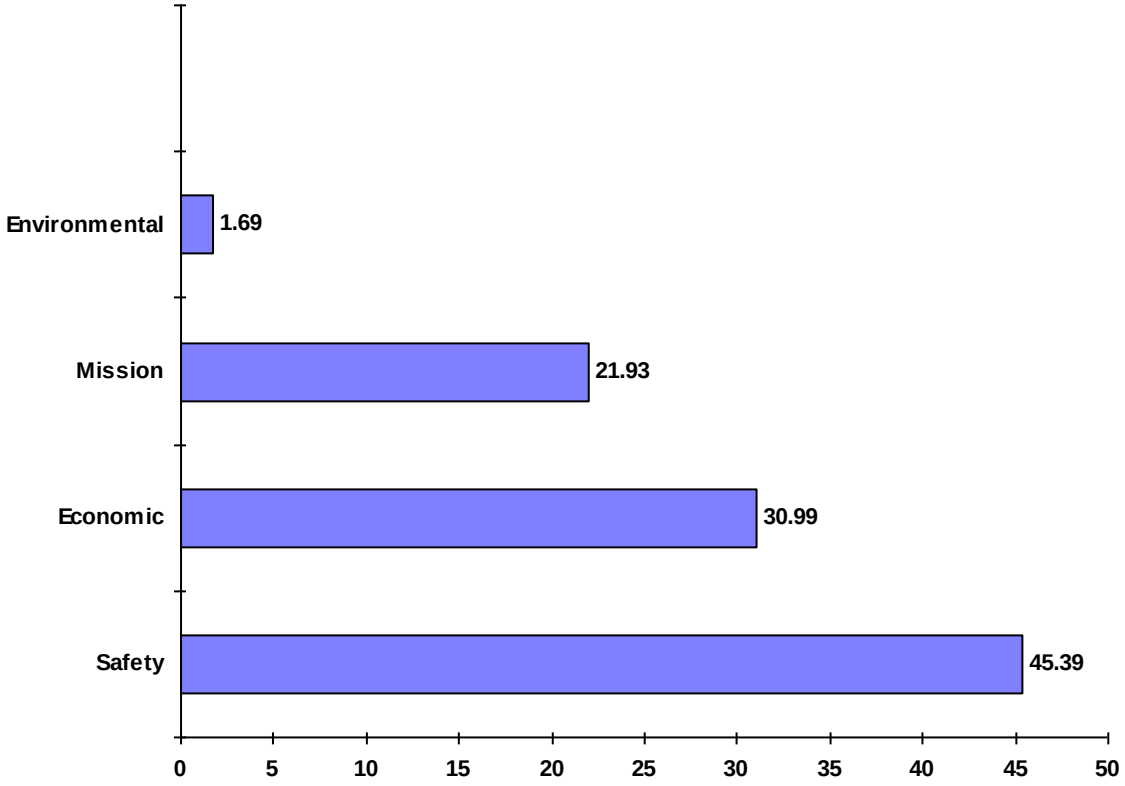

Figure 4.3 Percent of Risk Associated with the Types of Effects.

Table 4.5 High Risk Types of Effects.

Types of Effects Contributing to 80% of Total Risk	Percent of Total Risk	Mishaps Contributing to 100% of Type of Effect Risk*	Percent of Type of Effect Risk
Safety	**45.39%**	Shore-side/Cargo Loading and Unloading/All Asset Types/Container/ All Content Forms *Acute hazard exposure: workers*	33.70%
		Water-side/Cargo Transportation/Deep Draft/All Package Forms/ All Content Forms *Acute hazard exposure: workers*	33.70%
		Water-side/Passenger Transportation/Excursion *Person overboard*	16.23%
		Shore-side/Passenger Loading and Unloading/All Asset Types *Acute hazard exposure: workers*	3.37%
		Water-side/Passenger Transportation/Excursion *Acute hazard exposure: public*	3.37%
		Water-side/Passenger Transportation/Excursion *Acute hazard exposure: workers*	3.37%
		Water-side/Cargo Transportation/Deep Draft/All Package Forms/ All Content Forms *Acute hazard exposure: public*	1.78%
		Shore-side/Cargo Loading and Unloading/All Asset Types/Bulk/Liquid *Acute hazard exposure: workers*	1.78%
		Water-side/Cargo Transportation/Deep Draft/All Package Forms/ All Content Forms *Person overboard*	1.77%
		Shore-side/Cargo Loading and Unloading/All Asset Types/Container/ All Content Forms *Person overboard*	0.32%
		Shore-side/Passenger Loading and Unloading/All Asset Types *Acute hazard exposure: public*	0.19%
		Shore-side/Cargo Loading and Unloading/All Asset Types/Bulk/Liquid *Acute hazard exposure: public*	0.18%

*Activities are shown in regular font, and mishaps are italicized.

