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The COAST GUARD Journal of Safety & Security at Sea PROCEEDINGS of the Marine Safety & Security Council

Risk Management

In this edition:

- Nonregulatory solutions for risk management
- Tried-and-true methods for security challenges
- Saving resources by managing risk

PROCEEDINGS

Spring 2007

Vol. 64, Number 1

On the cover: A Coast Guard 47-ft. motor lifeboat practices surf drills in 25-foot waves. Search and rescue coxswains train in heavy surf to maintain their proficiency in heavy weather. USCG photo by BM1 Christopher Enoksen.

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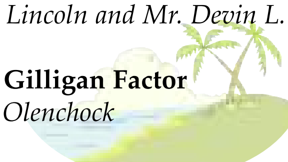

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Assistant Commandant's Perspective

By RDML C. E. Bone
U.S. Coast Guard Assistant Commandant for Prevention

For nearly a decade now, the Coast Guard has been aggressively employing risk management to inform decisions at the strategic, operational, and tactical levels. The Coast Guard's highest-level doctrinal text, "U.S. Coast Guard: America's Maritime Guardian" (also known as CG Pub 1), identifies seven principles of Coast Guard operations. One of these, the principle of managed risk, provides the strategic foundation for all of the Coast Guard's prevention and response missions and capabilities. In addition, the Coast Guard has operational guidance in the form of two Commandant Instructions on the integration of risk management principles and techniques in daily operations.

Over these past years, the Coast Guard implemented risk management strategies throughout the organization using scientific, structured risk-based decision making principles. At the tactical level, considerations of risk inform routine decisions such as what actions to take in a given situation, which asset to use to execute a mission, and the inclusion of contingencies in operational plans. At the operational level, the Coast Guard uses a number of risk assessment tools, tailored to specific kinds of activities like Search and Rescue, Maritime Safety and Security, Ports and Waterways Management, and Law Enforcement. At the strategic level, the Coast Guard is adapting risk management principles at the highest levels to include most planning and budgeting processes.

This effort is not yet complete, but it is ever-evolving and continuously improving. The Coast Guard is currently developing a web-enabled risk management system, as well as activity-based costing systems, fully aligned with other Coast Guard decision support systems to ensure optimum information is provided to key decision makers. The key to these processes is ensuring the appropriate degree of detail and depth of objective data available to support decisions.

Clearly, the risk-based decision making skills now employed by Coast Guard personnel have made a significant positive impact on how we do business as an organization, and have served us well during the recent years of rapid change and increased responsibilities. More importantly, taking actions based on a rigorous risk-based decision making methodology ensures best use of available resources, protects the public, and saves lives. The breadth and depth of the articles in this issue of Proceedings are a testament to this. The principles of risk management are not the sole domain of the Coast Guard, as we hear from our partners in government and industry helping to make the marine transportation system safer and more secure. I hope that you will find the articles in this issue interesting and informative.

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Champion's Point of View

By CAPT Patrick Little
Chief, U.S. Coast Guard Office of Design and Engineering Standards

Several years ago, the first issue of the Proceedings journal devoted to Risk Management was published (July-Sept 1999), highlighting the early successes of the Coast Guard's new emphasis on this management initiative. Around the same time, the Coast Guard Marine Safety and Environmental Protection Directorate initiated a strategy within its business plan aimed at developing Risk-Based Decision Making (RBDM) as a core competency throughout the Directorate. RADM Robert C. North wrote in Proceedings, "The end goal for this initiative is to achieve a culture in which a risk-based approach is used to aid decision making and planning throughout the Coast Guard." Indeed, that culture has flourished and paid tremendous dividends in the ensuing years—not only within the Marine Safety community but throughout the entire Coast Guard. This issue serves as a progress report on a management technique that has helped the Coast Guard to strategically change and purposefully adapt to an operating environment and risk landscape that has changed much since the issue last devoted to the subject.

The content in this issue is varied, with strong contributions from Coast Guard field units, industry, and other government agencies. The diversity of the articles and authors demonstrates the widespread applicability and use of the RBDM process. I would like to offer my sincere thanks for the hard work of all the authors who submitted articles—they've taken some very specific, complex processes and tools, and explained them in a practical manner.

For those unfamiliar with risk-based decision making, we have included a short course on basic RBDM and a refresher on the USCG's Operational Risk Management process. While much can be learned from the stories that follow, there are other RBDM resources that are readily available, including the RBDM website (http://www.uscg.mil/hq/g-m/risk/) and the RBDM Guidelines (available in electronic format on the website). In addition, there is an RBDM help desk, which is staffed by the Human Element and Ship Design Division (CG-3PSE-1). As part of the Prevention Through People initiative, the staff members from CG-3PSE-1 were involved in the development of the RBDM Guidelines. As such, they are essentially the plankowners of the RBDM process, and have facilitated many issue workshops using the RBDM process as their guide. Within the last year, personnel from CG-3PSE-1 have been consulted for a very wide variety of projects, some of which have been highlighted in this issue. The Office of Performance Management and Decision Support (G-0931) can also assist you.

With ever-increasing pressure to execute our missions more effectively and efficiently, the RBDM process is a proven tool that can help decision makers make more informed management choices. While our organization has come a long way in embracing risk management, there is more to be done and there are always new crewmembers to train. I hope you find these articles enlightening and that they inspire the uninitiated to get their hands dirty with these tools—if used properly, they won't disappoint!

Risk-Based Decision Making

A tool for effective management.

by Mr. Joseph J. Myers
Risk Analyst, U.S. Coast Guard Office of Design and Engineering Standards

The U.S. Coast Guard has always been in the business of managing risks. Throughout its history and under various names (U.S. Lighthouse Service, U.S. Lifesaving Service, etc.), Coast Guard personnel have worked to prevent shipwrecks, rescue mariners in distress, and mitigate the consequences of a marine casualty incident. As a service, we understand the underlying principles of risk assessment and risk management.

The more formalized approach currently in place began in the late 1990s when the Assistant Commandant for Marine Safety and Environmental Protection published the first edition of the *U.S. Coast Guard's Risk-Based Decision Making Guidelines*, a guide for decision makers on the use of risk assessment, risk management, and risk communication.[1] This was basically a parallel process to the adoption of operational risk management principles for Coast Guard tactical operations.

Risk-Based Decision Making

Risk is all around us, and has been receiving a great deal of attention recently. It is nearly impossible to read a magazine or newspaper or watch the evening news without hearing terms like "threat," "hazard," "probability," or "risk." In addition, risk-based (and risk-informed) decision making is used in most private- and public-sector organizations.

The material in this article was abstracted from the 3rd edition of the U.S. Coast Guard Risk-Based Decision Making Guidelines. *Interested readers may learn more at: http://www.uscg.mil/hq/g-m/risk/.*

Risk-based decision making (RBDM) provides a process to ensure that optimal decisions, consistent with the goals and perceptions of those involved, are reached. "Optimal" decisions are not necessarily those that achieve the best outcome (this may be a result of chance as much as decision-making skill) but rather are those that are most appropriate for the information, values, and goals applicable to the particular situation. The use of a risk-based system allows for consistent decisions to be made that will also be consistent with the values of the organization. The Coast Guard's risk assessment process does not replace a decision maker or eliminate uncertainty. Its sole purpose is to support the decision maker as another source of information, supplying not only the preferred solution, but also providing insight regarding the situation (including uncertainties involved); objectives; tradeoffs; costs and benefits; and the various assumptions, value judgments, and assessments of the stakeholders involved. The decisions reached using this process are proven to be rational, defensible, and repeatable.

The use of risk-based decision making is applicable in all aspects of Coast Guard activities. This includes search and rescue and maritime law enforcement cases, pollution response, security measures, regulatory development and enforcement efforts, and planning activities. *The Coast Guard's Risk-Based Decision Making Guidelines* contain a set of risk assessment and risk management tools and techniques that have general applicability in the field. The structure provided through RBDM ensures a process that organizes information about the possibility for one or more

Figure 1: Risk-based decision making process model. USCG graphic.

unwanted outcomes into a broad, orderly structure that helps decision makers make more informed management choices.

The guidelines lay out a model of the risk-based decision making process that includes the following steps (Figure 1):

- Establish the decision structure.
- Perform the risk assessment.
- Apply the results to risk management decision making.
- Monitor effectiveness through impact assessment.

Throughout all steps:

- Facilitate risk communication.

Risk Assessment

Establishing the decision structure requires the decision maker/analyst to identify the issues at hand, to think about and clarify what problems need to be solved, and decide who needs to be involved. This critical step structures the issue for subsequent stages. The problem must be described, stakeholders identified, options developed, and influencing factors noted. The level of detail and precision required, along with the amount of uncertainty to be tolerated, must be understood and agreed upon.

Generally, to complete the risk assessment process, a model of "risk" as the product of "consequence" and "probability" is used. This allows comparison of risks for different events. In recent years, the model has been adapted to consider probability as the combination of "threat" and "vulnerability." While these terms may indicate a security mindset, they are generally applicable to any situation if one considers threat as the probability of an event, and the vulnerability as the conditional probability of experiencing the consequences given that the event occurs.

The RBDM guidelines outline a hierarchical concept of risk assessment and risk management to ensure that the level of detail and complexity is appropriate for the situation. This concept is illustrated in figure 2 and begins with a coarse, high-level assessment to screen for issues of concern. Not only

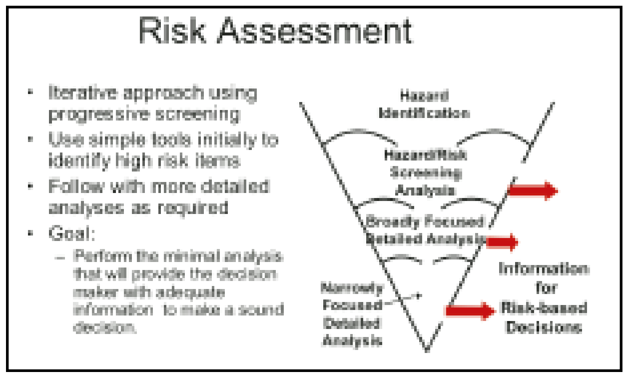


Figure 2: As a goal, the risk assessment should stop at the first stage that provides adequate support for the decision at hand.

does this screening approach allow the expenditure of the minimum level of resources for a particular decision, but by performing the initial analysis using the simpler, coarse, qualitative steps, successive analyses (if needed) are better focused on key issues, and therefore more efficient.

Progression through the various layers increases time and effort expenditures substantially. As a goal, the assessment should stop at the first stage that provides adequate support for the decision at hand.

Risk Management

The next block in the process model in figure 1 is risk management. At this phase of the process, the decision maker considers what measures can be implemented to reduce the risk. Most risk management strategies can be

The risk assessment process involves general hazard-identification and risk-assessment techniques.
This step generally answers the questions:

"What can go wrong?" . . . .(HAZARD IDENTIFCATION)
"How bad would it be?" . . . . . .(CONSEQUENCE ASSESSMENT)
"How likely is it?" . . . .(PROBABILITY ASSESSMENT)

THE GOAL IS to reduce risks by lowering the probability and/or decreasing the consequence(s) until their sensitivity to risk management is too low. For example, if a risk is considered high, due to a high likelihood, then countermeasures must be developed to prevent the mishap from occurring. Tracing back through the causal chain and implementing countermeasures to stop accident precursors might do this. Similarly, if a risk is considered high due to a high consequence, then measures must be developed to minimize the potential effect or mitigate the consequences.

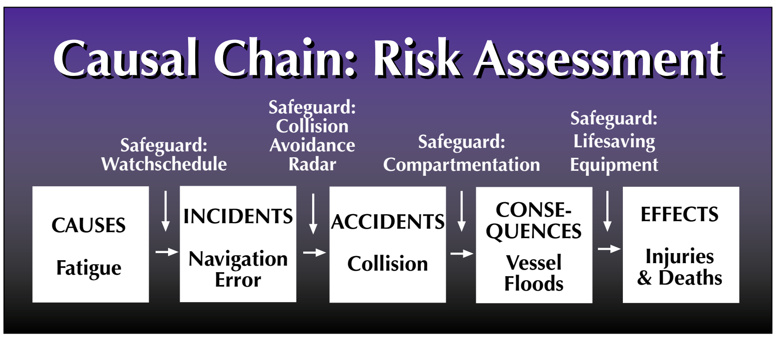


Figure 3: The causal chain is a description of how mishaps are generated and propagate. Risk management measures (labeled "safeguards") can be introduced at various points along the error chain to interrupt the casualty.

viewed as either "prevention" or "response." Preventive actions aim to reduce the probability of a loss and thereby reduce the risk. Conversely, response efforts are aimed at mitigating the consequences once a mishap occurs.

Risk management involves the process of developing and evaluating alternative risk mitigation strategies, selecting preferable countermeasures, and implementing them in an integrated fashion to optimize risk reduction efforts. The risk management approach relies on two models, the mishap causal chain (Figure 3) and the risk characteristic triangle (Figure 4).

The causal chain is a description of how mishaps are generated and propagate. Understanding this process either for accidental or deliberate acts allows the decision maker to target the risk management strategies where they can be most effective. An example causal chain is shown in figure 3. Here the chain is subdivided into five stages, although this is not required. Examples of each stage are shown at the bottom of each box.

Causal chains provide a powerful tool for developing risk management actions through the graphical description of how mishaps develop. Countermeasures for various risks can then be seen as interruptions in the development of the potential mishap, placing a break between stages. Figure 3 illustrates how risk management measures (labeled safeguards) can be introduced to interrupt the causal chain. It can readily be seen that the earlier countermeasures are enacted in the error chain, the more effective and efficient they will be.

As noted, the risk management phase uses the information developed during the risk assessment phase. Three key characteristics of risk considered for management are probability, consequence, and sensitivity, as modeled in figure 4. With information on these three areas, those involved in risk management can develop an effective, integrated approach to risk control.

Sensitivity is used as an indicator of the potential efficiency and effectiveness of risk management measures (hazards with high sensitivity are more manageable than those with low). In figure 4, the precept is that risk management is applied to address the consequence and/or probability of the hazard until the sensitivity decreases to a point where further risk management is not attractive as an option. The sensitivity of a risk to these countermeasures is thus an important factor in prioritizing risk management efforts. This helps avoid allocating resources to risks that do not have the potential to respond well to management.

Risk management measures can take many forms and can be enacted throughout the system. A taxonomy shown in table 1 is used to categorize risk management measures. Included in table 1 are examples

RISK CHARACTERISTICS

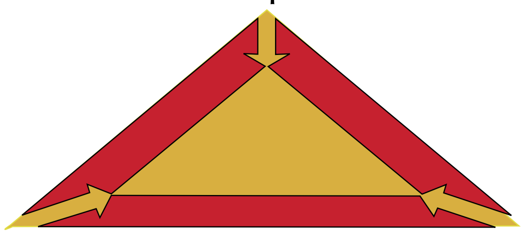


Figure 4: Three key characteristics of risk are probability, consequence, and sensitivity.

of risk management measures for security risks in a proposed cruise ship operation.

Potential risk management measures are often difficult to compare and contrast, due to their wide range of effects. Three general measures by which risk management techniques can be assessed are identified and defined in table 2.

Impact Assessment and Risk Communication

Impact assessment and risk communication are somewhat unique to the risk management process. The impact assessment is aimed at evaluating the effectiveness of the risk management measures. It allows the decision maker to monitor the measures' effectiveness and continuously improve performance. The goal is to identify if the issue is being addressed and its risks are being reduced adequately.

Because the Coast Guard is also a regulatory agency that deals with the public, risk communication is emphasized heavily in the process. Note in figure 1 that this model shows a two-way communication path from each of the other steps of the process. This is intended to ensure open dialogue, exchanges of information and opinion among individuals, and participation in the process. The intent is to include both those affected by the decision as well as those most knowledgeable about the issues under consideration.

One of the key benefits of the RBDM process is its ability to foster and improve communication. By engaging the stakeholders in the discussion, and using the structured approach of risk assessment and risk management, decisions are more rational and defendable. As discussed earlier, and shown in figure 1, risk communication must be initiated at the start of the decision-making process and carried throughout. Much of the "process," then, consists of obtaining information from and providing information to the stakeholders involved. However, given the combination of the technical nature of the material, the need to ascertain and utilize the values of the participants, and the democratic nature of our society, there are numerous pitfalls that can be encountered.

RISK MANAGEMENT CATEGORIES

Category	Action	Description	Example
S	Spread Out	Spread the loss exposure responsibility out among different entities, across operations, or across time.	Request local authority involvement in security measures and planning.
T	Transfer	Make others accept loss exposure responsibility.	The ship's operator may purchase insurance and transfer the risk to the insurer.
A	Accept	Live with the current loss exposure level and responsibility.	Do nothing–Accept the current risk.
A	Avoid	Cancel or delay the activity that involves the risk, or do not operate equipment that involves the risk.	Deny application–Don't allow the new cruise ship to operate.
R	Reduce	Do something to reduce the accident potential either in terms of probability or consequence.	Require that the cruise ship screen passengers' luggage prior to departure.

Table 1: Examples of risk management measures for security risks in a proposed cruise ship operation.

RISK MANAGEMENT CRITERIA

CRITERION	Description
EFFICACY	The degree to which the risk will either be eliminated or minimized by the proposed action—"Will it work?"
FEASIBILITY	The acceptability of implementing the proposed preventative action (economic, legal, physical, political, social, technical, etc.)—"Can we do it?"
EFFICIENCY	The cost-effectiveness of the proposed action in terms of potential dollars lost if no action is taken versus the cost of the action. Dollar figures for cost, if developed, need only be "ballpark" figures—"Is it worth it?"

Table 2: Risk management measurement criteria.

About the author:

Mr. Joseph Myers is a risk analyst in the Office of Design and Engineering Standards at Coast Guard headquarters. He helped develop the Coast Guard approach to risk-based decision making. He currently works to apply risk analysis techniques to myriad issues facing the Coast Guard, including pollution prevention and response, commercial fishing vessel safety, and homeland security issues.

Endnote:

[1] An updated version of these guidelines can be found at http://www.uscg.mil/hq/g-m/risk/e-guidelines/rbdm.htm.

Is it a Ship, a Plane, or a WIG?

Novel craft and risk management.

by LCDR Michael Simbulan
Staff Engineer, U.S. Coast Guard Office of Design and Engineering Standards

"... The traditional method of regulating ships should not be accepted as being the only possible way of providing an appropriate level of safety. Nor should it be assumed that another approach, using different criteria, could not be applied."[1]

As technology enables us to travel farther, faster, and more efficiently, novel craft such as the wing-in-ground-effect craft (WIG) find their way into the marketplace. As they do, the traditional method of regulating ships must also change, so that these craft can be operated in a safe manner equivalent with today's commercial vessel standards.