Table 4.5 High Risk Types of Effects. (continued)

Types of Effects Contributing to 80% of Total Risk	Percent of Total Risk	Mishaps Contributing to 100% of Type of Effect Risk*	Percent of Type of Effect Risk
Safety (cont'd)		Water-side/Passenger Transportation/Traditional Ferry *Acute hazard exposure: public*	0.18%
		Water-side/Passenger Transportation/Traditional Ferry *Acute hazard exposure: workers*	0.03%
		Shore-side/Cargo Loading and Unloading/All Asset Types/Container/ All Content Forms *Acute hazard exposure: public*	0.02%
		Shore-side/Passenger Loading and Unloading/All Asset Types *Person overboard*	0.00%
		Shore-side/Cargo Loading and Unloading/All Asset Types/Bulk/Liquid *Person overboard*	0.00%
Economic	30.99%	Water-side/Cargo Transportation/Deep Draft/All Package Forms/ All Content Forms *Fire/explosion*	25.88%
		Water-side/Cargo Transportation/Deep Draft/All Package Forms/ All Content Forms *Collision with another vessel*	23.74%
		Water-side/Cargo Transportation/Deep Draft/All Package Forms/ All Content Forms *Grounding*	23.74%
		Shore-side/Cargo Loading and Unloading/All Asset Types/Container/ All Content Forms *Collision with a fixed object*	4.70%
		Water-side/Passenger Transportation/Excursion *Collision with a fixed object*	2.82%
		Water-side/Cargo Transportation/Deep Draft/All Package Forms/ All Content Forms *Collision with a fixed object*	2.61%

Table 4.5 High Risk Types of Effects (continued).

Types of Effects Contributing to 80% of Total Risk	Percent of Total Risk	Mishaps Contributing to 100% of Type of Effect Risk*	Percent of Type of Effect Risk
Economic (cont'd)		Water-side/Passenger Transportation/Excursion *Collision with another vessel*	2.61%
		Water-side/Cargo Transportation/Deep Draft/All Package Forms/ All Content Forms *Collision with a floating object*	2.61%
		Water-side/Passenger Transportation/Excursion *Capsizing*	2.59%
		Water-side/Passenger Transportation/Excursion *Sinking*	2.59%
		Water-side/Passenger Transportation/Excursion *Fire/explosion*	2.59%
		Water-side/Passenger Transportation/Excursion *Grounding*	2.38%
		Water-side/Passenger Transportation/Excursion *Collision with a floating object*	0.47%
		Shore-side/Cargo Loading and Unloading/All Asset Types/Bulk/Liquid *Fire/explosion*	0.47%
		Shore-side/Cargo Loading and Unloading/All Asset Types/Container/All Content Forms *Fire/explosion*	0.07%
		Shore-side/Passenger Loading and Unloading/All Asset Types *Collision with another vessel*	0.05%
		Shore-side/Passenger Loading and Unloading/All Asset Types *Collision with a floating object*	0.03%
		Water-side/Cargo Transportation/Deep Draft/All Package Forms/All Content Forms *Sinking*	0.02%

Table 4.5 High Risk Types of Effects. (continued)

Types of Effects Contributing to 80% of Total Risk	Percent of Total Risk	Mishaps Contributing to 100% of Type of Effect Risk*	Percent of Type of Effect Risk
Economic (cont'd)		Water-side/Cargo Transportation/Deep Draft/All Package Forms/All Content Forms *Capsizing*	0.02%
		Shore-side/Passenger Loading and Unloading/All Asset Types *Capsizing*	0.00%
		Shore-side/Passenger Loading and Unloading/All Asset Types *Sinking*	0.00%
		Shore-side/Cargo Loading and Unloading/All Asset Types/Container/All Content Forms *Capsizing*	0.00%
		Shore-side/Passenger Loading and Unloading/All Asset Types *Fire/explosion*	0.00%
		Shore-side/Passenger Loading and Unloading/All Asset Types *Grounding*	0.00%
Mission impact	21.93%	Water-side/Cargo Transportation/Deep Draft/All Package Forms/All Content Forms *Non-conformance leading to loss of commerce*	66.42%
		Water-side/Passenger Transportation/Excursion *Non-conformance leading to loss of commerce*	33.21%
		Shore-side/Cargo Loading and Unloading/All Asset Types/Container/All Content Forms *Non-conformance leading to loss of commerce*	0.33%
		Shore-side/Cargo Loading and Unloading/All Asset Types/Bulk/Liquid *Non-conformance leading to loss of commerce*	0.03%

5.0 PRELIMINARY RISK ANALYSIS RECOMMENDATIONS

Table 5.1 is a summary of the recommendations developed by the preliminary risk analysis team to help reduce the risks of potential mishaps. The recommendations can be used to better manage risk levels in the port. Each of the recommendations from the PrRA are designed to reduce the risk associated with the mishaps analyzed during the analysis. The benefit of implementing each recommendation can be estimated by determining the potential reduction in frequency scores of mishaps affected by the recommendations. The field unit decision-maker can compare this dollar savings to the cost of implementing the recommendation in a cost/benefit analysis. An analysis of the RIN impact from implementing recommendations was not attempted during this proof-of-principle demonstration.

Table 5.1 Summary of Recommendations.

Recommendations Generated for ACTBALT Operations (Not Prioritized)	
1	Consider providing a vessel traffic system for Baltimore.
2	Consider conducting a waterways management study for the Port of Baltimore.
3	Consider establishing crew fatigue guidelines.
4	Consider requiring that vessels maintain updated electronic navigational charts.
5	Consider increasing enforcement activities associated with the use of the English language.
6	Consider developing stricter standards for communications between vessels.
7	Consider providing site-specific pier designs.
8	Consider conducting a 6-month assessment of classification society examinations.
9	Consider increasing the patrol frequencies to increase the Coast Guard's presence in the port.
10	Consider increasing awareness of wearing life jackets (i.e., pass out pamphlets to foreign vessels).
11	Consider providing video training on Coast Guard expectations of compliance, particularly to foreign vessels in advance of the vessels coming into port.
12	Provide a means to convey Coast Guard expectations to agents from port and classification societies. Consider using forums such as Industry Days, newspapers, etc.
13	Consider providing public education brochures at passenger terminals in advance of cruise ship departures.

Recommendations Generated for ACTBALT Operations (continued)	
14	Consider providing educational pamphlets on the proper use of personal protective equipment (PPE) and general safe work practices.
15	Consider providing the boarding teams with dedicated vehicles that contain water sampling equipment so the teams can monitor the water quality around individual vessels.
16	Investigate the use of booming in specific applications to minimize the impact of environmental releases if they occur.
17	Consider providing more stringent ballast water standards.
18	Consider providing the Coast Guard with the authority to issue citations for environmental violations (because the Coast Guard is the agency that witnesses the violations) rather than having the Coast Guard notify other agencies.
19	Consider operational restrictions (e.g., wind speeds) on the Certificate of Inspection (COI) so that vessels can operate only under certain parameters.
20	Consider reviewing stability risk at each inspection.
21	Consider providing commercial vessel personnel with more training on regulations.
22	Consider establishing more user-friendly regulations by writing to the education level of the audience and by making the regulations more vessel-class specific.
23	Consider providing hazard awareness training.
24	Review and consider implementing the list of ideas compiled by the Maryland Port Administration's Safety and Risk Assessment Group.
25	Consider implementing the International Maritime Organization’s (IMO’s) updated guidelines when they are complete. (IMO is currently investigating better HAZMAT packaging and improved handling procedures.)
26	Eliminate jurisdictional redundancy in response plans, and emphasize the importance of chemical releases in the plans.
27	Pursue further automation of the loading and unloading operations.
28	Improve communications by providing radios for all workers (e.g., headset radios that do not have to be held by hand).
29	Apply more resources to the transfer monitor activities so that more loading and unloading operations may be monitored.
30	Consider requiring additional verification to help ensure that trained Coast Guard personnel perform stability qualifications.
31	Consider providing guidance to help ensure that the captain of the port is more selective in designating barge fleeting areas.

6.0 RBDM PROCESS IMPROVEMENT EVALUATION

The following evaluation of process improvement is based on an ACTABALT follow-up visit by the R&D Center several months after the proof-of-principle test. ACTBALT staff continued with some additional analysis since the R&D test but ended up waiting for the activity cost model to be completed. This was because they wanted the structure of the risk analysis model to be consistent with their cost model.

6.1 PROCESS DESCRIPTION

The RBDM activity application can be classified as being a routine business planning activity for establishing port and waterway management priorities. The process of establishing port & waterway priorities has been based on customer alignment with the port needs and program goals. In the past, no formal risk basis was used to identify port priorities. The process for determining what and why certain unit activities were done was based on customer orientation, i.e., the field unit aligned itself to best satisfy port customer needs. This determined how prevention and response teams were structured. Although, the Coast Guard field unit was mandated to perform certain activities the basic organizational structure was still built along customer lines. The unit listened to port stakeholder concerns, often related to regulation issues. In general, decisions on port priorities were made in the port based on historical trends and personnel knowledge of things that could go wrong. Response and prevention planning were driven by program goals. From the units perspective, it has been the Coast Guard Headquarters program that would require the development of a response or prevention plan to address risk which did not necessarily originate from a systematic understanding of risks in that port.

6.2 DECISION VALUE

The outcome of the new process, assuming that risk levels identified are effectively tied to activity costs, is expected to be an improvement in resource allocation based on identified port risk priorities. They also see value in how it will provide field staff the big picture which gives them a framework to chart their future efforts while understanding what their impacts are on unit

goals. In other words, they have a sense that by understanding how their job contributes to the big picture they will be more empowered to identify things they can do to make business improvements.

6.3 IMPACT ON USE

In general, ACTBALT staff felt that the PrRA approach was simple to use, produced the right kind of risk information, generated easy to understand results, and they believed in its scientific basis. However, they felt that the implementation of the process to initially examine port-wide risks would be time consuming and require considerable up-front staff commitment. Risk reduction recommendations were generated in this proof-of-principle R&D test but they have not been applied.

They felt that a high-level port-wide risk assessment using the PrRA would enhance Coast Guard unit management's understanding of its loss exposure and hazard priorities and ability of the COTP to see where he can influence those areas. The initial goal in employing the PrRA will be to outline activities and their relative risks that occur in the port and to see where Coast Guard influences those activities and how the Coast Guard can reduce the risk within their sphere of influence.

ACTBALT staff felt that the new process will create more creative risk control options for managing port risks. Even though measured losses are low in the Port of Baltimore, they expected that there would be some loss exposure improvement. They felt it would be a reproducible and effective process.

ACTBALT is comprised of a sophisticated cross-section of the Coast Guard with a high degree of analytical skills and interaction experience with port community issues. The application of the PrRA tool was easy for the Operations Division Chief and his team leaders to understand. The concept for the tool's use was made practical by its application to an activity hierarchy that made sense to ACTBALT operations.