While this may sound simple, novel craft present many unique hazards that are neither covered by current regulations nor ever considered by traditional ship designers or engineers. As such, care must be taken to ensure that a comprehensive analysis is completed to identify all hazards and manage the risks associated with them.

RBDM and the Vessel Design Life Cycle

Fortunately, the Coast Guard has a process or framework that facilitates decision making, known as risk-based decision making.

For those of you who have already read the risk-based decision making (RBDM) primer at the beginning of this magazine or have seen the RBDM website, you are probably asking yourself, "Exactly how does the risk-based decision making process help me determine if a vessel is safe?" That's a good question. While the RBDM process is helpful in laying out the steps to make a risk-based decision, the process is not specific to any project or discipline.

continued on page 12

Imagine building an aircraft that is not bound by the rules and regulations of the Federal Aviation Administration because it does not operate within federal airspace. Imagine operating such craft and skimming just above the surface of the water, carrying passengers and cargo at speeds in excess of 80 knots. Imagine operating a craft that is more efficient than an airplane because it flies within the "ground effect." Imagine using the waterways, but not being constrained by draft. Lower fuel costs, no airport operating costs, no need for a runway—think of all the money you could make if you could build such a machine. Sounds great, doesn't it?

Now let's look at some real-world issues that may help bring us all back to earth. Imagine flying just above the surface of the water at 80 knots in a vessel traffic scheme where everyone else is traveling at 20 knots or less. Imagine picking up a contact half a mile away, while traveling at 80 knots. At this speed, you have 60 to 90 seconds to detect another vessel, identify its route and intentions, and then decide on a course of action. Imagine how quickly your situation would deteriorate if something went wrong with your propulsion, navigation, or control systems (keeping in mind that you are only about 10 to 20 feet above the water's surface). Imagine hiring a licensed master to operate a craft that moves in three dimensions, has different controls than a boat, and travels four to five times faster than any boat he or she has driven before.

Imagine you are the Captain of the Port or officer in charge of marine inspection or the prevention department head, and someone from industry proposes bringing a WIG craft to your area of operation. What are your safety and security concerns for the port? How will you determine what is safe? What set of regulations or design criteria will this vessel have to meet? How will you articulate your concerns to stakeholders?

Wing-in-Ground-Effect Craft

A "novel craft" is a craft that is:

1) Constructed using new technology or exotic materials such as composites

OR

2) Not currently covered by existing regulations.

Wing-in-ground-effect craft (WIGs) are a type of novel craft. WIGs have been around since the 1960s and were initially developed by the Russians, who had hoped to use the WIG as a military platform. Since then, wing-in-ground-effect designs have changed, and the emphasis has been on smaller-scale WIGs. While no commercial WIGs are currently operating, there are multiple vendors who have designed recreational wing-in-ground-effect craft, as well as many entrepreneurs who have attempted to bring commercial WIG craft to market in the U.S. and abroad.

What makes WIGs so appealing? Speed and efficiency. When you look at the potential to operate at a higher efficiency than an airplane and travel at speeds faster than a high-speed catamaran, WIG craft (with a cruising speed of 100 to 400 km/hour and a lift over displacement ratio of 15 to 30) fill a niche in the transportation spectrum between marine and air transport. When you also consider that you don't need a runway or airport to operate a wing-in-ground-effect craft, these types of craft sound even more enticing.

What does the Coast Guard have to do with WIGs? Simply put, WIG craft operate within the Marine Transportation System. WIGs may fly a few feet above the surface of the water, but they use the same waterways used by marine traffic, and interact with all other waterways users. As such, the Coast Guard is in the best position to not only determine their impact on the MTS, but manage it as well. In addition, while wing-in-ground-effect craft may resemble an aircraft, they are not regulated by the Federal Aviation Administration or the International Civil Aviation Organization (an organization like the IMO, but for airplanes).

What is the Coast Guard doing about WIGs? Besides reviewing conceptual plans for any operator attempting to bring a wing-in-ground-effect craft into commercial services, the Coast Guard has also been involved at the national and international levels to ensure that commercial WIG craft provide a level of safety equivalent with today's traditional, commercial vessel standards. For example:

1. Wing-in-ground craft have been defined in 46 U.S. Code 2101(48), and have been defined as a small passenger vessel if they carry one or more passengers for hire.
2. The Coast Guard was involved in the development of the Interim Guidelines for Wing-In-Ground Craft (MSC/Circular 1054), developed at the International Maritime Organization.[1]
3. The Coast Guard has been involved in the discussions at IMO concerning the training and certification of WIG operators, which led to the development of MSC/Circular 1162 General Principles and Recommendations for Knowledge, Skills and Training Requirements for Officers on Wing-In-Ground craft.[2]
4. The Coast Guard was also involved in the development of changes to the International Regulations for Preventing Collisions at Sea that defined the WIGs, as well as other provisions related to WIG operation (hierarchy, lights, etc.).
5. The Coast Guard has a WIG policy dated August 2001 that pre-dates the Interim WIG rules put out by IMO. The policy defines a wing-in-ground-effect craft, how WIG proposals will be processed, and what information should be contained in a WIG proposal.[3]

For further questions or guidance on novel craft, such as WIGs, contact the Marine Safety Center or the USCG Human Element and Ship Design Division, which is part of the Office of Design and Engineering Standards at Coast Guard headquarters. There are engineers or "techies" at both offices who are well-versed in the regulatory and technical aspects of novel craft design, and can help you walk through the design process from concept to construction.

[1, 2] Available at www.imo.org.

[3] Available at www.navcen.uscg.gov/mwv/regulations/wig/wig.htm.

Photos courtesy of Mr. Linus Romey, president of Pacific Seaflight.

The Hazard Analysis Guidelines for Transit Projects, developed by the Federal Transit Administration, would be a good resource for you.[2] The transit project life cycle (Figure 1) in this guide is another depiction of the RBDM process. In this instance, it has been tailored to a specific application—the design and construction of vehicles or vessels. This concept is very similar to the "design spiral" that is sometimes used in engineering disciplines.

As you move from left to right on the table, you move from a flexible conceptual design to a more rigid, concrete design on the right. The "hazard analysis" techniques listed in the left column of figure 1 represent different risk analysis techniques. The techniques at the top of the left column are coarse risk analysis techniques, while the techniques at the bottom of the left column are more detailed analysis techniques, applying to only certain systems or modes of operation. As you move through the vessel life cycle, the analysis techniques become more comprehensive and more focused.

OK, Where Do I Fit In?

If you understand the design process and different analysis techniques involved, it is easier to understand your role in the design and construction of a vessel. As an officer-in-charge, marine inspection; Captain of the Port; or member of a prevention department at a USCG sector, you are an important stakeholder. You are also often the main conduit for communicating risks between the vessel operators and designers and the public, industry, and other waterway users.

In addition, you may also provide the expertise that is required in the various analysis techniques, or you may be responsible for bringing in other stakeholders who may need to be involved in the ship design process.

The following provides an overview of how you may be involved in the various hazard analyses conducted when a new vessel is built:

- **Preliminary Hazard Analysis**

  As demonstrated in figure 1, a preliminary hazard analysis (PHA) takes place in the concept phase of a vessel design. This relatively coarse hazard analysis provides the flexibility that is often needed in the concept phase. Although few vessel plans or system drawings are available in the concept phase, the PHA allows for many hazards or potential hazards to be identified based on the concept, route, and other basic information.

  During the preliminary hazard analysis, hazard identification is normally accomplished through five basic methods:

  1. data from previous accidents (case studies) or operating experience,
  2. scenario development and judgment of knowledgeable individuals,
  3. generic hazard checklists,
  4. other formal hazard analysis techniques,
  5. design data and drawings.

  While methods 4 and 5 are normally employed by the "techies" at Coast Guard headquarters, methods 1 through 3 should involve staff at the field level who are intimately familiar with the port, vessel routes, traffic patterns, weather, and other relevant local conditions. Some form of preliminary hazard analysis is usually the basis for the initial dialogue between the vessel operators and the Coast Guard.

- **Failure Modes and Effects Analysis and Fault Tree Analysis**

  The failure modes and effects analysis (FMEA) and fault tree analysis (FTA) techniques listed in figure 1 are more comprehensive and require specific vessel or system information in order to conduct them. This is the part where vessel drawings are submitted and reviewed. In many cases, the FMEA and FTA are conducted by professional engineers, with oversight provided by the Marine Safety Center.

- **Operating Hazard Analysis**

  There will always be unforeseen hazards until the vessel is built and actual trials are conducted with crew onboard. The purpose of the operating hazard analysis (OHA) is to proactively identify and analyze hazards associated with personnel and proce-

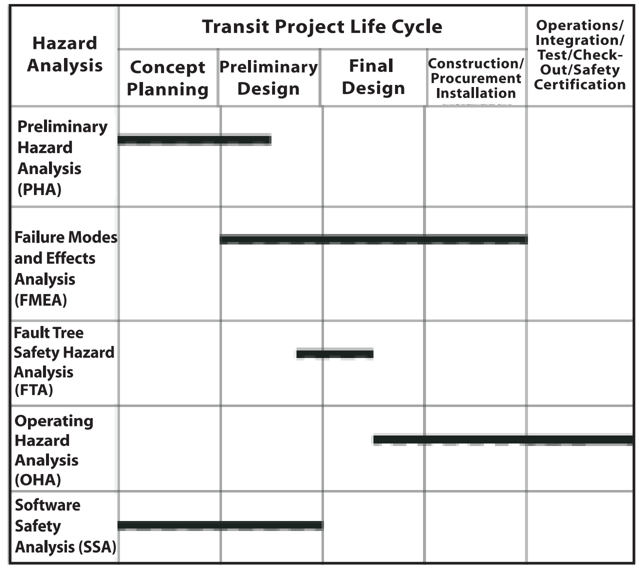


Figure 1: Transit project life cycle / required hazard analysis. Courtesy Federal Transit Administration.

dures during design, production, installation, testing, training, operations, maintenance, and emergencies.

Coast Guard inspectors are always involved in this analysis. The findings from the OHA are often incorporated into the vessel's operating procedures. In addition, a vessel's safety management system will continue to improve upon many aspects of ship operation covered in the operating hazard analysis.

- **Software Safety Analysis**
  The Software Safety Analysis (SSA) is a set of specialized techniques applying proven system safety and reliability analysis methods to identify and manage the risks of safety-critical computer software components. The emphasis is to identify all computer hardware and software components of a system in which errors can create a hazard or loss of control or predictability. The process allows the developers to identify the hazards of a system and to impose design requirements and management controls to prevent mishaps by eliminating hazards or reducing risks. The SSA is a very labor-intensive analysis, usually only performed by specialists, on key computer-based systems like auto-pilots and other safety critical systems.

Hazard Resolution
Once we have identified hazards and associated risks, then we can take steps to manage them. Table 1 shows the hazard reduction precedence.[3]

Many hazards require a multifaceted approach to reduce risk to an acceptable level. Table 1 illustrates this important part of managing risk and presents various methods for doing so in the order of their effectiveness. In other words, the methods at the top of the table are more effective than the methods at the bottom. The table is also important because it further emphasizes the importance of early recognition of hazards, since it is much easier and cheaper to change plans than it is to change equipment and arrangements after the vessel has been built.

Hazard Reduction Precedence	Examples
Eliminate use of the system, subsystem, or equipment that creates an unacceptable hazard.	Resolution: Eliminate ice machine.
Design to eliminate or reduce the hazard.	Resolution: Install newer, quieter equipment.
Provide safety devices.	Resolution: Provide hearing protection.
Provide warning devices.	Resolution: Provide signs in vicinity of noisy equipment.
Institute special procedures.	Resolution: Shut down equipment when working near or around it.
Accept the hazard.	Resolution: Don't do anything.

Table 1: Hazard: Machinery noise from ice machine.

RBDM and WIGs
There are no commercial wing-in-ground-effect craft in current operation. However, there have been several attempts to bring this technology to the commercial market. Even without doing a full analysis, it is obvious that WIGs present many unique hazards, including speed and vertical motion.

If someone proposes to bring a commercial WIG to your port, the good news is that the Coast Guard and the International Maritime Organization (IMO) have already put out some guidance concerning WIGs. This guidance has defined what a WIG is, and the basis for the guidance is based on flexible risk management. The bad news is that there are still many questions that need to be answered before commercial WIGs become a safe, viable transportation alternative.

Since previous attempts to design and construct a commercial wing-in-ground-effect craft did not go beyond the concept phase, a comprehensive analysis of a WIG, the systems aboard, and the craft's impact on the Marine Transportation System are lacking. Furthermore, the training of crew has not been thoroughly addressed.

While the process above was discussed in the context of WIGs, the same process or analysis techniques are also helpful in looking at any novel craft or vessel. While professional engineers are often employed to do the "heavy lifting" that accompanies comprehensive risk assessment, personnel in the field should not be afraid to apply these processes, ask questions regarding assessment, or ask engineers to "show their work." This is a major part of the RBDM process because if you don't understand it, how will you communicate risk to your stakeholders?

About the author:
LCDR Michael Simbulan is an engineer in the Office of Design and Engineering Standards at Coast Guard headquarters. He has served in prevention billets in San Juan, Puerto Rico, and Honolulu, Hawaii. He is currently responsible for programs and policy related to the design and construction of novel craft.

Endnotes:
1. An excerpt from the preamble of the International Code of Safety for High-Speed Craft, 2000.
2. A printed copy of the Hazard Analysis Guidebook for Transit Projects, developed by the Federal Transit Authority, January 2000, is available to the public through the National Technical Information Service, Springfield, Va.
3. From the Military Standard System Safety Program Requirements (MIL-STD-882C).

To Go or Not to Go, That Is the Question

Navigating hazardous waters.

by LT Kevin Ferrie
Staff Engineer, U.S. Coast Guard Office of Design and Engineering Standards

and LCDR Niles Seifert
U.S. Coast Guard District 13 Prevention and Investigations Department

The Washington and Oregon coasts are home to a unique marine operating environment—the "river bar." At these bars, thousands of gallons of river water per minute flow into the Pacific Ocean, and this causes an extremely dynamic, dramatic, and, on occasion, dangerous environment. The forces that collide at the mouths of these rivers in the Northwest at times cause conditions where waves break across the entire mouth of a harbor entrance, and the only way to get out or (more importantly) in, is to cross through a breaking wave.

The Coast Guard has long recognized the uniqueness of this operating environment and subsequently provided specialized training to its coxswains in boat-handling skills for this environment since 1980, when the National Motor Lifeboat School at Cape Disappointment, Wash. was opened.

Go/No Go

The Coast Guard has the authority to restrict recreational and uninspected passenger vessels from crossing a bar in rough conditions by regulations found in Title 33 of the Code of Federal Regulations, but this law does not apply to inspected passenger vessels (that carry more than six passengers for hire). So for many years, the small passenger vessel fleet had policed itself, and had remained a safe industry where accidents involving rough bars were relatively rare.

In Oregon in June of 2003, a small passenger vessel named the *Taki Tooo* sat inside the Tillamook bar as the captain assessed the conditions. During this assessment, three vessels of similar size successfully crossed the bar. When the master made the determination to go ahead with the trip as planned, the vessel capsized during the crossing and he and 10 other people perished.

The subsequent National Transportation Safety Board (NTSB) investigation report placed the responsibility for the incident on the master, highlighting his decision process as a key causal factor. The NTSB recommended, and the Coast Guard agreed, to consider regulatory changes that would require small passenger vessel masters to develop and implement go/no go policies. These policies would require the masters to consider the risk factors every time a bar crossing was planned, and if the risks are too great, either avert the crossing or take additional safeguards to reduce the risk to an acceptable level.

Because small passenger vessels cross these bars every day, there was a need to act quickly and implement any safety measures as soon as possible. Since regulation development can be a long process, addressing this problem through regulation was clearly not feasible as the initial step to manage this risk. Instead, Coast Guard personnel met with the most experienced masters at each bar during the winter of 2005–2006 to determine a method to manage this risk swiftly and effectively.

The industry supported the initiative, and this group determined that a written go/no go policy would be beneficial to the community. The charter captains that represented the industry in these meetings had been crossing these bars for years and already used some sort of a "go/no go" policy when conditions were rough. These experienced masters considered each risk factor and made a decision based on the years of experience they possessed. So, in essence, these experienced masters already were using a go/no go policy, it just had not been standardized across the industry. The group recognized that not every operator of small passenger vessels possessed the high level of experience represented in the group, and operators with little or no experience face the same kind of decisions every day. A formal, written guideline would benefit this population.

> ***"Charter vessel captains here in the Northwest deal with a variety of government agencies. Passenger safety is a top priority issue. Working with the Coast Guard on the Go/No Go policy in a proactive and collaborative fashion has been a very worthwhile and rewarding experience. Hopefully we can continue to use this sort of forum to resolve future issues in like manner. Our thanks to the Guard for a process well-done."***
>
> ***– Mark Cedergreen, Westport Charter Association***

Formulating a Written Policy

The first question the group had to answer was: "How bad is this problem?" The most critical step in any risk assessment is to clearly identify the problem. This would allow the group to answer the correct questions. Without a thorough knowledge of the problem, any work completed would be flawed from the start.

In order to understand the scope of the problem, the group turned to the Marine Information for Safety and Law Enforcement (MISLE). MISLE is the database the Coast Guard uses to capture vessel incidents and is a good database of known casualties. This allowed the group to study the causes of past incidents in order to understand what went wrong when small passenger vessels encountered problems crossing bars. Three incidents found in the database occurred between 1976 and 1983, and resulted in 17 deaths. In these events, one vessel was under tow and thus had no control, and the other two capsized while the master had full control of the vessel. The investigation for those in which the master had control identified the decision to cross the bar as the key causal factor. With the *Taki Tooo* added to these three incidents, 75 percent of them were the direct result of the master's decision-making process. This gave the group a clear indication of the major causal factor in these events, and validated the development of go/no go policies.

With a thorough grasp of these incidents and what caused them, the group then attempted to determine the frequency with which incidents involving bar crossings occur. It was difficult to find any data on how many successful bar crossings have occurred in the last 30 years during hazardous conditions. If nothing goes wrong, the event is normally undocumented. This made it impossible to determine with certainty the probability of the event occurring.

While the group agreed that any incident causing a death needs to be addressed, it is difficult to understand the overall risk without knowing the number of successful bar crossings in hazardous conditions. While the risk in this situation could not be quantified, the group understood through their experience that small passenger vessels cross the bar every day during the season, and very few incidents occur. This led the group to conclude that overall, the industry is generally safe.

Formulating a Proactive (Not Reactive) Approach

Early on in the process, the charter captains expressed a fear that the *Taki Tooo,* because of its high publicity, could heavily influence the outcome of the go/no go policies. More specifically, they feared that a policy would be developed that addressed the specific causal factors in that incident but did not adequately address the risk of the industry as an entire system. The goal was to produce a solution that considered the entire evolution of a bar crossing, not one that would have addressed the Tillamook bar and the *Taki Tooo*, but ignore all other risk factors. The group wanted to manage risk, not just react to it.