7.0 RISK-BASED DECISION-MAKING GUIDELINES IMPLICATIONS

Risk analysis tools in the 2nd Edition of the RBDM Guidelines are generalized in three broad categories. They are hazard/risk-screening tools; broadly focused, detailed analysis tools; and narrowly focused, detailed analysis tools. The Preliminary Risk Analysis tool applied to the Port of Baltimore is a "What-if" type of tool for understanding and comparing risk across an organization. It is an approach that has been comparably used by other industries. The Coarse Risk Analysis technique from the Coast Guard's Office of Health & Environmental Safety's (G-WKS) Integrated Risk Assessment program is a more detailed version of the PrRA and is used to generate risk profiles on internal Coast Guard assets. This level of analysis may be sufficient to generate much of the strategic and routine information that field unit decision-makers need. Instruction of the PrRA technique and the Coast Guard RBDM activities that could benefit by its use is provided in the draft 2nd edition of the RBDM Guidelines.

Two other risk tools were tested at the same time as the PrRA. A risk change analysis on the upcoming OPSAIL 2000 marine event and a detailed analysis of lifeboat inspection and drills on deep draft foreign vessels was performed and is reported elsewhere. ACTBALT has been applying the risk change analysis technique and has performed some detailed risk analysis on small passenger vessel inspection activities. Appendix B 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 don't 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.

8.0 CONCLUSIONS/OBSERVATIONS

The analysis established a partial risk baseline for both water-side and shore-side activities at the Port of Baltimore. The following are some general conclusions and observations from the evaluation of the PrRA for the activity of establishing port and waterway management priorities.

- In the past, no formal risk basis was used to identify a specific port's priorities. The process for determining what and why certain unit activities were done was based on regulations, program goals, and customer orientation, i.e., the field unit usually aligned itself to best satisfy port customer needs.
- The PrRA is an effective and simple tool for establishing a baseline risk profile for a COTP zone. The tool is flexible in that it can be modeled to reflect an activity hierarchy structure that makes sense to the individual port and still have a common risk metric that ties the analysis of different activities together.
- Implementation of the new process to initially examine port-wide risks is expected to be time consuming and require considerable up-front unit Coast Guard staff commitment.
- The PrRA technique creates a variety of risk results that can serve as a starting point for better managing risks, e.g., risk matrix, high risk mishaps, frequency analysis, high risk activities, and risk reduction opportunities. PrRA results can help field unit decision-makers compare dollar savings to the cost of implementing the recommendation in a cost/benefit analysis.
- An important outcome of the new process that employs a mishap-based technique like the PrRA, assuming that risk levels identified are effectively tied to activity costs, is expected to be an improvement in resource allocation based on identified port risk priorities.
- ACTBALT felt that a high-level port-wide risk assessment using the PrRA would enhance COTP's understanding of its loss exposure and hazard priorities and ability to see where he or she can influence those areas.

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

- 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.

APPENDIX A

Table A.1 Preliminary Risk Analysis Data Table.

Water-side/Cargo Transportation/Deep Draft/All Package Forms/All Content Forms								
			Frequency of Events in Category:					
No.	Mishap	Most Significant Contributors	1	2	3	RIN	Certainty	Recs.
1.1	Capsizing	Human error - improper balance on trim and ballast Loss of hull integrity Adverse weather Failure to adapt to weather changes (e.g., wind, sea conditions) Improper loading	2	0	0	0.1650	High	
1.2	Collision with another vessel	Navigational errors resulting from communications error, crew fatigue, failure of communications equipment, failure of navigational aids, failure of navigational equipment, failure of steering/propulsion systems, human errors, and/or using incorrect/outdated navigational charts	5	5	0	166.6	High	1 2 3 4 5 6

Table A.1 Preliminary Risk Analysis Data Table. (cont'd)

Water-side/Cargo Transportation/Deep Draft/All Package Forms/All Content Forms								
			Frequency of Events in Category:					
No.	Mishap	Most Significant Contributors	1	2	3	RIN	Certainty	Recs.
1.3	Collision with a fixed object	Navigational errors resulting from communications error, crew fatigue, failure of communications equipment, failure of navigational aids, failure of navigational equipment, failure of steering/propulsion systems, human errors, and/or using incorrect/outdated navigational charts	4	5	6	18.32	High	1 2 3 4 5 7
1.4	Collision with a floating object	Navigational errors resulting from communications error, crew fatigue, failure of communications equipment, failure of navigational aids, failure of navigational equipment, failure of steering/propulsion systems, human errors, and/or using incorrect/outdated navigational charts	2	6	7	18.32	High	1 2 3 4 5
1.5	Grounding	Navigational errors resulting from communications error, crew fatigue, failure of communications equipment, failure of navigational aids, failure of navigational equipment, failure of steering/propulsion systems, human errors, and/or using incorrect/outdated navigational charts Low visibility	5	5	0	166.6	High	1 2 3 4 5

Table A.1 Preliminary Risk Analysis Data Table. (cont'd)

Water-side/Cargo Transportation/Deep Draft/All Package Forms/All Content Forms

No.	Mishap	Most Significant Contributors	Frequency of Events in Category: 1	2	3	RIN	Certainty	Recs.
1.6	Sinking	Loss of hull integrity Improper loading Adverse weather Failure to adapt to weather changes (e.g., wind, sea conditions)	2	0	0	0.1650	High	
1.7	Fire/ explosion	Failure of the inert gas system resulting in a buildup of flammable gas in a fuel tank and an explosion if an ignition source is present Fires due to electrical shorts, mishaps in the galley, accumulations of flammable material in the ventilation system, and/or leaks in the stacks/exhaust systems Human error - improper storage of flammable materials	5	6	6	181.7	Medium	8 9
1.8	Person overboard	Crew defecting (jumping ship) Equipment failure - safety rails Human error - not wearing PFD when required Slips, trips, and falls	4	5	4	18.15	High	10

Table A.1 Preliminary Risk Analysis Data Table. (cont'd)

Water-side/Cargo Transportation/Deep Draft/All Package Forms/All Content Forms								
No.	Mishap	Most Significant Contributors	Frequency of Events in Category: 1	2	3	RIN	Certainty	Recs.

Water-side/Cargo Transportation/Deep Draft/All Package Forms/All Content Forms								
			Frequency of Events in Category:					
No.	Mishap	Most Significant Contributors	1	2	3	RIN	Certainty	Recs.
1.9	Non-conformance leading to loss of commerce	Large cargo vessel retained in port (transit delayed) resulting from crew incompetence, fire hazards present on board, ILO violations, inoperable lifesaving equipment, equipment failures (load lines, propulsion/steering equipment), and/or structural inconsistencies/deficiencies	5	7	0	330.0	High	11 12
1.10	Acute hazard exposure: public	Passengers on board cruise ships being exposed to hazards resulting from fires and/or explosions (see item 1.7 for most significant contributors to fires/explosions) Release of material into the waterway resulting from equipment failures (seals, gaskets, etc.), misaligned valves, and/or sabotage (intentional dumping)	3	6	6	18.32	Low	13
1.11	Acute hazard exposure: workers	Improper or inadequate control of contaminants (e.g., TB, parasitic infestation) Exposure during maintenance activities resulting from improper use of personal protective equipment or improper application of safety controls (e.g., lockout/ tagout, hot work permitting) Poor housekeeping Slips, trips, and falls	5	7	8	346.5	High	14

Table A.1 Preliminary Risk Analysis Data Table. (cont'd)

Water-side/Cargo Transportation/Deep Draft/All Package Forms/All Content Forms								
			Frequency of Events in Category:					
No.	Mishap	Most Significant Contributors	1	2	3	RIN	Certainty	Recs.
1.12	Environmental impact	Introduction of non-indigenous species from ballast tanks Spills during maintenance	3	5	7	4.950	High	9 15 16 17 18

Table A.1 Preliminary Risk Analysis Data Table. (cont'd)

Water-side/Passenger Transportation/Excursion

No.	Mishap	Most Significant Contributors	Frequency of Events in Category: 1	2	3	RIN	Certainty	Recs.
2.1	Capsizing	Failure to adapt to weather changes (e.g., wind, sea conditions) Overaggressive sailing Overloading one side of the boat	4	5	5	18.17	High	19 20
2.2	Collision with another vessel	Failure to recognize or avoid other vessels resulting from inattention by operator; loss of steering, radar, propulsion; poor navigation choice; reduced visibility and/or too much speed	4	5	6	18.32	High	
2.3	Collision with a fixed object	Failure to recognize or avoid a fixed object resulting from inattention by operator; loss of steering, radar, propulsion; reduced visibility and/or too much speed	4	5	7	19.80	High	
2.4	Collision with a floating object	Failure to recognize or avoid floating objects resulting from inattention by operator; loss of steering, radar, propulsion; reduced visibility and/or too much speed	3	5	5	3.316	High	
2.5	Grounding	Failure to set or maintain proper course resulting from inattention by operator; loss of sonar or fathometer; loss of steering, radar, propulsion; reduced visibility and/or too much speed	1	6	6	16.68	High	

Table A.1 Preliminary Risk Analysis Data Table. (cont'd)

Water-side/Passenger Transportation/Excursion								
No.	Mishap	Most Significant Contributors	Frequency of Events in Category: 1	2	3	RIN	Certainty	Recs.
2.6	Sinking	Adverse weather Deterioration of the hull	4	5	5	18.17	High	

Water-side/Passenger Transportation/Excursion								
			Frequency of Events in Category:					
No.	Mishap	Most Significant Contributors	1	2	3	RIN	Certainty	Recs.
2.7	Fire/explosion	Fuel line leak into exhaust manifold Sparking Massive engine failure Cooking fires Trash can fires due to smoking	4	5	5	18.17	High	
2.8	Person overboard	Alcohol Inadequate railing Inattention Suicide	5	5	6	166.8	High	
2.9	Non-conformance leading to loss of commerce	Deficiencies in hull, lifesaving equipment, or fire-fighting equipment No inspection certificate Hull failure resulting from poor maintenance, construction, or management of change Loss of propulsion	1	7	0	165.0	High	21 22

Table A.1 Preliminary Risk Analysis Data Table. (cont'd)

Water-side/Passenger Transportation/Excursion								
			Frequency of Events in Category:					
No.	Mishap	Most Significant Contributors	1	2	3	RIN	Certainty	Recs.