Operating on the assumption that the overall industry is safe, the group sought a systematic solution by capturing industry best practices during the entire decision-making process of whether or not to cross a bar. Group members broke down the major decision factors from the time the master listens to the weather the evening before a trip to the time he or she punches the throttles to make the crossing. This would enable the group to capture the key decision-making points experienced charter captains make on a daily basis.

If the go/no go policies were developed based upon the information gained from a best practice analysis, this would help the more inexperienced captains make sound judgments. This would not necessarily change the industry, but it would identify the operators who don't operate within industry safe practices.

The Most Important Variables

The end product was developed by industry, Coast Guard Search and Rescue station personnel, and

continued on page 17

GRAYS HARBOR BAR CROSSING AND PERSONAL FLOATATION DEVICE POLICIES FOR COMMERCIAL PASSENGER VESSELS

1. Vessels should not leave Grays Harbor and cross the bar if a red condition exists in any one of the three categories.

2. Vessels should not leave Grays Harbor and cross the bar if ebb velocity is category 5 or higher combined with a swell condition that is category 5 or higher.

3. Vessels should not leave Grays Harbor and cross the bar during periods of restricted visibility (one quarter mile or less) if both the wind and swell conditions are in the highest yellow category.

4. If multiple category yellow conditions exist, operators should view the bar conditions first, if possible, consult with other operators as appropriate, and carefully consider weather forecasts before crossing the bar.

5. If yellow conditions exist in any one of the three categories, vessel operators should take the following precautions in addition to their normal safety actions before and during a bar crossing:

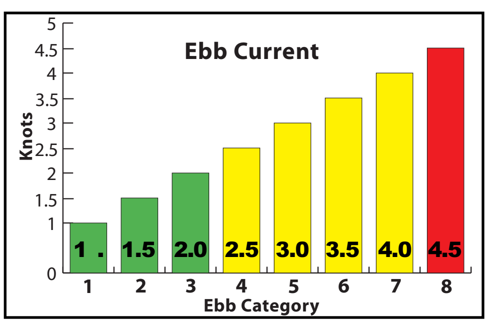
   - Passengers should be seated on a stationary seat (no coolers or portable seats) or should be standing in a position where they have a stationary handhold.
   - Passengers should be restricted to the back deck or in the cabin area.
   - Passengers should be advised that rough bar conditions might exist.
   - Passengers should be monitored by the deckhand to ensure compliance with safety rules and crew instructions.
   - Vessel operators should consider the size and capabilities of their vessel before crossing the bar.
   - Vessel operators should consider the physical characteristics of their passengers and their ability to deal with rough water conditions.
   - Vessel operators should be mindful of the tide and current conditions.
   - Vessel operators should avoid night crossings when multiple yellow conditions exist.

6. If a vessel crosses the bar, departing or returning, when hazardous conditions exist, the vessel master shall have all passengers don a personal floatation device. In addition, upon returning under hazardous conditions, consider calling the USCG for an escort.

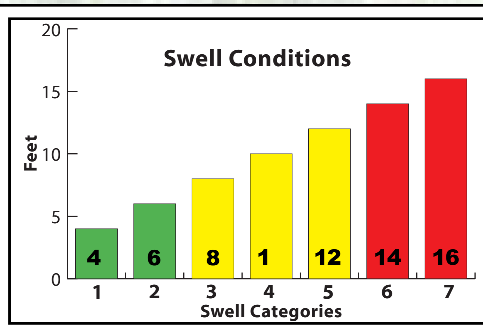
Hazardous conditions are deemed to exist if:

- swell height is category 6 or higher,
- ebb velocity is category 5 or above combined with a swell height category of 5 or above,
- the master deems that the circumstances may be hazardous to his vessel and crew.

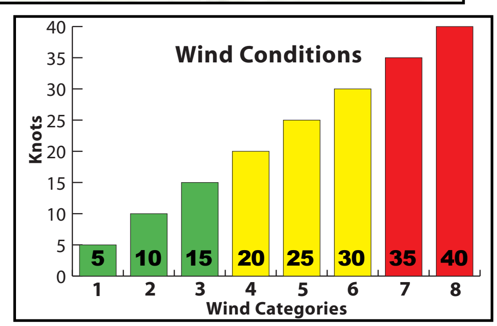
7. Grays Harbor bar crossing policy guidance, procedures, and wearing of personal floatation devices are applicable



The ebb current category will be determined by using the NOAA Current Table Publication for the Grays Harbor entrance or other documents using it as its source.



Swell height will be determined by using the most recent 0-20 mile Point Grenville to Cape Shoalwater forecast made by the National Weather Service. If a range of swell height is predicted, the highest swell height within the range will be used to determine the swell height category.



Maximum wind speed will be determined by using the most recent 0-20 mile Point Grenville to Cape Shoalwater wind speed forecast made by the National Weather Service. If a range of wind speed is forecast, the highest value in the range will be used to determine the wind speed category.

Figure 1: Nearly a dozen go/no go policies have been developed.

The decision to go or not go clearly rests within the yellow zone. The yellow zone is the transition zone, the "grey area" where difficult decisions are made. From this, the go/no go policies were written to give guidance on when a master should consider staying at the dock or putting additional safeguards in place.

Coast Guard Marine Safety personnel. They identified three major variables that must be considered when assessing the conditions of a bar:

- swell size,
- wind speed,
- current velocity.

These three variables are the main drivers of the conditions on a bar at a given time, and each can be measured discretely by weather buoy data.

Along with the conditions of the bar, seakeeping qualities of a vessel and the master's experience make up the other key contributors to the risk of crossing a bar. Since vessels within the local fleet generally have similar seakeeping qualities and members of the group were the most experienced in the industry, the group determined that if it could capture the decisions of the experienced masters, it would be valid for the other, less experienced operators.

For each of the variables (swell height, current, and wind speed) three distinct zones were determined based upon expert opinion:

- a green zone, in which there is low risk in the given state;
- a yellow zone, in which there is an increased risk in the given state;
- a red zone, in which there is clearly a high risk in the given state.

The Written Policies

Tailored to each port, the resulting go/no go policies (see figure 1 for an example) were voluntarily embraced by the small passenger vessel operators in the spring of 2006, less than six months after the Coast Guard and boating safety profession held the initial meeting. The involvement of the industry was heavily credited for influencing its willingness to accept the policies.

Support for the policies was evident from the start, as the masters immediately began talking more about whether or not to go among themselves, and all of a sudden it became "taboo" to make a transit across a bar when the other masters were staying at the dock. The completed work may not be the final answer, but it did provide a timely solution that increased the safety of charter boats crossing bars in the Pacific Northwest. Now that this initial step is in place, there is time to step back and take a more comprehensive look at the problem. It may be that what has been developed is already the best answer, but further study would allow us to examine the problem at a higher resolution and evaluate its effectiveness.

About the authors:

LT Ferrie has been a staff engineer in the U.S. Coast Guard Office of Design and Engineering Standards since 2004. Previous assignments include an engineer tour aboard USCGC Venturous *and the Marine Safety Office in Tampa, Fla. LT Ferrie earned a Bachelor of Science degree from the U.S. Coast Guard Academy in 1997, and a Master of Engineering degree in Concurrent Marine Design from the University of Michigan in 2004.*

LCDR Seifert has been a staff officer with the 13th Coast Guard District since 2006. Previous assignments include a chief of inspections tour at the Marine Safety Office/Sector Portland, Ore., inspections and investigations tours at the Marine Safety Office, New Orleans, and a number of afloat tours aboard U.S. Navy and U.S. Coast Guard ships.

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- John Brown, *charterboat operator, Tillamook, Ore.*
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- LT Ray Cain, *U.S. Coast Guard, detached duty officer, Astoria, Ore.*
- Mark Cedergreen, *Westport Charterboat Association, Westport, Wash.*
- Steven Dana, *charterboat operator, Tillamook, Ore.*
- BMCM John Dunn, *Station Chetco River, Ore.*
- CWO4 Richard Glasgow, *Station Yaquina Bay, Ore.*
- CWO4 Arnold LeCompte, *commanding officer, Station Coos Bay, Ore.*
- Ken Lawrenson, *inspector, Sector Portland, Ore.*
- Jan Pearce, *charterboat operator, Brookings, Ore.*
- CWO2 Michael Russell, *Station Umpqua River, Ore.*
- Butch Smith, *charterboat operator, Ilwaco Charterboat Association, Ilwaco, Wash.*
- LCDR Scott Stewart, *inspections, Sector Portland, Ore.*
- BMC Chris Sparkman, *Station Depoe Bay, Ore.*
- Jeurgen Turner, *charterboat operator, Depoe Bay, Ore.*
- CWO2 Darrin Wallace, *Station Grays Harbor, Wash.*
- Bill Whitmer, *charterboat operator, Coos Bay, Ore.*

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An Ounce of Prevention

Leading indicators represent the future of proactive, preventive safety performance metrics.

by Mr. Kenneth Davidson
Manager of Vessel Wellness, American Commercial Lines Inc.

In a world where some form of human error is involved in almost all accidents and incidents, it should come as no surprise that trailing indicators (measurements taken after something undesirable has already occurred) are the traditional metrics that transportation organizations use to measure operational safety, health, and wellness performance.

Leading vs. Trailing Indicators

Various common trailing indicator measurements in maritime operations include OSHA recordable personal injury rates, allisions, collisions, groundings, cargo damage, and man overboards. The severity and cost of each event are also commonly studied as trailing indicators. While these measurements are vital measurements of the health of an organization, they are historical measurements of undesirable events that have already had a negative impact upon individual employees and the organization's bottom line.

Trailing indicators document what happened in the past and thus cannot be changed. While trailing indicators play a role in determining what needs to be done to improve results, they should not be solely relied upon. More importantly, this approach by itself does not help to identify or champion the specific activities, actions, and behaviors required to achieve the desired results. If you rely on trailing indicators, you are still taking a reactive rather than a proactive approach to the prevention of unwanted events. Many times, transportation companies will try to hold on to trailing indicators for planning purposes—like a man who can't swim clings to a life ring for survival. He places his trust in this method because it is a proven product with a solid history of saving lives. The key word here, however, is "history."

Leading indicators, on the other hand, are those activities, behaviors, processes, standards, etc. that lead to desired results from employees properly implementing their training and subsequently being held accountable for those actions. While a safety management system based on leading indicators will ultimately affect all of those measurements associated with trailing indicators, the impact will be much broader in all performance fields and will be felt much farther upstream.

Figure 1: The ACL flagship, the M/V *Norb Whitlock*. Photo courtesy of American Commercial Lines Inc.

Results of a safety management system based on leading indicators in maritime operations might safely achieve productivity improvements reflected in vessel run times, barge turn rates, and reduction in port times.

These improvements may lead further to the desired results of reduced insurance premiums and other intangible benefits. The shift to management via leading indicators will change the company's entire culture, impacting everyone regardless of rank or position, and will very likely result in significant performance improvements and additional cost savings.

Leading Indicators in Action

American Commercial Lines Inc. (Figure 1) uses a leading indicator-based safety management system. This system includes a continuous-improvement implementation and evaluation program that requires:

- proper training for all crewmembers,
- adherence to operational and safety procedures,
- a mandatory near-miss reporting policy,
- implementation of the Crew Endurance Management System (CEMS) program.

The first step in shifting from a reactive, trailing indicator-based safety management system to a proactive, leading indicator-based safety management system is to understand where each organization is at the present time. You must have a clear definition of the current status, developed from field behavioral observations.

American Commercial Lines Inc. (ACL) implemented a field workplace performance standards verification program in which experienced personnel and supervisors conduct unannounced observations of employee behavior (Figure 2). The written reports from the workplace performance standards verification program document whether or not employees are following policies and procedures, such as wearing required personal protective equipment and complying with safety rules and hazardous communication policies.

Additionally, supervisors hold regular safety meetings and provide written documentation of their findings to senior managers, who, in turn, must also take the necessary actions to assure safety through adherence to company policies, standards, and procedures.

This "leading indicator emphasis" requires that companies place a much greater focus on training and accountability at all levels within the organization. We all must understand that being truly proactive means creating an organizational vision of how you want things to be while simultaneously dealing with the conditions that currently exist.

With that said, the challenge becomes shifting our operational culture from post-incident, corrective actions based on root cause analysis results, to the new frontier of proactive risk management, based on leading indicators.

At American Commercial Lines, the first set of leading indicators comes as a result of employee participation with a mandatory near-miss reporting policy. Near-misses are accidents that almost happen or might have happened. An analysis of the chain of events leading up to the near-miss event enables procedures to be evaluated and revised, as necessary, to prevent an unwanted event in the future.

The key here is that, if left unaddressed, these behaviors could eventually result in an unwanted event. In

Figure 2: An American Commercial Lines employee (upper left) observes work practices as part of the company's workplace performance standards verification program. Photo courtesy of American Commercial Lines Inc.

other words, many "near-misses" may eventually add up to a "hit." That is why the behaviors must be reviewed. By exposing patterns of behavior, ACL has identified leading indicators that can be proactively addressed.

Near-miss reports are often submitted to the manager of vessel safety and/or the appropriate operations manager. These reports of incidents that resulted in neither injury nor vessel accident must contain the following information:

1. what occurred,
2. what could have resulted,
3. what the significant causes were,
4. how to help fellow employees to avoid this type of near-miss,
5. boat or facility name,
6. date of the incident,
7. date a safety meeting was held concerning this near-miss.

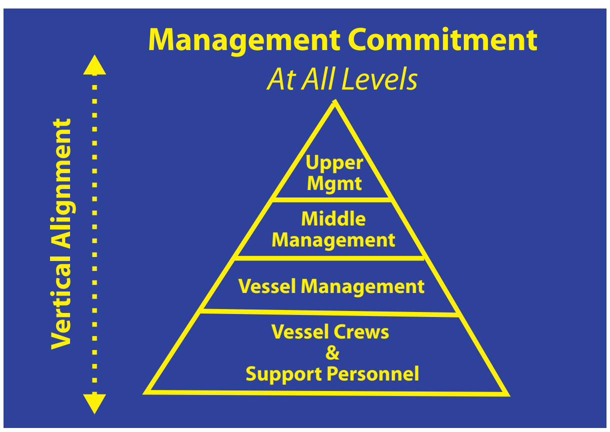

Figure 3: ACL found that the best way to introduce any new safety program was through demonstrated management commitment at all levels.

This is the first snapshot of the behaviors present, documented by employee participation, and will highlight some of the leading indicator areas where training and education programs should focus. ACL developed key leading indicators in the war against "competent errors" (errors made by otherwise qualified personnel) in maritime operations by adding a mandatory Crew Endurance Management System policy in addition to the company's mandatory near-miss reporting program.

American Commercial Lines found that the best way to introduce any new safety program is through demonstrated management commitment at all levels in a top-down approach, as depicted in figure 3. ACL began by educating the organization's vertical alignment, establishing a common mental model, and developing a final common path through open discussion. This process will progress to full implementation of the leading indicator approach to safety.

Managing Crew Endurance Risk Factors

After an organization's working group and/or major stakeholders have acquired a solid understanding of basic CEMS principles, the next step is to conduct an assessment of risks onboard the vessel. By addressing crew endurance risk factors, mariners are armed with the tools necessary to combat error. A more alert mariner will be able to make better risk-based decisions through a higher level of situational awareness.

"Improper management of crew endurance risk factors, including sleep, diet, and stress, has been shown to reduce the body's ability to conduct physical and mental tasks, thereby causing crewmembers to:

- Think less clearly.
- Make poor decisions.
- Become irritable.
- Have problems communicating with others.
- Experience degraded endurance throughout work and leisure hours.
- Become withdrawn and less willing to resolve issues and problems.
- Have less ability to fight disease."[1]

Identifying crew endurance risk factors within an organization and managing the associated risks are key in this process. The USCG CEMS Guide for Maritime Operations Addendum outlines 15 principal risk factors that are found in maritime operations.[2]

Using the list of principal risk factors enables a working group to outline the current situation and identify the most common factors present. ACL and many other operators have found the following to be the most common crew endurance risk factors, in order of frequency of occurrence:

1. sleep fragmentation,
2. poor sleep quality,
3. insufficient daily sleep duration,
4. family stress,
5. isolation from family,
6. poor diet.

The frequency with which each of the risk factors occurs can be a leading indicator to a problem. Studies have found that human error accidents and incidents can be directly attributed to these risk factors if left uncontrolled.[3] The key to improvement is how these leading indicator risks are managed. The best place to start is with the following guidance, reprinted from the USCG CEMS Guide for Maritime Operations.

American Commercial Lines recognizes the importance of crew endurance and, specifically, the importance of ensuring an adequate work and sleep environment for our crewmembers. As such, ACL is investing millions of capital dollars to improve crew work spaces and living spaces (Figure 4). These improvements include:

- darkening staterooms,
- increasing light intensities,
- reducing noise and vibration,
- providing quality bedding.

Crew Endurance Tips

Stress reduction and morale boosters can render a large payoff for a relatively small investment. In addition to the vessel modifications described above, ACL found that installing satellite television also easily boosted morale, as crewmembers realized the company's keen interest in their mental and emotional well-being.

Management, captains, and crewmembers can all contribute to the control of stress-related risk factors by implementing a consistent stress management program. American Commercial Lines has found the following list of recommendations to be successful in reducing stress and improving the quality of life onboard vessels:

- Train employees new to their job situation, particularly those recently promoted.
- Develop time-management strategies.
- Make a variety of exercise equipment available to crewmembers (treadmill, stationary bicycle, etc.).
- Promote crew participation in problem-solving using a team approach.
- Identify and reduce stressful factors, particularly those involving interpersonal relationships.
- Provide crew resource management training.
- Emphasize good communication with crewmembers, realizing that alienation, withdrawal, and lack of participation are signs of stress in all ranks and positions.
- Implement an on-watch rest policy.
- Implement an on-watch early meals policy.
- Implement an on-watch early shower policy.
- Implement a watch change time policy.
- Implement a common courtesy policy.
- Implement a continuous feedback policy.
- Provide vessel culinary training for cooks and modify the daily menu so that meals are balanced. Offer plenty of fresh vegetables and fruits, fresh juices, whole-grain bread, and low-fat meats such as turkey, fish, and chicken.

Instituting a near-miss program, CEMS, and workplace behavioral observations are examples of how American Commercial Lines began the transition to a leading indicator-based safety management system. As shown in figure 5, ACL's personal injury incident rate has drastically declined over the years. This decline is a result of changes in our organization's safety culture, driven by continuous innovation and changes in our safety management system. The decrease in injuries also reflects millions of dollars in cost savings for the company through reductions in injury claims.