Water-side/Passenger Transportation/Excursion								
			Frequency of Events in Category:					
No.	Mishap	Most Significant Contributors	1	2	3	RIN	Certainty	Recs.
2.10	Acute hazard exposure: public	Slips, trips, and falls Impaled by fishhooks Struck by boom	4	6	7	34.65	High	
2.11	Acute hazard exposure: workers	Slips, trips, and falls Caught in rotating equipment in engine room Caught between boat and pier Hand pulled through cleat Noise exposure in engine room Asphyxiant exposure in engine room Caught in gas-powered bait grinder	4	6	7	34.65	High	23
2.12	Environmental impact	Release of fuel or other contaminants resulting from design problems with fuel systems; lack of crew knowledge of fuel, marine sanitation systems; mechanical problem (e.g., oil in the exhaust); or poor maintenance	0	3	8	16.52	High	

Table A.1 Preliminary Risk Analysis Data Table. (cont'd)

Water-side/Passenger Transportation/Traditional Ferry								
			Frequency of Events in Category:					
No.	Mishap	Most Significant Contributors	1	2	3	RIN	Certainty	Recs.
3.1	Capsizing		0	0	0	0.000		
3.2	Collision with another vessel		0	0	0	0.000		
3.3	Collision with a fixed object		0	0	0	0.000		
3.4	Collision with a floating object		0	0	0	0.000		
3.5	Grounding		0	0	0	0.000		
3.6	Sinking		0	0	0	0.000		
3.7	Fire/explosion		0	0	0	0.000		
3.8	Person overboard		0	0	0	0.000		
3.9	Non-conformance leading to loss of commerce		0	0	0	0.000		
3.10	Acute hazard exposure: public	Slips, trips, and falls Struck by vehicle	3	4	5	1.832	High	
3.11	Acute hazard exposure: workers	Slips, trips, and falls Struck by vehicle Caught between ferry and pier Noise exposure	2	4	5	0.3465	Medium	
3.12	Environmental impact		0	0	0	0.000		

Table A.1 Preliminary Risk Analysis Data Table. (cont'd)

Shore-side/Cargo Loading and Unloading/All Asset Types/Bulk/Liquid								
No.	Mishap	Most Significant Contributors	Frequency of Events in Category: 1	2	3	RIN	Certainty	Recs.
4.1	Capsizing		0	0	0	0.000		
4.2	Collision with another vessel		0	0	0	0.000		
4.3	Collision with a fixed object		0	0	0	0.000		
4.4	Collision with a floating object		0	0	0	0.000		
4.5	Grounding		0	0	0	0.000		
4.6	Sinking		0	0	0	0.000		
4.7	Fire/explosion	Explosion in vapor spaces of tanks containing flammable materials Ignition sources (sparks, smoking, static discharge, etc.) present when contact with flammable material is expected (e.g., while disconnecting hoses) Release of flammable material and subsequent ignition (sparks, smoking, static discharge, etc.) resulting from an inadvertently disconnected hose, hose failure, piping system failure, or overfilled/overpressurized tank during transfer operations	3	5	4	3.302	Medium	29

Table A.1 Preliminary Risk Analysis Data Table. (cont'd)

Shore-side/Cargo Loading and Unloading/All Asset Types/Bulk/Liquid								
No.	Mishap	Most Significant Contributors	Frequency of Events in Category: 1	2	3	RIN	Certainty	Recs.
4.8	Person overboard	Worker slips, trips, or falls overboard	1	2	2	0.01817	High	
4.9	Non-conformance leading to loss of commerce	Late filing of an advanced notice of transfer resulting in a loading and unloading delay	0	1	6	0.1652	High	
4.10	Acute hazard exposure: public	Major release of volatile toxic material (transfer system failure or tank overfilling/ overpressurization) that disperses widely enough to reach public receptors	3	4	5	1.832	Medium	
4.11	Acute hazard exposure: workers	Chemical exposure because of an inadvertent release during a transfer operation or because of not wearing appropriate personal protective equipment when material contact is anticipated Physical injuries during handling operations Slips, trips, or falls during handling operations	2	6	7	18.32	Medium	
4.12	Environmental impact	Major release of hazardous material (transfer system failure or tank overfilling/ overpressurization) outside of secondary containment	2	3	8	16.68	Medium	

Table A.1 Preliminary Risk Analysis Data Table. (cont'd)

Shore-side/Cargo Loading and Unloading/All Asset Types/Container/All Content Forms								
			Frequency of Events in Category:					
No.	Mishap	Most Significant Contributors	1	2	3	RIN	Certainty	Recs.
5.1	Capsizing	Improper loading and unloading resulting in loss of vessel stability	1	1	1	0.01667	High	
5.2	Collision with another vessel		0	0	0	0.000		
5.3	Collision with a fixed object	Crane failures resulting in uncontrolled movement of a container during loading and unloading Improper movement of a container during loading and unloading	0	6	8	33.00	Medium	24
5.4	Collision with a floating object		0	0	0	0.000		
5.5	Grounding		0	0	0	0.000		
5.6	Sinking		0	0	0	0.000		
5.7	Fire/explosion	Damaged hazardous material packaging leading to a release of flammable material and subsequent ignition (sparks, smoking, static discharge, etc.) during container handling Damaged hazardous material packaging leading to a release of material that energetically self-reacts or reacts with other materials in a container (or the container itself)	2	4	6	0.4950	Low	

Table A.1 Preliminary Risk Analysis Data Table. (cont'd)

Shore-side/Cargo Loading and Unloading/All Asset Types/Container/All Content Forms								
			Frequency of Events in Category:					
No.	Mishap	Most Significant Contributors	1	2	3	RIN	Certainty	Recs.
5.8	Person overboard	Worker slips, trips, or falls overboard Worker struck by container being moved and falling overboard	3	5	2	3.300	Medium	
5.9	Non-conformance leading to loss of commerce	Facility not authorized for a particular hazard (related to explosives loading and unloading) Improper stowage, labeling, segregation, packaging, or integrity	0	2	7	1.652	High	
5.10	Acute hazard exposure: public	Biological contamination within a container that affects public receptors when the container is opened Damaged hazardous material packaging leading to a major release of volatile toxic material that disperses widely enough to reach public receptors Damaged hazardous material packaging that affects public receptors when the container is opened Discharge of a concealed chemical, biological, radiological, or nuclear weapon	2	2	3	0.1668	Medium	25 26

Table A.1 Preliminary Risk Analysis Data Table. (cont'd)

Shore-side/Cargo Loading and Unloading/All Asset Types/Container/All Content Forms

No.	Mishap	Most Significant Contributors	Frequency of Events in Category: 1	2	3	RIN	Certainty	Recs.
5.11	Acute hazard exposure: workers	Dropped objects from cranes Improper entry into container confined spaces having hazardous environments (chemicals or oxygen deficiency) Noise exposure Physical injuries during handling operations Slips, trips, or falls during handling operations	5	7	8	346.5	Medium	27 28
5.12	Environmental impact	Damaged hazardous material packaging allowing material to leak from a container into the water or onto the shore during handling	1	1	6	0.1817	Medium	25

Table A.1 Preliminary Risk Analysis Data Table. (cont'd)

Shore-side/Passenger Loading and Unloading/All Asset Types								
No.	Mishap	Most Significant Contributors	Frequency of Events in Category: 1	2	3	RIN	Certainty	Recs.

Shore-side/Passenger Loading and Unloading/All Asset Types								
			Frequency of Events in Category:					
No.	Mishap	Most Significant Contributors	1	2	3	RIN	Certainty	Recs.
6.1	Capsizing	Improper stability calculation during construction	1	2	2	0.01817	Medium	30
6.2	Collision with another vessel	Inadequate navigation of nearby vessel because of poor communication Inadequate navigation of nearby vessel because of poor navigation choice Inadequate navigation of nearby vessel because of propulsion failure Inadequate navigation of nearby vessel because of steering failure	2	4	5	0.3465	High	
6.3	Collision with a fixed object	Not applicable	0	0	0	0.000		
6.4	Collision with a floating object	Barge breaks away from mooring and moves into vessel Material failure on buoy (e.g., chain break)	1	4	4	0.1832	Medium	31
6.5	Grounding		1	1	1	0.01667	High	
6.6	Sinking		1	1	1	0.01667	High	
6.7	Fire/explosion		1	1	1	0.01667	High	

Table A.1 Preliminary Risk Analysis Data Table. (cont'd)

Shore-side/Passenger Loading and Unloading/All Asset Types

No.	Mishap	Most Significant Contributors	Frequency of Events in Category:			RIN	Certainty	Recs.
			1	2	3			
6.8	Person overboard	Inadequate railing Intentionally jumping in to be entertaining	1	3	5	0.04950	Medium	
6.9	Non-conformance leading to loss of commerce	Not relevant	0	0	0	0.000		
6.10	Acute hazard exposure: public	Hit by unsecured door Inhalation of exhaust gases Slips, trips, or falls	2	5	6	1.980	High	
6.11	Acute hazard exposure: workers	Inhalation of exhaust gases Struck by gate, vehicle	4	6	7	34.65	High	
6.12	Environmental impact		1	1	1	0.01667	High	

Appendix B

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,

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

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,

$$(\text{Mishap}_{\text{marine event RIN}} - \text{Mishap}_{\text{PrRA RIN}}\,(1/365)) / \text{Mishap}_{\text{PrRA RIN}}$$

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.