Figure 4: Renovated crew accommodation spaces, modified to CEMS specifications. Photo courtesy of American Commercial Lines Inc.

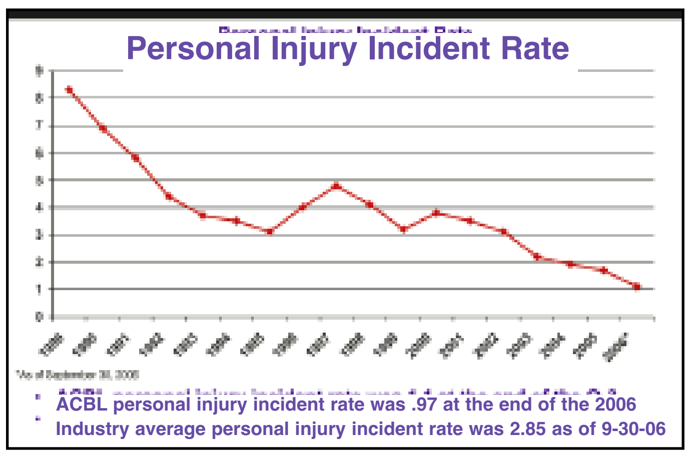

Figure 5: Chart of personal injury incident rates over time. Chart courtesy of American Commercial Lines Inc.

About the author: *Mr. Kenneth Davidson is manager of Vessel Wellness at American Commercial Lines Inc., headquartered in Jeffersonville, Ind. Mr. Davidson has worked for the last nine years in the areas of vessel operations, safety, and training. As a USCG crew endurance expert, he manages both the company's vessel crew endurance program and USCG-approved training programs. Mr. Davidson is also an FAA-licensed airline transport pilot. Prior to joining ACL, he worked in airline and corporate flight operations management at the University of Mississippi and Eastern Airlines.*

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The Coast Guard's Data Warehouse

Using maritime safety data to support risk management.

by Mr. David H. Dickey
Management Analyst, U.S. Coast Guard Office of Investigations and Analysis

In 2001 the Coast Guard deployed a new information system known as MISLE (Marine Information for Safety and Law Enforcement). MISLE replaced the aging Marine Safety Information System (MSIS), which was developed in the early 1980s. As the name implies, MISLE was designed to collect a variety of information on the vessels and facilities that operate on United States waterways. Among its many capabilities, MISLE records details of boardings, inspections, response operations, and casualty investigations. Also, new tools to analyze this valuable information, in the form of a data warehouse, became available shortly after MISLE was activated.

The new data warehouse, currently known as Coast Guard Business Intelligence (CGBI), was designed to help managers throughout the agency assess mission performance and strategies for risk management. When compared to earlier capabilities, CGBI was a significant breakthrough. Prior to Coast Guard Business Intelligence, only a limited number of employees at Coast Guard headquarters had the capability to analyze data from MSIS. Further, updates to the MSIS analysis database occurred only four times a

F E A T U R E S

OF THE COAST GUARD BUSINESS INTELLIGENCE DATA WAREHOUSE

CGBI is easy to use.
The application is web-based, which allows Coast Guard personnel to generate statistics with no specialized training or software. The information is available on CG Central on the CG Analytics tab and is organized into data sets that represent the major activity types and populations from MISLE. The data sets include the vessel and facility populations, inspection activities, enforcement actions, and incident investigations. The data is updated daily, bringing the information very close to real-time.

Each of the Coast Guard Business Intelligence data sets can be filtered (or queried) by selecting choices from dropdown lists, such as year, Coast Guard district, type of vessel, etc. After setting the desired filters, CGBI presents the requested statistics. If needed, there is also a "drill through" function to extract additional details from the individual MISLE records. The extracted information is automatically placed in a spreadsheet for further analysis.

CGBI is well supported.
When Coast Guard missions or management requirements change, project managers and programmers are available to revise or create new data sets. For example, data sets were created to track the implementation of new security requirements after passage of the Maritime Transportation Security Act of 2002.

MAJOR CAUSAL FACTOR	Breakdown of MAJOR CAUSAL FACTOR	Percent within Medium-and High-Consequence Casualties
Human Factors (56%)	Situational Awareness	20.2%
	Task Performance	17.9%
	Navigation Error	12.9%
	Improper Lookout	3.9%
	Voyage Planning	1.1%
Equipment (31%)	Propulsion	6.5%
	Cables/Lines	5.3%
	Electrical	4.0%
	Hull	3.7%
	Fuel	3.1%
	Other	3.1%
	Steering	2.8%
	Cargo/Deck Machinery	2.5%
External (13%)	External Causes	13.0%

An example of how the data within the warehouse can be analyzed. The table shows the major causal factors of medium- and high-severity failures within the towing vessel industry from 1994-2005.

year, resulting in significant reporting lag times. Today, CGBI provides virtually everyone in the Coast Guard with up-to-date maritime safety information.

Content

Even though MISLE and the data warehouse are only a few years old, Coast Guard Business Intelligence contains a significant amount of historical data that can be used for trend analysis or other purposes. Much of the data in MSIS was transferred into the MISLE system, so that it would be available for both reference and analysis purposes.

For example, all vessels in MSIS (with limited exceptions) were copied into MISLE. Consequently, the system has nearly 900,000 vessels that have had some contact with the Coast Guard, dating back to the early 1980s. MSIS casualty events, injuries, and fatalities from 1992 through 2001 were transferred into MISLE and are available in CGBI. Similarly, vessel inspection information is available, beginning in 1990. Also, Coast Guard Business Intelligence contains data from other information systems, such as the Coast Guard Search and Rescue database.

Using CGBI With Risk Management

Risk is generally defined as the probability of an occurrence multiplied by the consequence of that occurrence. In the risk-assessment process, the information in CGBI plays a valuable supporting role:

- Vessel and facility data help to define populations that may be affected by an occurrence.
- Casualty and pollution data are used to validate identified occurrences and quantify potential consequences.

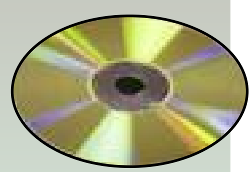
For example, casualty and population data have been used in two iterations of the Coast Guard's National Maritime Strategic Risk Assessment. That assessment assists senior managers with resource allocation decisions for the entire organization.

The data warehouse is also being used to support a significant rulemaking project. The Coast Guard and

T O O L S F O R T H E P U B L I C

Even though Coast Guard Business Intelligence was designed for internal Coast Guard use, much of the data is publicly available. The Coast Guard Marine Information Exchange (CGMIX) was created to provide several types of information to the public, including individual vessel histories and incident investigation reports.[1]

CGMIX is available on the Internet at: http://cgmix.uscg.mil/.



Also, for those who would like to analyze Coast Guard casualty data directly, the Prevention Directorate produces a Marine Casualty and Pollution CD-ROM, with details about each completed investigation report, beginning in 1982. The CD-ROM includes a data dictionary and is available through the National Technical Information Service.

The Marine Casualty and Pollution CD-ROM is updated quarterly and can be ordered at www.ntis.gov.

[1] *For an overview of CGMIX, see the Spring 2004 edition of* Proceedings, *(Volume, 61, No. 1), pp 33-35.*

CAVEATS

- MISLE is a complex system, capable of recording information on a wide variety of topics, including some that are relatively rare or obscure. Thus, it is not practical to present all of its data in Coast Guard Business Intelligence.
- Further, an exhaustive list of data sets would overwhelm users of the warehouse. Instead, the warehouse focuses on the most frequently needed information.
- Fortunately, when requirements change and new data sets are needed, the support staff can create them. For those occasions when a "one time" issue arises, analysts are available at headquarters to query the MISLE database directly.
- Although Coast Guard Business Intelligence can provide statistics very quickly, it is helpful to understand how information is recorded in the MISLE system. For example, casualty information can be retrieved for incidents overall or by certain casualty types.
- Users must select the correct data set for their questions.
- The most recent casualty data should be considered preliminary. The data will change as ongoing investigations are updated in the system.

Maritime Transportation Act of 2004 (P.L. 108-293) requires the Coast Guard to develop an inspection regime for U.S. flag towing vessels. The warehouse shows that approximately 5,000 vessels will be affected by the new regulations. When implemented, towing vessels will become one of the largest industry segments to be inspected.

Early in the ongoing regulatory process, which is ongoing, the Coast Guard invited interested parties, including the Towing Safety Advisory Committee (TSAC), to provide recommendations for the inspection regime. TSAC immediately chartered a working group to prepare a detailed proposal. As part of its deliberations, the group used risk-assessment methodologies to develop and validate their recommendations. The group studied casualty reports for a 12-year period, from 1994 through 2005. The data provided insights into accident types, frequencies, severities, and causes. The Towing Safety Advisory Committee recommendations were submitted to the Coast Guard in September of 2006.

Coast Guard Business Intelligence is being used in a similar manner at local or regional levels, as well. In fact, the warehouse appears to be an increasingly valuable tool throughout the Coast Guard. In 2005, the system was accessed nearly 44,000 times, or about 121 times a day. Of that number, approximately 62 percent of the usage was distributed among the Coast Guard Districts.

The Coast Guard's data warehouse is only one of many tools available to the risk assessment process. The availability of population and casualty data, however, serves to bring the process closer to the real world and allows the data to be utilized by those that need it most: the end user. The warehouse's ability to provide data directly to the field personnel only strengthens the need for accurate, thorough data collection in order to ensure any risks determined through analysis are an accurate representation of reality. As the warehouse evolves and personnel continue to be educated about its functions, it should help anyone involved in the maritime safety community to be better prepared when undesirable events occur.

About the author: *Mr. Dickey has been a management analyst with the U.S. Coast Guard Compliance Analysis Division since 1997. He has worked for the marine safety program, as a commissioned officer and civilian employee, for more than 30 years. Previous assignments have included assignments at the Marine Inspection Office in New Orleans, La., and as supervisor of the Marine Safety Detachment in Key West, Fla. Mr. Dickey holds a Bachelor of Science Degree and earned his Third Mate's License while attending the U.S. Merchant Marine Academy in 1976. He earned a Master of Science Degree (Natural Resources) from the University of Michigan in 1990.*

Promoting Parasail Safety

Using the Passenger Vessel Association risk guide to develop USCG Sector St. Petersburg's voluntary commercial parasail vessel safety exam program.

by LCDR Scott W. Muller
Project Manager, U.S. Coast Guard Office of Vessel Activities

The west coast of Florida provides tourists and locals alike with year-round pleasant weather, beautiful beaches, and abundant boating opportunities. These factors support a significant commercial parasailing industry. Passengers can enjoy a parasail ride that takes them soaring hundreds of feet above the water, harnessed to a parachute being towed by the parasail vessel below.

However, this thrilling parasail activity is not without its risks. In 2001, a tragic parasail incident in Ft. Myers, Fla. claimed the lives of a mother and daughter when high winds and rough seas caused the parasail towline and riser straps to part from the parasail, causing the two to freefall more than 200 feet into the water. A steady trend of other incidents resulting in parasail rider injuries during the next few years heightened the level of concern at USCG Sector St. Petersburg (MSO Tampa at that time). It was clear that intervention was needed.

The Problem: The Need to Improve Parasail Vessel Safety

Figure 1 displays historical data indicating that in a 10-year period (1992-2001), the Coast Guard has investigated an increasing number of reportable parasail vessel marine casualties and injuries. In the 59 cases during this period, there were 64 injuries and three deaths. Twenty-eight percent of these parasail casualties occurred in Sector St. Petersburg's area of responsibility (AOR).

Many of these parasail incidents could have been easily avoidable if only the parasail vessel operators had better training or had followed best practices. However, the parasail industry is not fully supported by any formal system of parasailing operating standards, training, or best practices. The industry is largely unregulated, other than some successful oversight by the Professional Association of Parasail Operators (PAPO) and by a few state or city ordinances, to some degree. PAPO is limited in its ability to enforce and/or detect violations of its guidelines. Most state or city ordinances, if present, do not go far enough to address the specific risk factors associated with parasailing operations.

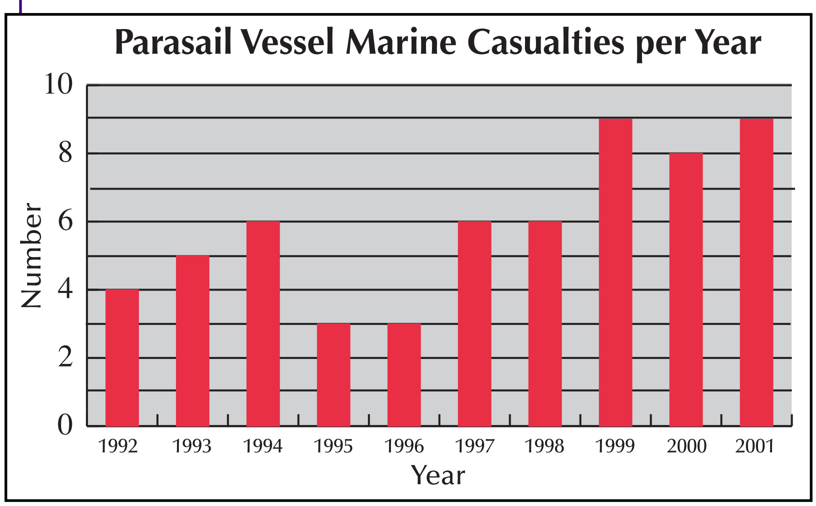


Figure 1: Parasail vessel marine casualties over a 10-year period.

In marine safety, risk can often be mitigated through federal regulation. However, the Coast Guard does not currently regulate the actual parasailing activity. Instead, commercial passenger vessel regulations only address vessel equipment and licensing require-

Figure 2: A near-collision of two parasail vessels with parasail riders aloft. Sector St. Petersburg case file photo.

ments, which are not related to parasail operations. There are no specific federal regulations for operator training and/or licensing endorsements required for conducting the complex tasks involved in parasailing. After all, not only is a parasail vessel operator required to safely navigate a vessel, but he or she must also do so while attending to the safety of the parasail riders aloft. This additional task increases the operator's workload, which may lead to increased risks, as figure 2 illustrates.

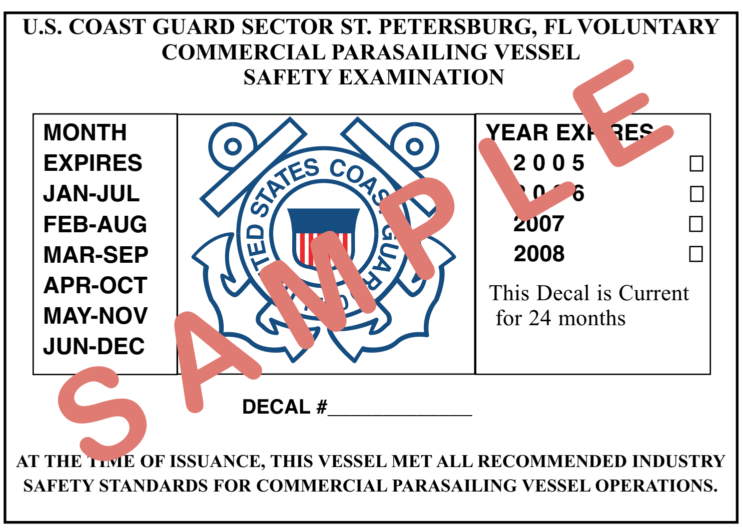


Figure 3: Sector St. Petersburg's Parasail Vessel "Seal of Safety" decal.

The Solution: Creation of the Voluntary Exam Program

In an effort to promote commercial parasail vessel safety in a nonregulatory manner, Sector St. Petersburg partnered with the parasail industry to embark on a number of safety program initiatives. In January 2004, Sector St. Petersburg hosted a parasail vessel safety workshop to provide an opportunity for the Coast Guard and parasailing industry representatives to meet, partner, and share safety recommendations.

Interest in this issue was so strong that more than 120 parasailing stakeholders from around the nation and the Caribbean participated. It was here that Sector St. Petersburg investigating officers proposed the idea of creating a voluntary commercial parasail vessel examination program.

The program was modeled after other successful Coast Guard voluntary exam programs for uninspected vessels, such as the commercial fishing vessel and uninspected passenger vessel programs. The aim of this proposed program was to improve parasail safety by promoting best safety practices. A "Seal of Safety" decal (Figure 3) would serve to distinguish compliant operators as meeting a recognized standard of best practice. The participants overwhelmingly supported the proposal.

In February 2004, Sector St. Petersburg established a developmental team. The team of 12 volunteers consisted of local parasail operators and manufacturers, Sector St. Petersburg investigating officers, and USCG Auxiliary members. During a two-day session, the team's goal was to develop a set of parasailing best practices that would form the basis of the voluntary exam program's compliance criteria.

As facilitators of the developmental team, Sector St. Petersburg investigating officers were faced with a challenging task—developing best practices that effectively addressed risk factors found in the complex nature of parasail operations. The team needed a methodology to help facilitate, focus, and organize their efforts to develop a creditable program. After careful consideration, the solution came in the form and utilization of the Passenger Vessel Association (PVA) risk guide.

In the spring of 2004, USCG Sector St. Petersburg launched its newly created and first-of-its-kind voluntary commercial parasail vessel safety exam program. In the three years the program has been in existence, there have been no reported marine casualties involving parasail vessels within Sector St. Petersburg's area of responsibility. This is significant, considering the alarming rate and consequences of parasailing accidents during the previous 10 years. Indeed, the program is a success because it reduced the risks associated with parasailing operations.

In the three years the program has been in existence, there have been no reported marine casualties involving parasail vessels within Sector St. Petersburg's area of responsibility.

Equally important, this program illustrates another type of success story—the successful use of a risk tool. In this case, the tool is the PVA risk guide. Because the guide established an efficient and effective means to assess, manage, and communicate parasail vessel risk factors, its use acted as a force multiplier in the promotion of parasail vessel safety in Sector St. Petersburg's area of responsibility.

Using the PVA Risk Guide

Using prepared forms/worksheets provided by the PVA risk guide to manage and record the findings, the team advanced through each of the risk assessment's ten steps. Drawing from the team's vast parasailing experience and lessons learned from previous Coast Guard investigations of parasail casualties, the team brainstormed and formed consensus along the way.

The team's risk worksheets developed during this process can be viewed on Sector St. Petersburg's parasail web page at http://www.uscg.mil/d7/units/mso-tampa/parasail.html. Highlights are briefly illustrated below:

- **Risk assessment (Steps 1–6)**. The team chose to address a particular aspect of risk associated with parasailing operations—the parasail ride itself. This includes the time from when the chute is inflated and the riders are airborne to the time of chute deflation. The team identified a number of hazardous events that could cause personal injury. The conditions that yielded the highest relative risk scores included:
    - towline separation,
    - mechanical failure,
    - operations in hazardous weather conditions.

- **Risk management (Steps 7–10).** The team then identified countermeasures that could best mediate the risk while at the same time considering cost. The team found that the countermeasures with the highest cost/benefit values included:
    - distance offshore (operational parameters),

THE METHOD FOR SUCCESS: THE PVA RISK GUIDE

Developed by the U.S. Coast Guard and the Passenger Vessel Association (PVA), the PVA risk guide is a very effective yet simple tool to address risk in marine operations. Marine operators can use the guide to evaluate and/or address maritime safety issues through three interrelated risk activities:

- risk assessment,
- risk management,
- risk communication.

The guide breaks these three activities into 10 easy steps, total. As illustrated in the guide, these ten steps help identify operational problem areas, balance tradeoffs, and assist in decision making.

This does not tell users which decisions to make, but rather shows what they should consider in order to make the best decisions possible to promote safety in their own vessel operations.

The guide can be downloaded from the Coast Guard's Prevention Through People website at http://www.uscg.mil/hq/g-m/nmc/ptp/pvarisk_guide.PDF.

- towline/winch spool connection,
- weather assessments,
- length of towline,
- towline standards.

- **Risk communication.** The guide naturally involved stakeholders in the decision-making process. This process also strengthened the ties between the Coast Guard and local parasail industry. Furthermore, the sound and proven methods provided by the guide supported the decision outcomes, adding to its credibility and potential effectiveness.

The team developed a list of approximately 20 countermeasures that would help mitigate parasailing risk. These countermeasures stressed proper maintenance and recordkeeping of parasail equipment and crew training. This also required operators to conduct parasail operations within certain established safety confines such as weather assessments and operational distance from shore. Ultimately, the team established countermeasures that represented parasailing "best practices" that were both cost effective and reduced risk.

The Way Forward

Sector St. Petersburg has greatly benefited from its utilization of the PVA risk guide in establishing its nonregulatory parasail exam program. The unit also used the guide to address waterway management issues regarding crew team boats (rowing).

The voluntary exam program reduced parasailing risk and facilitated risk communication, which increased parasail safety awareness for parasail vessel operators and customers alike. In light of success stories illustrated here, I strongly encourage other Coast Guard offices to include the PVA risk guide in your marine safety initiatives.

About the author: *LCDR Scott Muller served as a marine inspector and senior investigating officer. Past assignments included MSO Hampton Roads and MSO Tampa as well as graduate school for modeling and simulation at Old Dominion University. He is currently a project manager in the Office of Vessel Activities at Coast Guard headquarters.*

THE VOLUNTARY COMMERCIAL PARASAIL VESSEL SAFETY EXAM PROGRAM

To create the exam program, the development team transfered the countermeasures into exam criteria. Once formatted, the team communicated their findings to the commanding officer of Sector St. Petersburg. Because the product was created using a proven risk approach, the process of obtaining approval to execute the exam program was greatly expedited.

Sector St. Petersburg announced the program through a press release to increase public awareness of the program and highlight the Coast Guard's sincere efforts to promote parasail safety. Sector St. Petersburg also advertised the program to vessel operators on the unit's web page, along with other pertinent parasail safety information.

This parasail exam program is executed in similar fashion as other Coast Guard voluntary exam programs. For uninspected parasail vessels, members of the Coast Guard Auxiliary conduct the voluntary examinations, while active duty marine inspectors conduct the exams for the inspected parasail vessels during the course of routine inspection for certification examinations.

Those who pass the exam are awarded the Seal of Safety decal. The decal is valid for a period of two years, with a re-exam on or about the first anniversary of issuance. To date, Sector St. Petersburg has issued parasail safety decals to more than 60 percent of the parasail vessels in their area of responsibility.

U.S. Coast Guard Auxiliarist LCDR Michael Shea of Sector St. Petersburg examines a parasail chute during a voluntary parasail vessel exam onboard the vessel *Serenity*, located in Clearwater, Fla. U.S. Coast Guard photo.

All Hands on Deck

Improving deck safety on commercial fishing vessels.

by DR. JENNIFER M. LINCOLN
Injury Epidemiologist, National Institute for Occupational Safety and Health

and MR. DEVIN L. LUCAS, MS
Injury Epidemiologist, National Institute for Occupational Safety and Health

It's the end of a beautiful day along the Alaskan coast. The fishing was very good. A full net of salmon is being hauled in by the crew of a 58-foot seiner. It's the last and largest set of the day and the crew is anxious to bring in the catch and head for port. As the purse line winds around the capstan winch, one of the fishermen becomes distracted and steps toward the line. The bottom corner of his raincoat contacts the rotating drum and he is quickly pulled down toward the winch.

Although this incident is fictional, many fishermen are killed and disabled each year in the commercial fishing industry in incidents similar to this. Although most fatalities occurring in the fishing industry are related to the loss of a vessel, most serious injuries are caused by deck hazards such as machinery, fishing gear, and falls. Deck injuries can occur at any time and can result in debilitating, severe, costly injuries.

Why Deck Safety?

Commercial fishing is one of the most dangerous occupations in the world. Sinkings like the *Arctic Rose* and *Big Valley* in Alaska, as well as other tragedies like the fatal fire aboard the *Galaxy*, take dozens of lives each year. From 1994 to 2004 in the United States, 641 commercial fishermen died—an average of 58 each year. Of those fatalities, 332 (52 percent) were due to a lost vessel and another 184 (29 percent) were caused by falls overboard. The remaining fatalities were caused by deck injuries, diving, fires, explosions, or other causes.[1] In 2005, 48 commercial fishermen were killed on the job, resulting in an occupational mortality rate of 118 for every 100,000 workers. That's the highest of all occupations in the country—30 times higher than the mortality rate for the average U.S. worker of four per 100,000.[2]

Although most fatalities in the commercial fishing industry are due to the loss of a fishing vessel, researchers at the National Institute for Occupational Safety and Health (NIOSH) Alaska Field Station have shown that most severe non-fatal injuries (67 percent) occur on deck during the deployment and retrieval of fishing gear.[3] "Severe" injuries are defined as those requiring hospitalization such as lacerations, broken bones, head injuries, and smashed limbs. The deck of a fishing boat is a slippery, constantly moving work platform that is often congested with machinery and fishing equipment. Most of the machinery used on commercial fishing vessels lacks adequate guarding and safety features common to other industrial settings.

NIOSH is the federal agency responsible for conducting research and making recommendations to improve the safety and health of U.S. workers. To address the safety issues in commercial fishing, NIOSH designed the Deck Safety Intervention Project, which began in October 2000. The goal of this project was to use risk management tools to determine when and where deck injuries occur, and then develop intervention strategies with industry and safety organizations to eliminate or lessen the risks deck machines pose.

NIOSH Deck Safety Intervention Project

To begin, we first had to understand when and where deck injuries occur. We began by reviewing injury data from hospitals, but this information only provided a piece of the puzzle and more was needed. We worked with our industry safety partners and the U.S. Coast Guard to organize meetings with commercial fishermen. Using the injury data to start the discussion, we asked fishermen to tell us what could go wrong on their vessels, how likely it is that something will go wrong, and how bad the consequences could be.

Deck Safety for Crab Fishermen

Published by Jensen Maritime Consultants, Inc. with technical assistance and funding from the Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health as a service to the commercial fishing industry. This booklet is available free of charge.

Additional copies are available from:

Jensen Maritime Consultants
404 Fisheries Building
4241 21st Avenue West
Seattle, WA 98199
206-284-1274

The first phase of the project focused on crab fishing vessels. The injury data and industry discussions identified both crab pots and launchers as significant hazards that caused many injuries. Crab pots used in the Bering Sea can weigh up to 800 pounds and are launched from the vessel by a hydraulically driven platform. Common injuries include blunt force trauma to the head and chest as well as crushing injuries to feet, hands, and arms.

To generate intervention strategies, NIOSH partnered with Jensen Maritime Consultants, a marine engineering and architectural firm in Seattle, to observe the crab fishing process and meet with commercial fishermen. A naval architect from Jensen Maritime spent time on the F/V *Royal Viking*, a vessel out of Akutan, Alaska, to study the pot fishing process. He took many photographs of the activities, which we used to generate ideas in discussions with fishermen. We toured vessels and worked with the North Pacific Fishing Vessel Owners Association and the U. S. Coast Guard to conduct meetings with crab fishermen to discuss potential modifications for deck safety problems.

Specific work practices and opinions regarding the effectiveness of the deck safety interventions were collected from crab fishermen with further assistance from the Coast Guard. The modifications that the fishermen thought would be effective solutions were published in Jensen Maritime Consultants' 2002 *Deck Safety for Crab Fishermen* handbook, complete with illustrations and general installation instructions.[4]

After the work with crab fishermen, the deck safety project shifted to other types of fishing vessels. NIOSH worked with the Coast Guard and the Alaska Marine Safety Education Association to conduct meetings with fishermen in Sitka, Petersburg, and Ketchikan, Alaska. Discussions revealed that fishermen were concerned about deck safety, and in particular with the deck winch on purse seine vessels.

The deck winch is a powerful capstan winch, usually in the center of the deck near the wheelhouse. The drum rotates while the crew is working on deck. Fishermen who lose their balance or who are inattentive can become entangled in the purse line as it is winding around the drum. Crushing injuries to the hands or arms are the inevitable results. Fatalities can occur if the head or torso is caught. The hydraulic controls are usually located on the bulkhead behind the winch—unfortunately, usually out of reach of the entangled fisherman.

Safety Solutions

The NIOSH Alaska Field Station partnered with the NIOSH Spokane Research Laboratory in 2004 to design and test a method of quickly stopping the deck winch. NIOSH Spokane Research Laboratory engineers designed an emergency-stop (e-stop) system that allows the winch to be quickly stopped by a worker, even if the worker is caught in the winch. A fisherman who becomes entangled can push the electronic button located on the winch. This in turn actuates a solenoid valve that stops the flow of hydraulic oil powering the winch, and the rotation stops.

A fishing vessel in Seattle worked with NIOSH on the design and installation of the e-stop system, which was successfully tested during the 2005 and 2006 Southeast Alaska salmon seasons. Crewmembers praised the device as a significant safety and productivity improvement, and they continue to use the system.

Combining diverse expertise to identify hazards and generate solutions has been the deck safety project's key to success. The program has resulted in greater industry awareness of deck hazards and novel ways to mitigate these hazards. More than 4,000 copies of *Deck Safety for Crab Fishermen* have been distributed in the Northwest, and several safety websites have posted copies.

By following the risk management steps, using epidemiologic methods to identify problems, encouraging input from the industry to develop solutions, and incorporating engineering expertise to develop products, this deck safety intervention project will continue to produce practical solutions to manage the risk of deck hazards.

About the authors:

Dr. Jennifer M. Lincoln is an injury epidemiologist with the National Institute for Occupational Safety and Health (NIOSH) Alaska Field Station in Anchorage, Alaska and leads the "Applying Safety Research and Design to the Fishing Industry" research program. She is a strong advocate of providing science to improve safety in the workplace. She strives to provide scientific information to develop palatable interventions in the form of engineering solutions, new operating procedures, or new policies in concert with industry, other safety advocates, and regulators.

Mr. Devin L. Lucas, MS, is also an injury epidemiologist with NIOSH Alaska Field Station in Anchorage, Alaska. He works exclusively on commercial fishing safety and feels strongly that research should be useful and result in practical solutions that make a difference in the industry. As a lifelong Alaskan commercial fisherman, he adds firsthand experience to his work.

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E-stop

National Institute for Occupational Safety and Health (NIOSH) Spokane Research Laboratory engineers have designed an emergency-stop (e-stop) system that allows the capstan winch to be quickly stopped by a worker, even if the worker is caught in the winch.

The system can be retrofitted to any winch and consists of a sturdy pushbutton mounted on the winch housing, electronic controls, and a hydraulic valve that is interfaced into the existing hydraulic controls.

Fishing crews are field testing the e-stop. The NIOSH deck safety intervention project will also produce a deck safety video and develop a commercially available retrofit kit for the e-stop. A control technology publication will also be released to increase the distribution and impact of the e-stop.

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Overcoming the Gilligan Factor

Enhancing mission effectiveness through risk management.

by LCDR Thomas Olenchock
Industrial Hygienist, U.S. Coast Guard Office of Safety and Environmental Health

Who remembers the television show "Gilligan's Island"? Do you think the professor and Mary Ann expected they were about to embark on a fateful three-hour tour? Would they have done anything differently if they knew about operational risk management? Just like they made the decision to get on the *S.S. Minnow,* we make risk-based decisions every day, whether we realize it or not. It is the weighing of the risks and benefits associated with the activities that we engage in that defines operational risk management, or ORM.

ORM is a simple way to discuss and evaluate our risks while helping us to look at the less obvious hazards we may encounter. Figure 1 shows the seven steps of ORM. While these seven steps may look like a lot, the process steps are fairly simple—you decide what you are trying to do, examine the hazards, assess the risk, evaluate your options, decide which option to undertake, conduct the task, and re-evaluate your risks.

The Steps in Operational Risk Management
***Step one:* Identify what you want to do.** This may appear to be an obvious step. However, you may not take into account that every step in a process can have a different risk associated with it.

It's easy to forget that the routine tasks we perform every day may pose as much or more risk to us than those we only do once in a while. For example, people often take traveling somewhere, such as transit to a ship terminal for a cruise, for granted. Yet the national vital statistics system claims that the leading cause of accidental fatalities is motor vehicle crashes. Knowing this, when we apply ORM to a trip to the terminal, the tasks could include choosing a method of transportation (car, motorcycle, vanpool, metro, etc.), driving to the terminal, and then parking.

***Step two:* Identify the hazards**. This means simply looking at each of the steps required to perform the task and assessing the various dangers surrounding the chosen activity. In the example above, what are the variables on the professor's trip to the ship terminal? In this instance, other drivers on the road, not getting enough sleep, or speeding enroute. Each poses a unique hazard. In similar fashion, each of the steps involved in your activities has its own hazards.

***Step three:* Assess the risk.** This is where operational risk management comes into play in those tasks we perform every day. We have all experienced that feeling that something is wrong while involved in a task—when those hairs on the back of your neck stand up and doubt enters your mind. The bigger problem is that many times we lack the tools to identify how bad the hazard truly is. Operational risk management gives us those tools. It provides us with ways to model hazards and risks, and to give them a tangible numerical value. A couple of these tools will be discussed later, but for now, understand that everything has a risk—some are acceptable and others are not.

Step four: **Identify your options.** This allows you to consider less hazardous steps to make your entire process safer. This also gives you the ability to tailor your tasks to minimize those specific risks identified, using the tools. If you looked at your commute and realized the most hazardous part of your commute was driving without sufficient rest, you might consider the options of public transportation or getting a full eight hours of sleep before driving. Each option not only reduces the risk of you falling asleep while driving, but also increases the likelihood of you completing your goal of getting to the dock on time.

Step five: **Weigh the risks against the benefits.** In the real world we don't get to eliminate every hazard. There will always be a job that requires us to do something that is dangerous, like entering a confined space, sailing a boat, painting, sand blasting, or even driving to work.

This is where you need to make a conscious effort to decide: "I know the risks. I have tried to reduce them. So do I really need to do this?" The point is, here you can make an informed decision and no longer rely on that "gut feeling" to warn you that something is wrong.

Step six: **Perform the task.** Without action (or a conscious decision not to act), the rest of the process is an exercise in futility. In this manner, the process will fail as quickly as that latest fad diet. If you do decide to go another way, or change your criteria, it is simple to review your risk assessments and then continue the process. The flexibility allowed by risk management easily and rapidly adjusts to all changes.

Step seven: **Monitor the situation.** It's been said, "The best-laid plans of mice and men often go awry." This statement is often true when dealing with real-time operations, where the variables are constantly changing. Maybe this is what happened when that "tiny ship was tossed," or maybe it was poor planning.

We will never know for sure, but at least we can explore the possibilities through the operational risk management process. Without continual monitoring of our processes and continually re-evaluating the risks, we may find our best-laid plans truly have gone awry and we now face a more challenging risk than expected.

This final step turns a process into a system. It is no longer a one-time evolution that allows you to check a box to say you did it. It is a feedback system, one that must continually be revisited throughout the entire activity, especially when circumstances change.

The Green, Amber, Red Model

So how did the crew of the *S.S. Minnow* get stuck on that remote island? Well, let's see if applying the ORM model of green, amber, red (GAR) would have suggested they reconsider their decision to sail that day.

The GAR model (Figure 2) has six inputs that are equally weighted to evaluate risk. These factors are:

- supervision,
- planning,
- crew selection,
- crew fitness,
- environment,
- event complexity.

Each of these categories is scored on a scale of 1 to 10, with "10" being a high risk.

Analyzing the "Gilligan Factor"

Supervision: In this case, the skipper was providing the supervision on the *S.S. Minnow.* I think we can all agree that he was not a substantial source of risk and could be scored low—let's call it a "1."

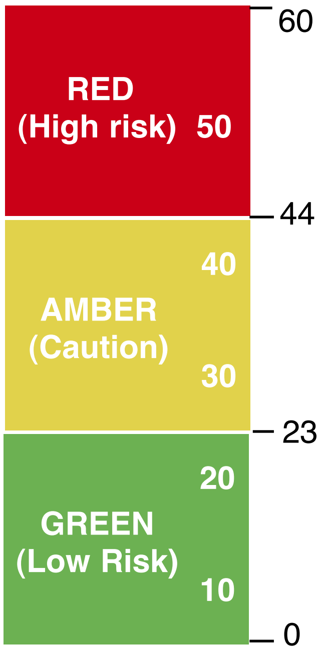
Planning: I would say it is reasonable to assume it is a trip they had made several times before, and would score it around a "2."

Crew selection: This is where we can factor in Gilligan. Here I would have to say that the "little buddy" is a walking risk and I would score him around a "7."

Even in just these first three categories you may be saying that you disagree with me. That's great! There's another program in the Coast Guard called team coordination training (TCT), which discusses ways to implement risk management principles in daily operations. Two of the issues it teaches are effective communication and assertiveness. When

continued on page 35

GAR Evaluation Scale



Calculating Risk

SUPERVISION	
PLANNING	
CREW SELECTION	
CREW FITNESS	
ENVIRONMENT	
EVENT/EVOLUTION COMPLEXITY	

To compute the total level of risk for the six elements (supervision, planning, crew selection, crew fitness, environment, and event complexity), assign a risk code of 0 (for no risk) through 10 (for maximum risk) to each element. This is your personal estimate of the risk. Add the risk scores to come up with a total risk score.

Figure 2: The GAR model can address more general risk concerns, which involve planning operations, or reassessing risks as we reach milestones within our plans.

Severity (S) ______________

Describes potential loss or consequences of a mishap (i.e. extent of injury, illness, equip. damage, mission degradation).

0 = No potential for loss
1 = Slight
2 = Minimal
3 = Significant
4 = Major
5 = Catastrophic

Probability (P) ______________

Likelihood that consequences will occur.