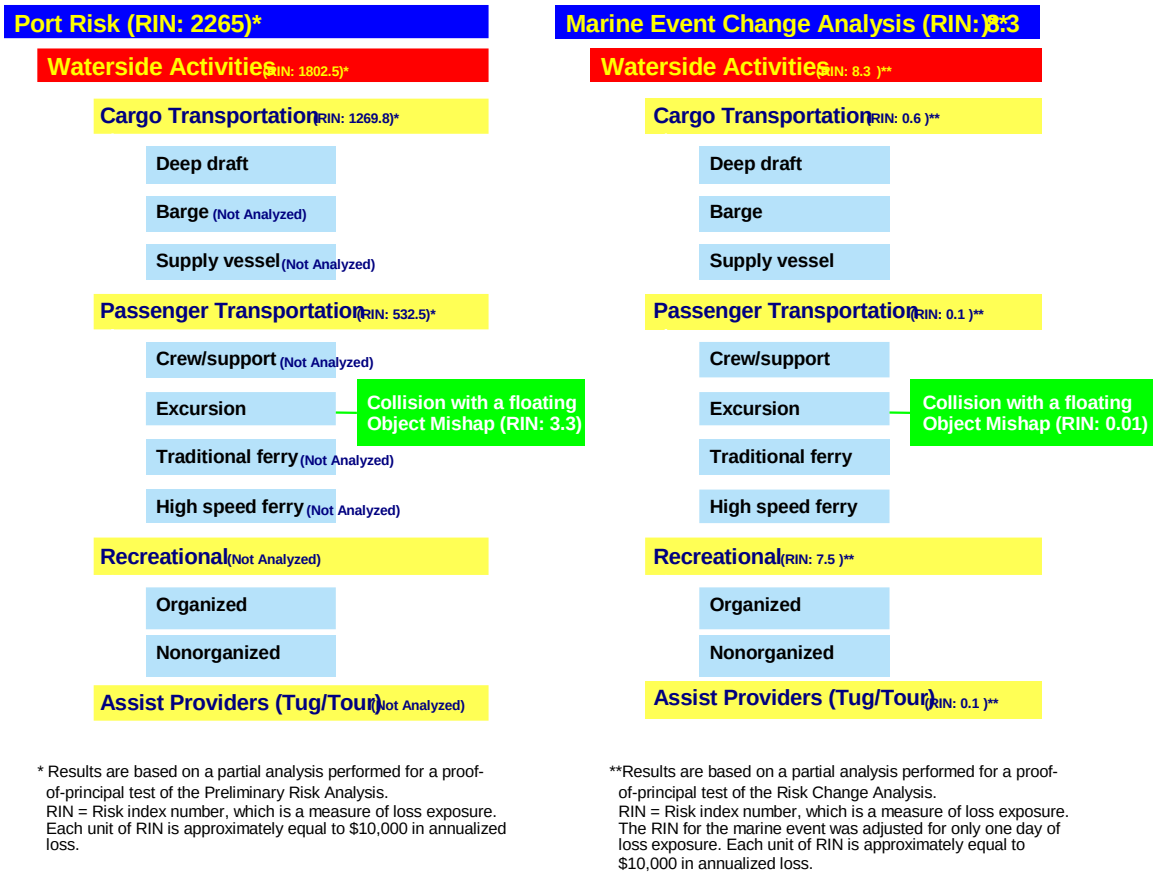

Figure B.1 Connection between Preliminary Risk Assessment and Change Analysis.

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.

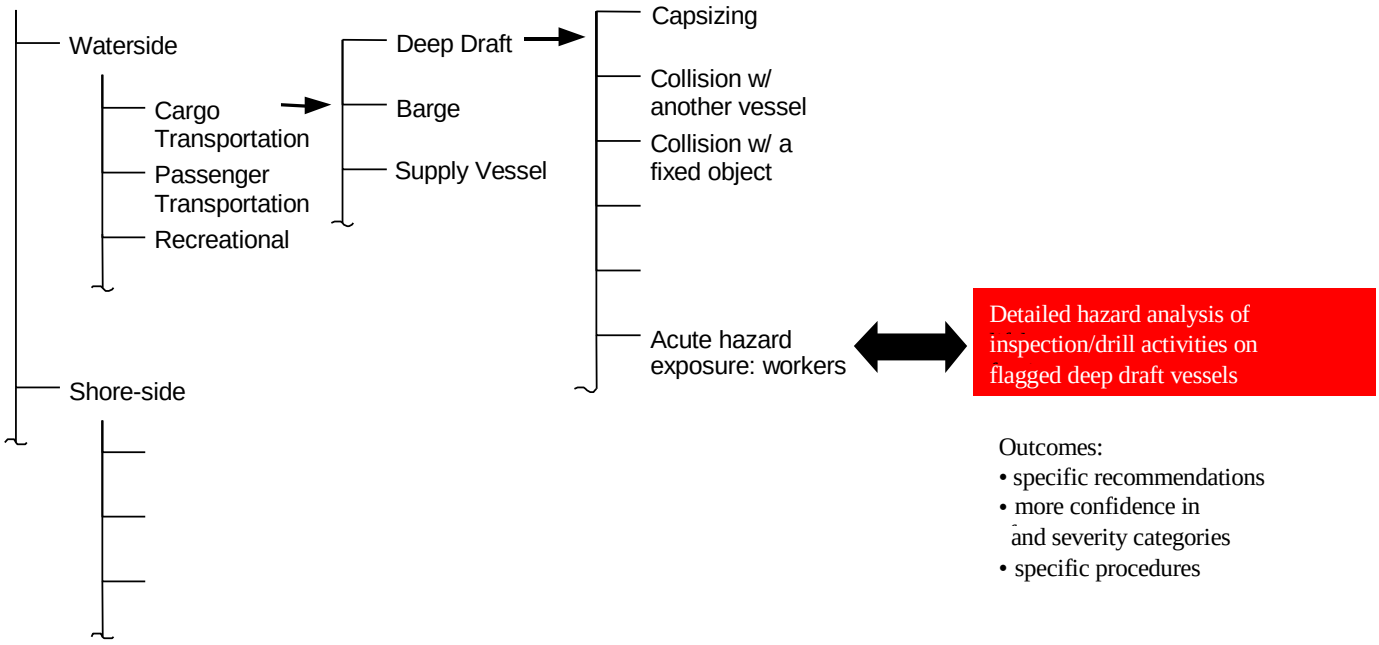

Figure B.2 Connection between Narrowly Focused Detailed Analysis and Preliminary Risk Assessment.