0 = Impossible
1 = Remote under any conditions
2 = Unlikely under normal conditions
3 = About 50-50
4 = Greater than 50%
5 = Very likely to happen

Exposure (E) ______________

Amount of time, number of people involved, number of repetitions.

0 = No exposure
1 = Below average
2 = Average
3 = Above Average
4 = Great

Specific Hazard: ________________

Risk = S x P x E = ________

Values	Risk Level	Action
80-100	Very High	Discontinue, Stop
60-79	High	Immediate Correction
40-59	Substantial	Correction Required
20-39	Possible	Attention Needed
1-19	Slight	Possibly Acceptable
0	None	None

Figure 3: The SPE model can address specific hazards, such as those involved in launching or recovering a small boat or the meeting of two vessels in a congested waterway.

you apply TCT teaching to this issue, you can see that your disagreement is actually an opportunity for a team to discuss concerns and look at the risk assessment in a different light.

Crew fitness: I would rate crew fitness a "2." Remember this is not just rating weight and strength, but also takes into consideration things like fatigue; alertness; and external stresses, like family life or pending court or work problems.

Environment: Sailing or flying into a typhoon sounds like a very high-risk maneuver to me. I would rate environment as a "10." Environment also factors in the platform or location you are working. For example, the *S.S. Minnow* would not weather the typhoon as well as would a large, steel-hulled vessel.

Event complexity: Finally, event complexity would probably be low. It was only a three-hour tour, so I'd rate it a "3."

Now that we have scored each of the categories, we simply add them together and get a score of 25.

- Supervision = 1
- Planning = 2
- Crew selection = 7
- Crew fitness = 2
- Environment = 10
- Event complexity = 3

When we look at this score, we find this falls into the grouping of "amber," which clearly tells us that something should be addressed to help mitigate the risk. We are further able to look at the categories to see that the environment is the largest source of risk. By postponing the tour, or taking a different route, or applying another minor correction, we could reduce that risk and make it a safer three-hour tour.

The Severity, Probability, and Exposure Model

That planning piece of the green, amber, red model is just an assessment of the risks associated with the plan. But how can we reduce risk during the planning process? The operational risk management green, amber, red model does not lend itself easily to planning. That is why ORM contains several risk models to choose from. For planning, the simplest one to use is the severity, probability, and exposure (SPE) model (Figure 3).

With the cruise of the *S.S. Minnow,* I would rate the severity (being stranded for years or even perishing) as a "5" on a scale of 1 to 5. I would rate the probability as "very likely" if you are going out with that typhoon around, so that would also be a "5." Exposure is the number of people affected—seven, for the cruise we're considering. I would consider this to be an average exposure for the cruise company, so I'd give it a score of "2."

- Severity = 5
- Probability = 5
- Exposure = 2

This plan to go out in a typhoon would have an SPE score of 50 (Risk = S x P x E), which clearly indicates to the company that substantial corrective actions would be needed to make this tour a success.

Enhancing Mission Success

Now that we understand the basic principles of operational risk management and some of the ways it may be applied, we must ask: "Why should we do it at all?" Hopefully, if you are still reading this, you understand that it is a tool to help you succeed, regardless of the task you need to complete. Let me elaborate a little. First, there is nothing in the models or the process that tells you NOT to do something. It is an objective system that lets you determine what you think the most severe hazards are and where you can focus your resources to mitigate those risks.

The system tells you to weigh those risks against the benefits. Particularly with Coast Guard jobs, we find that some of our missions must be completed despite the high risks associated with the job. This is the type of situation in which ORM truly helps enhance our success. The USCG formalized the concepts of ORM in 1999 with the publication of Operational Risk Management (COMDTINST 3500.3). However, the ideals of risk management have been present in various communities much longer than that.

The models point to your hazards and allow you to address them prior to the mission. What you end up with is a tool that you have been using without even knowing it. Now you can consciously look at your day and apply an objective tool to help your team communicate, focus your resources where they will be most effective, and accomplish more tasks, safely.

About the author:
LCDR Olenchock is an industrial hygienist in the U.S. Coast Guard Office of Safety and Environmental Health. He has spent the past three years working on risk management issues surrounding sector operations, vessel inspections, and safety management. He holds a Master of Science degree from the University of Washington in industrial hygiene.

The Maritime Security Risk Analysis Model

Applying the latest risk assessment techniques to maritime security.

by LCDR Brady Downs
MSRAM and Port Security Grant Program Manager,
U.S. Coast Guard Domestic Port Security Evaluation Division

After the terrorist attacks on September 11, 2001, a new era of protective security was thrust upon America. Overnight, a wide array of America's critical infrastructure and key resources were identified as potential terrorist targets. The ability to protect the critical infrastructure and key resources of the United States is vital to our national security, economic vitality, and way of life. U.S. national security policy focuses on the importance of enhancing this protection to ensure that essential governmental missions, public services, and economic functions are maintained in the event of a terrorist attack, natural disaster, or other type of incident, and that elements of critical infrastructure and key resources are not exploited for use as weapons of mass destruction against our people or institutions.[1]

PS-RAT/MSRAM

Shortly after September 11th, the U.S. Coast Guard Atlantic Area Commander (at that time Vice Admiral Thad Allen) commissioned the port security risk assessment tool (PS-RAT). The tool gave the local Captains of the Port the fundamental capability of assessing port vulnerabilities and potential consequences of maritime-related terrorist attacks. PS-RAT aided in setting priorities at the Captain of the Port level. However, the scope of the assessment and the level of rigor applied to the assessment were prescribed by the local Captains of the Port. This subjectivity resulted in variations between ports and complicated the use of port-level data to obtain an overall national security perspective.

Building upon this foundation with the lessons learned from PS-RAT, and in synchronization with Homeland Security Presidential Directive (HSPD) 7,[2] the U.S. Coast Guard Domestic Port Security Evaluation Division created the maritime security risk analysis model (MSRAM) with the assistance of field, district, and area commands.

The pressing dilemma facing the Coast Guard was the complexity of the maritime transportation system and the vast array of potential targets within our nation's maritime domain. MSRAM was designed to enhance security and reduce the risk of terrorism by prioritizing critical infrastructure and key resources using a common risk methodology, taxonomy, and metrics to measure security risk at the local, regional, and national levels.

The Process

This risk-based principle served as the foundation of the maritime security risk analysis model methodology, and as the MSRAM team developed requirements and began the design of the tool, it established several key additional principles. The tool articulates these as:

- Create an intuitive user interface to maximize the user's efficiency.
- Enhance the consistency of field-level evaluations by developing recommended ranges for factor scoring and providing target-relevant benchmark examples.
- Capture accurate and precise location information for targets, so that the risk profile can be displayed geographically.
- Enforce a consistent level of analysis across ports by requiring a baseline of terrorist attack scenarios. In addition, provide the flexibility for individual users to perform additional analysis for many optional scenarios, including attacks involving weapons of mass destruction.

In order to address all potential attack scenarios, the team coordinated with former U.S. Navy Seals and special forces personnel to develop a comprehensive collection of attack scenarios. Addressing assessment inconsistencies from previous models, the team created tightly defined required scenarios for each type of target, so that users across the country would be assessing the same types of attacks on the same types of targets.

To incorporate a genuine threat component, the MSRAM team actively engaged the Coast Guard's Intelligence Coordination Center (ICC) to provide strategic threat information to differentiate terrorist intent and capability. The analysts at the ICC provided a revolutionary threat assessment by assigning numerical estimates to the terrorist intent to conduct a type of attack against a type of target and the capability that terrorists possess (or could soon obtain) of conducting such an attack. In addition, ICC analysts provide their confidence in these judgments.

In addition to these refinements in the scenario definition and threat assessment components, the team improved the vulnerability and consequence assessment components of the tool as well (Figure 1). With assistance from experts in vulnerability and consequence modeling, they established target-relevant benchmark examples and response ranges to improve the validity and consistency of the assessments.

They tied vulnerability assessments to observable attributes, such as target vulnerability and the capability of the owner/operator, local law enforcement, and the USCG to interdict the attack. The consequence scales were expanded to include higher-severity outcomes for scenarios of national significance. The team also paid careful attention to the consequence scales to ensure equivalency across categories (safety, environmental, etc.) for the same level of severity. Finally, to enhance the applicability of the tool as a strategic planning aid, the team developed a factor to capture the ripple effect that a successful attack on a target would have on the local, regional, and national economies.

Implementation

Conducting a national evaluation of critical infrastructure is an arduous task. Each Coast Guard unit was first trained to use the maritime security risk analysis model. Those units then conducted a detailed evaluation of the maritime critical infrastructure, key resources, and high-consequence vessel scenarios within their areas of responsibility using the supporting methodology.

The results have been collected and reviewed by each level of the Coast Guard chain of command. The information is stored in a secure database with

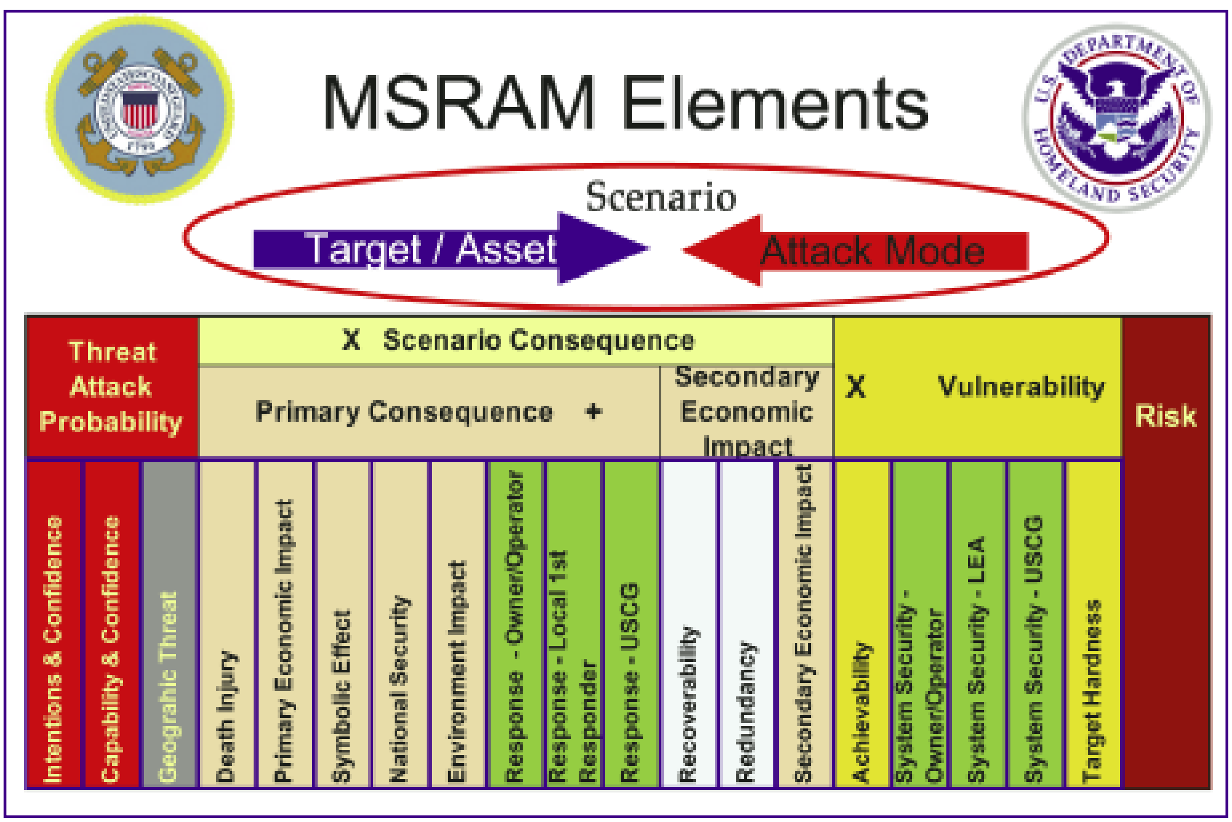


Figure 1: The MSRAM risk model illustrates all of the factors considered in the evaluation.

Figure 2: Current National Maritime Security Risk Analysis Model geographic coverage.

approximately 18,000 potential critical infrastructure targets across the nation.

At the national level (Figure 2), MSRAM data will be used to:

- conduct long-term strategic resource planning,
- identify capabilities needed to combat future terrorist threats,
- identify the highest risk scenarios and targets in the maritime domain.

At the local level, the Captains of the Port can use MSRAM as an operational planning tool. The maritime security risk analysis model will help them identify the highest-risk scenarios in their ports, providing them the ability to maximize the use of their assets to reduce security risk.

In the future, entities competing for port security grant money will be able to use the standardized MSRAM risk criteria to characterize the risk reduction potential for their specific grant proposals. Furthermore, area maritime security committees will use the maritime security risk analysis model information to update their area maritime security plans.

Evaluation

A recent Government Accounting Office risk management report stated that the Coast Guard's good foundation for risk management was further refined and strengthened by using the MSRAM process.[3]

The MSRAM team is currently developing the second version of the maritime security risk analysis model tool. This version will focus on providing better analysis capability for all levels of the MSRAM user community, including development of "what-if" scenarios. This enhanced functionality will help correlate risk to USCG activities within the layered security strategy. The second version will also focus on increasing the certainty of the vulnerability and consequence judgments by:

- integrating countermeasures/checklists to capture current defense posture for regulated facilities
- providing improved guidance and examples from available studies and modeling.

As a testament to the groundbreaking approaches they applied on this effort, the Commandant of the Coast Guard recognized the Coast Guard MSRAM team by awarding them the 2006 Joel Magnussen Innovation Award for Management (Figure 3).

Figure 3: In recognition by the Commandant for outstanding innovation and implementation, the Coast Guard MSRAM team won the 2006 Joel Magnussen Innovation Award for Management. Pictured left to right: ADM Thad Allen, Commandant, U.S. Coast Guard; Mrs. Joel Magnussen; LCDR Brady Downs; the Honorable Mr. Michael Jackson, Deputy Secretary, Department of Homeland Security.

Development of a Portwide Risk Management Strategy

by Mr. Ryan F. Owens
Chief of the Maritime and Port Security Branch, Department of Homeland Security Preparedness Directorate
and Ms. Bethann Rooney
Manager, Port Security for The Port Authority of New York and New Jersey

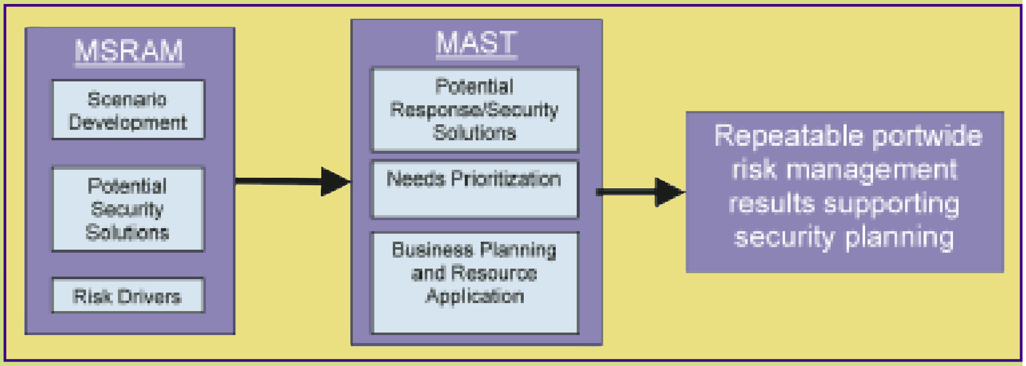
Recently, the Area Maritime Security Committee (AMSC) of the Port of New York & New Jersey developed a portwide strategic plan to provide a framework to guide the AMSC's action for the next two to three years. Although the plan includes more than 100 initiatives that have been identified through various means, including regulatory requirements, best practices, risk assessments, lessons learned from drills and exercises, and real incidents, a scientific and defendable model does not currently support it.

Therefore, this spring the AMSC will be utilizing the Maritime Assessment and Strategy Toolkit (MAST), which builds on the results of Maritime Security Risk Analysis Model (MSRAM) assessments to implement a response capabilities assessment of assets within the port and produce a security-needs assessment for the port area. MAST then factors in a cost/benefit analysis, which provides AMSCs with a valuable piece of the port's risk management puzzle and allows us to focus our limited resources in the right areas and to be on the front edge of continuous improvement.

The purpose of MAST is twofold:

1. It enables ports to prioritize needs in terms of security countermeasures, emergency response capabilities enhancements, and recovery capability enhancements based on terrorist threats and risk.
2. It allows ports to define resources that can reduce the risk of terrorist attack.

MAST evaluates the capability of agencies in the local area to respond to and recover from a terrorist event. Utilizing this data, a needs assessment is then conducted. This process allows AMSCs to evaluate specific security, response, and recovery solutions and to calculate their potential to reduce their level of risk. The results of the needs assessment is a list of potential solutions and a rating of the potential relative risk reduction that is possible with the implementation of individual solutions or groups of solutions. Following the needs assessment, a cost/benefit analysis is layered into the process, allowing the AMSC to see how to "buy down" the risk in their ports (Figure 1).



MAST, which will be available to all eligible port areas at no charge on a first-come, first-served basis (subject to available DHS technical assistance funds), will help AMSCs around the country to evaluate and prioritize each of the initiatives in their strategic plans.

About the authors:
Mr. Ryan Owens is chief of the Maritime and Port Security Branch, Department of Homeland Security Preparedness Directorate, Office of Grants and Training. He is also program manager of the Port Security Grant Program. Mr. Ryan is a licensed deck officer and a graduate of Maine Maritime Academy.

Ms. Bethann Rooney is the Manager, Port Security for The Port Authority of New York and New Jersey and the chair of the Port of New York & New Jersey's Area Maritime Security Committee. A graduate of the New York Maritime College with both graduate and undergraduate degrees in Marine Transportation and International Business, Ms. Rooney has been actively involved in port and supply chain security concerns since 9/11, including publishing many articles and testifying before Congress.

About the author: *LCDR Brady Downs serves in the U.S. Coast Guard Domestic Port Security Evaluation Division as the MSRAM and Port Security Grant program manager as well as the Ferry Transit Security grant coordinator for the Coast Guard. LCDR Downs was originally commissioned in the U.S. Marine Corps. He has a Bachelor of Arts in economics from the University of Missouri–Columbia and a Master of Science degree in quality systems management from the National Graduate School, Falmouth, Mass.*

Endnotes:
1. Interim National Infrastructure Protection Plan, January 2006.
2. Homeland Security Presidential Directive 7: Critical Infrastructure Identification, Prioritization, and Protection (Washington D.C: The White House, December 17, 2003).
3. GAO Risk Management Report: *Further Refinements Needed to Assess Risks and Prioritize Protective Measures at Ports and Other Critical Infrastructure.*

Using Risk Ranking Tools to Identify Which Vessels to Examine or Board

How does the Coast Guard decide which foreign vessels to visit?

by LCDR Norbert J. Pail Jr.
U.S. Coast Guard Office of Vessel Activities

Which vessel poses the biggest risk? A 20-year-old, single-hulled liquid cargo carrier? A chemical tanker carrying acrylonitrile? A liquefied natural gas carrier? A passenger ferry with 300 persons onboard? A 5-year-old bulker that has visited a country that has not implemented the International Ship and Port Facility Security (ISPS) code?

Coast Guard sector commanders must ask that question each day as they determine where safety and security resources must be used. One set of tools sector commanders have to help answer this question and manage risk is a package of matrices that rely on risk-based decision making principles. The three important features of these matrices are that they are implemented nationally, updated routinely to address gaps and incorporate the latest information, and balanced with regard to the need to protect classified information and the need to advertise the successes of safe operations.

Using matrices within the risk-based decision making process is not a new Coast Guard business practice. One of the first port state control matrices was created in 1994, following the beginning of the international port state control initiatives. The details of this matrix will be described more in-depth later in this article. Another way matrices were used to assess vessel risks occurred during the period before the year 2000 (Y2K) transition, when it was unknown if vessels' computer systems would operate properly at midnight on December 31, 1999. These Y2K risk matrices were used to determine the consequences of vessel computer system malfunctions and determine the appropriate safeguards to protect U.S. ports and waterways. Throughout their uses, matrices and the risk assessment results they produce have been touted for their continuous and iterative abilities. They are also quite easy to assemble when heightened readiness or an understanding of priorities is required in short order.

The risk-based decision making process consists of five steps:
- goal setting,
- risk assessment,
- risk management,
- impact assessment,
- risk communication.

An integral part of the second step of this process (risk assessment) is completed by using risk-ranking tools and matrices. The matrices help sector commanders answer the following questions:
- What potential risk does the vessel pose to the safety or security of the port?
- What threats are associated with the vessel?
- Does the vessel frequent foreign ports that may present a higher degree of risk to the U.S.?
- Has the vessel or its owner/operator been involved in safety-related incidents in the past?
- Is the vessel currently at increased risk for being involved in an accident or security incident?
- What is the likelihood of an incident happening?
- What potential consequences does the vessel, cargo, or crew pose to the port?

By answering these questions, a relative risk ranking can be developed. The answers to these questions are important for the sector commanders, as they determine how to implement their daily operations.

PSC Safety and Environmental Protection Compliance Targeting Matrix

COLUMN I	COLUMN II	COLUMN III	COLUMN IV	COLUMN V
SHIP MANAGEMENT	**FLAG STATE**	**CLASSIFICATION SOCIETY**	**VESSEL HISTORY**	**SHIP TYPE**
5 Points Listed owner, operator, or charterer	**7 Points** Listed Flag State	**Priority I** A detention ratio equal to or greater than 2% **5 Points** A detention ratio equal to 1% or less than 2% **3 Points** A detention ratio equal to 0.5% or less than 1% **0 Points** A detention ratio less than 0.5%	**Priority II** First time to U.S. **5 Points Each** Detention within the previous 12 months **1 Point Each** Other operational control within the previous 12 months **1 Point Each** Casualty within the previous 12 months **1 Point Each** Violation within the previous 12 months **1 Point Each** Not boarded within the previous 6 months	**1 Point** Oil or chemical tanker **1 Point** Gas carrier **2 Points** Bulk freighter over 10 years old **1 Point** Passenger ship **2 Points** Carrying low value commodities in bulk TOTAL:

Priority I Vessel (PI):

- 17 or more points on the matrix, or
- ships involved in a marine casualty that may have affected seaworthiness, or
- USCG Captain of the Port determines a vessel to be a potential hazard to the port or the environment, or
- ships whose classification society has a detention ratio equal to or greater than 2%.
- Port entry may be restricted until vessel is examined by the Coast Guard.

Priority II Vessel (PII):

- 7 to 16 points on the matrix, or
- outstanding requirements from a previous boarding in this or another U.S. port, or the vessel is overdue for an annual tank or passenger exam.
- Cargo operations or passenger embarkation/debarkation should be restricted until vessel is examined by the Coast Guard.

Non-Priority Vessel (NPV):

- 6 or fewer points on the matrix.
- Vessel is a low risk, and will probably not be examined.

Downgrade Clause: If a vessel has scored either a PI or PII based on points or association, and has had a USCG PSC examination within the past 6 months with no serious deficiencies, it may be downgraded to an NPV. If vessel is downgraded, it must be considered for the pool of random examinations.

Figure 1: The Port State Control Safety and Environmental Protection Compliance Targeting Matrix.

The Port State Control Safety and Environmental Protection Compliance Targeting Matrix

Two of the three vessel matrices use factors that are based on vessels' compliance with international conventions. To utilize the first of these matrices, which is known as the Port State Control Safety and Environmental Protection Compliance Targeting Matrix (Figure 1), it is necessary to identify the vessels, vessel managers, classification societies, and flag states that are most often associated with substandard ships.

Substandard ships are those ships with hulls, machinery, equipment (such as lifesaving, firefighting, or pollution prevention equipment), or safety management systems substantially below the standards required by U.S. laws or international conventions. Substandard ships present an increased risk that can be addressed through compliance inspection during port calls.

The ISPS/MTSA Compliance Targeting Matrix
The second matrix, the ISPS/MTSA (International Ship and Port Facility Security Code/Marine Transportation Security Act) Compliance Targeting Matrix, was developed during the implementation of the ISPS Code of 2004. Figure 2 depicts this matrix.

To implement this matrix, it is necessary to identify the ship management, flag states, and recognized security organizations that have received the greatest number of security-related deficiencies. The ISPS/MTSA Compliance Targeting Matrix also incorporates the individual vessel's security regulation compliance history (the degree to which the vessel

ISPS/MTSA SECURITY COMPLIANCE TARGETING MATRIX

COLUMN I	COLUMN II	COLUMN III	COLUMN IV	COLUMN V
SHIP MANAGEMENT	**FLAG STATE**	**RECOGNIZED SECURITY ORGANIZATION**	**SECURITY COMPLIANCE HISTORY**	**LAST PORTS OF CALL**
ISPS I Owner, operator, charterer associated w/ ISPS-related denial of entry/expulsion from port in past 12 months * **5 Points** Owner, operator, or charterer has a CAR of 5 percent or more or is on the G-MOC targeted ship management list **2 Points** Owner, operator, or charterer has a CAR of 1, and up to 5 percent **2 Points** *Owner, operator, or charterer associated w/ 10 or fewer vessel exams in the past 3 years beginning 1 July 2004*	**7 Points** Flag State has a CAR* of 5 percent or more **2 Points** Flag State has a CAR from 1 to 5 percent **2 Points** *Flag State associated w/ 20 or fewer vessel exams in the past 3 years beginning 1 July 2004*	**ISPS I** RSO has a CAR of 5 percent or more **5 Points** RSO has 1 percent CAR, and up to 5 percent **2 Points** RSO has a CAR of 0.5, and up to 1 percent **2 Points** *RSO associated w/ 20 or fewer vessel exams in the past 3 years beginning 1 July 2004* Note: Use RSO attribution process for Flag States not using RSOs	**ISPS I** ISPS-related denial of entry/expulsion from port in past 12 months** **ISPS II** *If matrix score does not result w/ ISPS I exam & no ISPS compliance exam within the past 12 months* **5 Points** Vessel has a CAR of 1 percent or more **2 Points** Vessel has a CAR of 0.5, and up to 1 percent **2 Points** *More than 1, but 10 or fewer ISPS compliance exams in the past 3 years beginning 1 July 2004* **1 Point** For each occurrence of any operational control assigned w/ past 12 months	**PRESCRIBED CONDITIONS OF ENTRY AND/OR DENY ENTRY** For last 5 ports, as specified by Federal Register; refer to G-MOC targeted list **ISPS I** For last 5 ports, if designated ISPS I; refer to G-MOC targeted list **ISPS II** If matrix score does not result w/ ISPS I exam & for last 5 ports, if designated ISPS II; refer to G-MOC targeted list

Italics indicate applicable scoring criteria at the onset of MTSA/ISPS enforcement.
Non-italicized criteria will require time to develop sufficient owner, operator, charterer, Flag, RSO, and vessel history.

* Control action ratio (CAR) = the number of major ISPS-related control actions divided by the number of ISPS examinations) x 100%, where the number of major ISPS-related control actions include security-related denial of entry or expulsion from port (within the 12 to 36 month period prior to the current vessel arrival). It also includes security-related detentions within the last three years, beginning on 1 July 2004. The number of ISPS examinations include a specified minimum number of distinct ISPS examinations.

** Depending upon circumstances of denial of entry, COTP or OCMI may relax assignment to ISPS II. Also, if denial of entry due solely to failure to provide NOA, assign 2 points.

Vessels that score 17 points or higher are ISPS I vessels and should be boarded prior to port entry.

Vessels that score between 7-16 points are ISPS II vessels and need not be examined prior to entry but should be examined upon port arrival.

Vessels scoring fewer than 7 points are ISPS III vessels and need not be boarded unless selected at random for random MTSA/ISPS examination.

Figure 2: The International Ship and Port Facility Security Code/Marine Transportation Security Act Compliance Targeting Matrix.

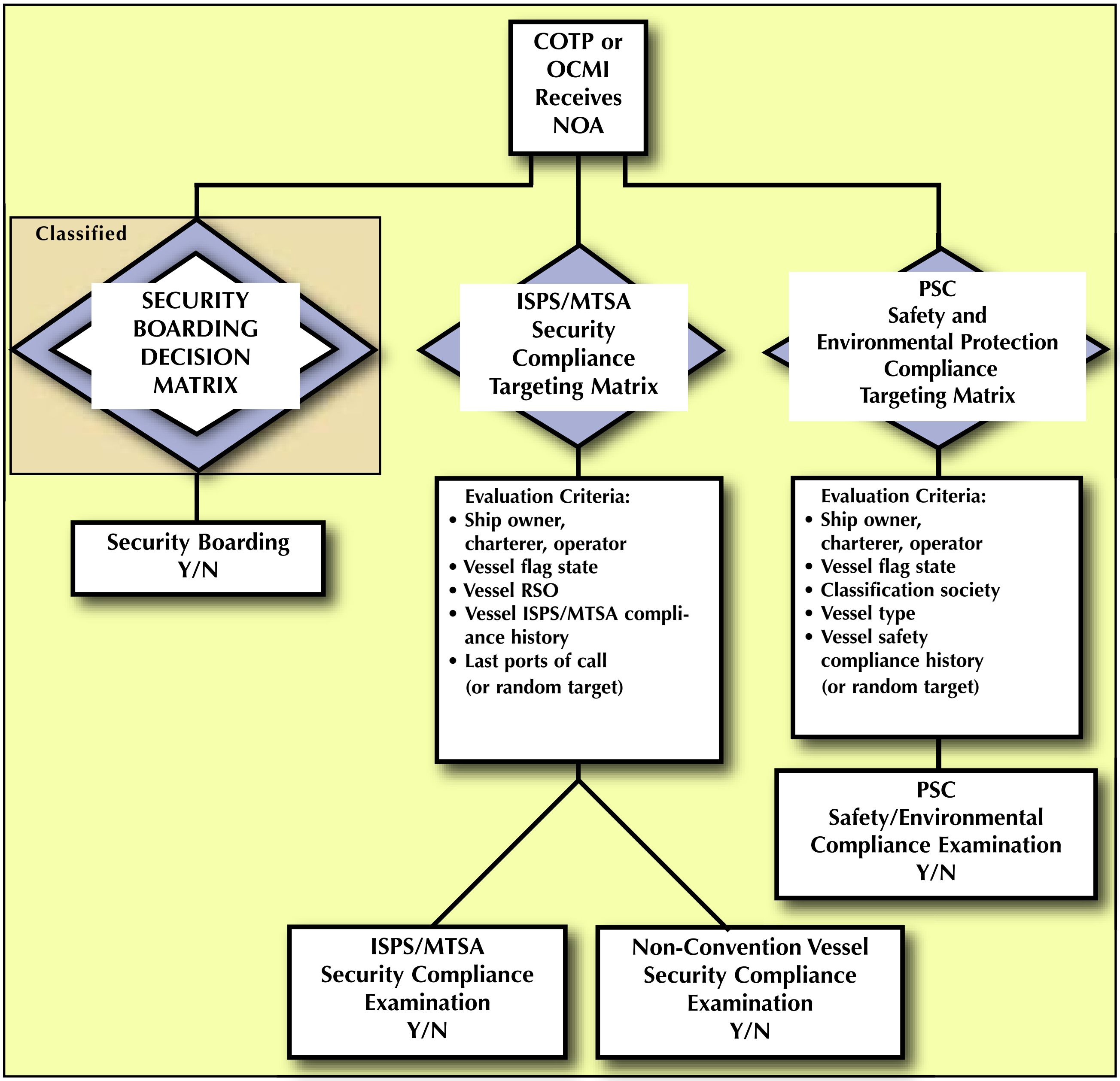


Figure 3: This examination or boarding decision-making process diagram depicts the relationships among all three vessel matrices.

has met both domestic and international maritime security standards) and the recent port calls the vessel has made. Those vessels that are affiliated with classification societies, recognized security organizations, flag states, and managements that receive the greatest amount of detentions will receive the greatest amount of attention from the Coast Guard.

Benefits Gained by Vessel Operators

Linking compliance examination decisions to the performance records of the ship, the owner, classification society, and the flag state sends a clear message that the number of compliance examinations may be reduced by improving the performance records. While reducing the number of compliance examinations is certainly a benefit to vessel operators, other incentives are available that promote regulatory compliance.

Because of the transparency of a vessel's compliance record through web services such as Equasis or Port State Information Exchange, a compliant vessel or company would be viewed favorably by prospective charterers. The Coast Guard may also reward vessel operators who consistently comply with the safety and security regulations by awarding them with the "Qual Ship 21" designation. A vessel receiving this designation is viewed as less of a safety risk to the port and is examined less frequently by Coast Guard inspectors.

Safety Compliance Matrices vs. Security Matrix

One of the reasons that such transparency may occur within the regulatory compliance arena is because there is trust within the safety community that members will use this information to benefit the maritime community as a whole. Members of the marine community, such as pilots, masters, port authorities, and facility dock workers who have a history of safe work practices establish a certain trust among one another.

Security measures implemented by ports, vessels, and crews are usually sensitive in nature and are not to be disseminated for public scrutiny. To ensure the success of these security measures, therefore, transparency is not promoted in the security arena, as transparency helps adversaries identify and exploit vulnerabilities. Therefore, tools that the Coast Guard uses to make decisions relating to security are classified, and kept within the secret confines of the organization.

There are other differences between the compliance matrices and security boarding matrix, as well. While the compliance matrices concentrate mostly on the past performance of a vessel, the security matrix focuses on its present onboard conditions and operations. Having real-time information, Coast Guard units can identify the potential consequences, vulnerabilities, and threats aboard the vessel and assign appropriate countermeasures.

While there is little or no room for sector commanders to provide input to the compliance matrices, the security matrix relies on the users at the sectors to provide some subjective judgment to scoring the vessels based on the risk that the vessel poses to the port, and the risk that the port poses to the vessel. With such important sector-level provisions in the security matrix, it is of tremendous value for sector commanders.

Petty Officer 3rd Class Nicholas Hallmark, maneuvers a tight space below the main deck during a boarding team inspection. USCG photo by PA3 Louis Hebert.

While the details of the elements of the security matrix cannot be published due to their classified nature, such elements are combined within a risk-based decision making principle referred to as the High Interest Vessel (HIV) matrix. This risk-based approach is one similarity that the HIV matrix has with the regulatory compliance matrices previously discussed. Once these vessels are scored by members of the Coast Guard at the local level, they will have essential information to help personnel make decisions on where security resources should be focused to receive the greatest risk management benefit for the security of the port.

It is understood that these matrices are tools that assist with risk profiling, but that they cannot address every gap. However, one area of particular strength relating to the security matrix is its inherent flexibility to address identified gaps. As mentioned, the security matrix requires some judgmental actions on the part of sector personnel. During this judgment process, the sector can enter additional information into the matrix to improve the output. This flexibility allows the matrix to capture unforeseen threats and promotes the growth of the matrix to identify and close these gaps. Figure 3 depicts the relationships among all three vessel matrices.

Final Thoughts and Future Goals

The Coast Guard's three matrices are tools that are utilized daily by sector commanders to assist in the assessment of vessels calling on their ports to better manage risks. These tools, in concert with other local level processes, allow the targeting of the Coast Guard's finite resources to those vessels posing the greatest risk to our ports and waterways.

At times, private companies and regulatory organizations will be alerted to the reason why vessels are being visited, particularly within safety operations. As gaps within these matrices are identified, we expect that they will expand and improve, to further assist the Coast Guard and other members of the maritime community in the identification of vessels that pose the highest safety and security risks.

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LCDR Norbert Pail, Jr. has served in the U.S. Coast Guard for 12 years and has received the Senior Marine Inspector designator.

The Impact of Terrorism and Risk Mitigation Policy on the Economy

by Dr. Anthony Homan, *Chief Economist,*
U.S. Coast Guard, Standards Evaluation & Analysis Division

and Mr. Todd Steiner, *Senior Economist,*
U.S. Coast Guard, Standards Evaluation & Analysis Division

The Coast Guard's Standards Evaluation and Analysis Division has developed an innovative program to look at the secondary economic impacts of terror acts and security policies. Analyzing these influences is important, given the problems with using current risk-assessment methods and analysis tools for maritime security. Current risk-assessment methods determine a baseline likelihood of an event occurring, based on historical data.

For maritime security, we do not know the likelihood of a terrorist attack or the likely impact of that risk. There is also a lack of historical data due to the rarity of terrorist events. There are also limitations in using expert panels to generate these estimates, due to the lack of consensus and high uncertainty in panel responses. Additionally, current analytical tools usually ignore the secondary economic effects from terrorism and security policies. They also don't adequately take into account supply chain disruptions such as longer lead times, higher inventories, and less reliable deliveries.

For a decision maker, these deficiencies make it difficult to compare the economic consequences of different policy options. Our current research program provides decision makers with tools to look at secondary effects and to compare different policy options. Our research on the impact of 9/11 and the Maritime Transportation Security Act (MTSA) legislation on financial risk showed that 9/11 had an adverse impact on the Coast Guard's regulated community and that MTSA was able to mitigate it.

This work has put the Coast Guard at the forefront of this exciting area of economic analysis of homeland security policies. We also recently completed research that analyzes the impact of changes in port charges, delays, and reliability (from changes in homeland security policies) on the demand for port services, the supply chain, and on accepted metrics such as gross domestic product (GDP) and economic surplus.[1] The approach provides a new paradigm for measuring the impact of homeland security policies.

Impact of Terrorism and Homeland Security Policy on Financial Risk

The attacks of 9/11 had both political and economic effects. After 9/11, investors may have perceived that the physical assets of the transport system were not only targets, but were potential means to carry out terrorist attacks. Additionally, the response to a significant terror attack has considerable effect on trade and transportation. For example, the U.S. government response included shutting down the air and sea traffic system, which caused huge delays and disruptions.

Given this, the market may have likely factored in a risk premium for marine operators. Market impacts following terrorist actions can have an adverse effect on the cost of capital, stockholder wealth, and the efficiency of markets to affected firms. This imposes real economic costs to affected firms and to society. Our results show that there were adverse market effects.[2]

The basis for our results is the market model and other accepted financial economic methods. The market model is a statistical model that represents the return on any given security to the overall market (e.g. S&P 500). The model isolates the impact of an important news event on an organization over and above the impact caused by changes in underlying market conditions. Investigating these effects is important, since they can provide identifiable metrics to look at secondary impacts from terror acts and efforts to mitigate them.

This is particularly valuable, since it is challenging to measure primary effects such as changes to risk levels from policy actions. Our results show that 9/11 had an adverse impact on stock market returns and resulted in a structural increase in systematic financial risk and adversely affected the ability and the costs of raising funds and also reduced the value of affected firms. This would result in firms starting fewer projects. This underinvestment would result in real economic costs. These are consequences that we should try to better account for in looking at the impact of a terror act. Conversely, policies that could mitigate those effects could provide ancillary economic benefits to both society and to firms directly affected by those policies.

Congress passed the Maritime Transportation Security Act on November 25, 2002. MTSA included several new vessel- and port-related security measures designed to protect U.S. ports and waterways from terrorist attacks. The International Maritime Organization adopted similar measures through the International Ship and Port Facility Security code in December of 2002.

Petty Officer Chad Olsen and Cisco search containers for explosives. USCG photo by PA3 Constantina Mourtos.

Using the same research methods as before, we found that MTSA resulted in a structural reduction in systematic financial risk and, in doing so, provided ancillary economic benefits such as reducing the cost of capital for marine operators by up to 25 basis points (1/4 of a percent).[3] On a hypothetical $40 billion worth of capital projects, this would imply annual interest savings of $100 million. This shows that homeland security policy can help "pay for itself" by reducing the cost of capital. Thus, our results show that policies that have credibility with the market can have significant economic consequences. Decision makers also need to factor in these effects when comparing different risk mitigation strategies.

Impact of Terrorism and Homeland Security Policy on Port Demand and the Supply Chain

In 1956, the voyage of the *Ideal-X* marked the birth of the shipping container and dramatically reduced the cost and time of shipping products from one place to another. The container has revolutionized supply chain logistics by leading to just-in-time (JIT) manufacturing and distribution. Users employ JIT, since it allows for reduced inventory costs, quicker order turnaround times, and increased reliability. In turn, improving these attributes results in reduced costs, which manufacturers and retailers then pass on to consumers as lower prices. Reducing these supply-chain costs allows society to produce and purchase more goods and services, and thus increases the size of the economy.

To a great extent, end users of the container ports use these ports because of the speed and schedule reliability of the container system. Degradations to the attributes users care about means that they would use the system less, and would instead engage in substitute activities. For example, instead of importing toys from China, they might manufacture them domestically. Given that this is not the current optimal manufacturing option; manufacturers would be worse off, and would pass on cost increases to consumers. This has an adverse economic impact.

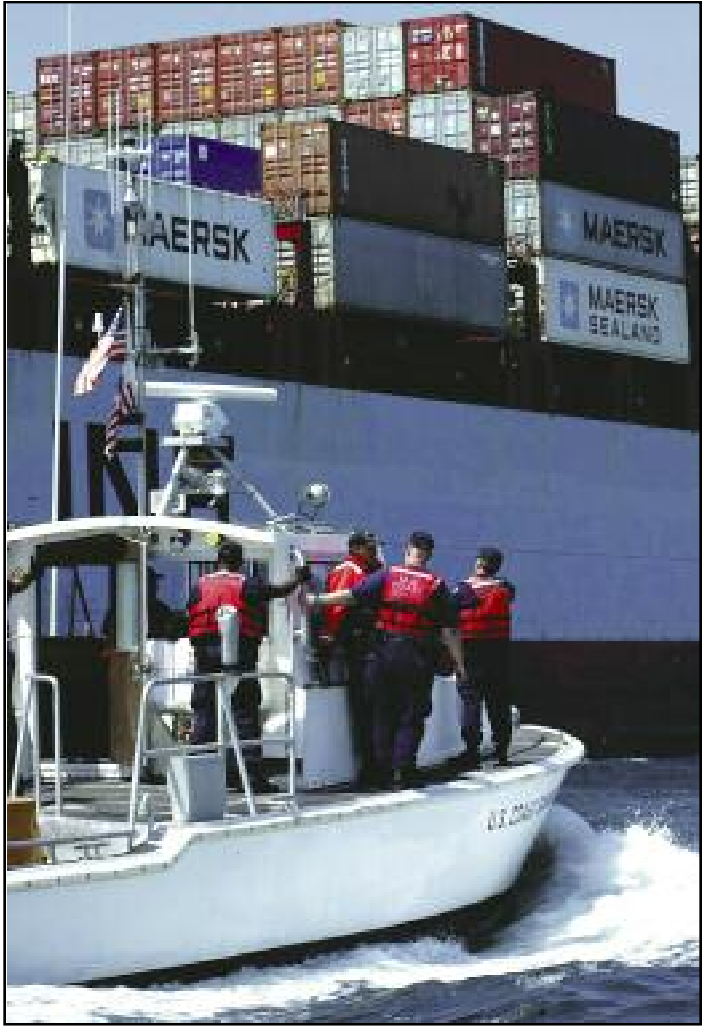
However, most analyses of the economic impact to ports fail to address how policies affect these attributes and the supply chain. Rather, most focus on port expenditures and related metrics, such as wages paid. As mentioned, our research measures how changes in attributes users care about affects metrics such as gross domestic product and economic surplus. These are significant economic consequences to consider in weighing how different risk mitigation policies affect container ports.

Changes in risk mitigation policies and threats from terrorism can have an effect on port charges and the service quality attributes users of the container ports care about. We have developed a decision-making tool that analyzes how changes in port charges, delays, and reliability impact demand for container ports. We then use the results of this model to estimate impacts to the economy as a whole.

Our work estimates how changes in port charges and service attributes affect the demand for container port services and substitution among ports and coasts. We

Continued on page 48

USCG photo by PA3 Kelly Newlin.



A boarding team from Group Los Angeles approaches a cargo ship in preparation for a security boarding. USCG photo by PA3 Louis Hebert.

can do this for a single port, a group of ports (including coast selection), and the port system as a whole. The basis for our results is a statistical model of how shippers select among U.S. container ports, given the foreign sources (ports) of imported goods, their ultimate U.S. destination, freight charges, schedule reliability at ports, and other information.

The model generates predictions about which coast and port shippers will choose for each shipment, given the costs and attributes of the shipment and the alternative coasts and ports. Using these predictions, we can quantify how users of container ports respond to changes in port charges and these attributes. By relating these results to changes in costs of imports, we can provide a realistic measurement of how the changes in one or more port attributes impact the demand for port services at one, several, or all container ports.

We do so by linking the results to an available computable general equilibrium model of the United States economy. These models estimate the potential increase or decrease in GDP and economic welfare. This is a similar approach to what the International Trade Commission uses to measure the impact of trade policies on dynamic interactions occurring in the economy (e.g., supply chain substitutions).

The decision-making tool allows policy makers to estimate the impact of risk mitigation strategies that affect throughput and reliability. For example, a nationwide policy that results in a long-term increase in average shipping time of four hours per container will reduce GDP annually by $117.3 million and economic surplus by $1.21 billion. If the increase was limited to only the ports of Long Beach and Los Angeles the reductions would be $58.9 million and $606.6 million, respectively.

The tool includes a menu-driven spreadsheet[4] for estimating the consequences of different potential actions or events that impact port charges and attributes. Users do not have to understand the underlying technical aspects driving the results. The spreadsheet calculates changes in transportation costs and changes in port demand for each port and the system as a whole. The spreadsheet further calculates changes in GDP, economic welfare, profits, and wages for a given change in port costs and attributes. This means policy makers can simulate how a potential action or event will change shipping cost, time, and reliability for container ports and, in turn, impact the U.S. economy as a whole.

We anticipate this research will provide prevention and response policy makers with a valuable decision-making tool to assess the economic consequences resulting from government risk mitigation policy or the impact from potential terrorist incidents.

About the authors:

Dr. Anthony Homan is the chief economist of the U.S. Coast Guard's Standards Evaluations and Analysis Division. Prior to the Coast Guard, Dr. Homan worked at the Securities and Exchange Commission and at the Mitre Corporation. He has presented and published research dealing with aviation, project finance, financial markets, and homeland security.

Mr. Todd Steiner is a senior economist at the U.S. Coast Guard. He has several years' experience performing economic and risk analysis of the maritime industry and Coast Guard safety, homeland security, and environmental protection regulations. Mr. Steiner also has extensive experience in support of antitrust and complex business litigation.

Endnotes

[1] Economic surplus is the sum of consumer surplus and producer surplus. The former is the difference between what consumers pay for products and what they would be willing to pay and the latter is the difference between what producers receive for their goods and what they would be willing to receive.

[2] Homan, A. "The Impact of 9/11 on Financial Risk, Volatility, and Returns of Marine Firms," *Maritime Economics & Logistics*, Vol. 8, No. 4, December 2006, pp. 387-401.

[3] Homan, A. "The Impact of MTSA on Financial Risk and Volatility of Marine Firms," *Maritime Policy and Management*, Vol. 34, No. 01, 2007, pp. 69-79.

[4] For more information or to access this tool, send a request with contact information and the nature of the request to: ARL-DG-NMCProceedings@uscg.mil.

TSA's PortSTEP

Exercising risk mitigation in the port transportation network.

by Captain James S. Clarkson (Ret.)
Transportation Security Administration

and Commander Richard M. Gaudiosi, USCG (Ret.)
Associate, Booz Allen Hamilton

The Transportation Security Administration (TSA), in partnership with the U.S. Coast Guard, has developed the port security training exercise program (PortSTEP) as a joint program to help meet the mandates of the 2002 Maritime Transportation Security Act. Since the attacks of 9/11, much concern has been expressed over the vulnerability of our ports and the need for more focused efforts to secure them. In August 2002, Congress appropriated $20 million to the Transportation Security Administration to develop and conduct port incident training exercises. PortSTEP is an industry-focused program designed to provide the transportation sector network nationwide with training exercises, evaluations, and accompanying information management products to help strengthen the nation's ability to prevent, respond to, and recover from a transportation security incident in a port environment.[1]

Our nation's seaports handle an estimated 95 percent of all United States foreign trade, by weight. The impact of disabling ports and disrupting trade, therefore, is a major concern. The ports of the U.S. are unique entities in that they form a nexus between maritime and surface modes of our nation's transportation system. The interdependence and economic importance of the modal assets within or in close proximity to the port structure gives this combined complex a high criticality rating and, therefore, demands significant security attention.

The port security training exercise program has begun to fully test and validate the integration of programs and exercises that target the maritime and surface transportation modes of the transportation sector network. PortSTEP exercises are specifically designed to address the unique transportation security issues found in the intermodal maritime environment of our nation's ports. The application of technology and response assets obviously has a place in enhancing port security. However, many believe that more emphasis should be placed on awareness, prevention, and recovery activities. These are the focus areas of the port security training exercise program, and the ports provide the perfect venue due to their intermodal nature.

A PortSTEP program team has been assembled to provide strategic support, planning, and analytical and technical services for these port security training exercises. This team is comprised of government agencies and commercial vendors that have significant expertise in the maritime domain and in exercise program development and delivery. Surface transportation modal expertise is provided through close coordination among TSA leadership in each transportation mode—aviation, maritime, rail, highways, pipeline, mass transit, and cargo.

TSA transportation modal expertise in programs, risk, policy, and stakeholder issues are critical elements of the port security training exercise program concept and design. The infusion of this robust modal expertise into the port environment through PortSTEP makes it unique among exercise programs, and creates an environment for enhanced awareness and cooperation among the stakeholders in transportation security.

PortSTEP is aligned with Department of Homeland Security goals and objectives and is consistent with the nation's infrastructure protection policies and programs, thus allowing future integration of the program with other TSA and DHS programs.

Ports—A Multimodal Environment

The multitude of stakeholders at ports significantly complicates preparedness and response by introducing questions of authority, jurisdiction, and responsibility. Multiple agencies within the Department of Homeland Security, agencies within the Department of Transportation, state and local governments, and a multitude of transportation industry stakeholders have a share in port operations and security. Each of these entities has the assets and the expertise necessary to safeguard our ports.

The multimodal transportation interface within the dynamic port area environment requires that all stakeholders involved in port security be able to recognize threat situations, process intelligence, and make sound judgments to implement countermeasures. To do this, port officials, employees, and the intermodal transportation community must be properly trained, have effective and proven contingency plans, understand the roles and responsibilities of each agency involved, be familiar with countermeasures, and have access to necessary resources. In short, the port community needs a comprehensive preparedness program—one that addresses both maritime and surface transportation issues.

PortSTEP, NMSEP, AMSTEP

The Transportation Security Administration and the U.S. Coast Guard are working together to provide a comprehensive approach to preparedness. TSA's port security training exercise program complements the National Maritime Security Exercise Program (NMSEP) and Area Maritime Transportation Security Program (AMSTEP), both of which are sponsored by the Coast Guard. These programs have many common processes, procedures, and design elements. The distinction lies in the different modal focus of each of the programs. Together they encompass the necessary scope to address the transportation security needs of the ports.

Despite their differences, both exercise programs fill a niche in the cycle illustrated in figure 1. This cycle, built along the same lines as the USCG "preparedness cycle,"[2] is a multifaceted effort that begins with the assessment of risk and progresses through planning, training, testing, and evaluation steps. TSA, in association with the U.S. Coast Guard, is sponsoring the delivery of 40 port security training exercises during a 36-month period from April 2005 through October 2007, effectively integrating with existing programs throughout the government and private industry.

Through the port security training exercise program, TSA is assisting ports and the surface transportation community by conducting exercises and providing tools that help meet steps in the cycle:

- identify planning gaps,
- assess plans,
- measure performance,
- collect and disseminate lessons learned and best practices,
- shape the policy that drives the requirements.

As the cycle begins again, PortSTEP provides updated information based on the results of the preceding cycle. This information is injected into the threat/vulnerability assessments and prevention initiative elements of the planning step in the cycle.

Working Together

The Transportation Security Administration and USCG have agreed to a delineation of responsibilities for the implementation of PortSTEP and AMSTEP based on each agency's authorities. TSA is focused on the surface transportation security issues and the Coast Guard is focused on the maritime issues. Transportation Security Administration and USCG program managers are sensitive to this delineation of authorities and realize that while the maritime sector is traditionally within the Coast Guard area of expertise, mission, and statutory responsibility, TSA also has a mission to secure surface transportation in the maritime domain. As a result, all PortSTEP exercises are delivered through the USCG-chaired area maritime security committee (AMSC) within each port.

Because PortSTEP exercises will validate processes and procedures in the area maritime security plans, TSA and USCG have been taking steps to promote surface transportation involvement in these exercises through policy guidance and direction; pre-exercise discussions with the USCG federal maritime security coordinator, port planners, and TSA federal security directors; and outreach to industry trade associations. The result of this approach is an increase in intermodal membership on the area maritime security committee and an increase in awareness, coordination, and communication between maritime and surface transporta-

DHS STRATEGIC GOAL

- Awareness—Identify and understand threats, assess vulnerabilities, determine potential impact, and disseminate timely information to our homeland security partners and the American public.

PortSTEP Program Goals

- Conduct exercises relevant to stakeholders' challenges and risks.
- Promote stakeholder awareness and involvement through an outreach program.
- Encourage stakeholder participation in program development.
- Refine the program through evaluation and continuous improvement.

tion sectors within the ports. This approach also provides for the effective application of agency expertise, avoiding duplication of effort among government entities while preserving the distinct authorities of the Transportation Security Administration and USCG.

To effectively coordinate activities between TSA and USCG in the port environment, TSA is committed to maintaining its focus on the surface transportation exposure within the port footprint. However, due to differences in risk assessment methodologies and approaches to risk management within the federal government, the surface transportation risk exposure in our nation's ports is not well-understood.

The complexity, type, and amount of surface transportation assets and infrastructure located within the port structure have not yet been fully explored. The Transportation Security Administration intends to obtain this data through PortSTEP and use it to determine the degree of involvement TSA must have in any given port structure. TSA and USCG are developing a common understanding of how surface transportation risks may affect port security, and identifying the mitigation strategies that will address the issues at hand.

In addition to delivering exercises and services to 40 ports across the nation, PortSTEP includes a business information center—an Internet-accessible knowledge management system serving all stakeholders. It integrates all components of the port security training exercise program and provides stakeholders with valuable exercise information tailored to the port and intermodal transportation industry involved.

This toolset will allow exercise developers to leverage past work and best practices. It is an interactive repository for exercise information that can be analyzed to provide trends in exercise design, modal involvement, scenario type, and other criteria. The after-action report component of the PortSTEP business information center provides analysis tools and reports that can assist users in identifying gaps and vulnerabilities in their plans and processes. Communications gaps, organizational structure issues, and knowledge of roles and responsibilities are just some examples of deficient areas that can lead to vulnerabilities and diminish the overall transportation security preparedness of a port. The data can be further sorted by industries, transportation mode, or geographic area to provide a higher-level perspective of the risks across the nation's ports. The business information center is designed to be adaptable to the changing needs of PortSTEP as it matures and evolves, and to support additional TSA programs that may be developed.

Although government participation is critical to its success, PortSTEP is aimed specifically at industry. This includes all of the transportation modes within the port footprint, including passenger, freight, and infrastructure components for maritime, rail, highway, mass transit, and pipelines. As mentioned, PortSTEP is coordinating exercise delivery through the area maritime security committees, providing the members and other participants with a range of services to validate the plans to prevent, respond to, and recover from a transportation security incident, and to disseminate lessons learned and best practices. But more importantly, the port security training exercise program is bringing together representatives from the maritime and surface transportation community in a more focused and purposeful manner, to better understand the risks, to coordinate actions, and to improve communications.

Since August of 2005, approximately 2,500 participants have been involved in PortSTEP, and approximately 200 subject matter experts have been trained to evaluate the 22 tabletop exercises conducted in large, small, river, Great Lakes, and coastal ports across the United States thus far. Each exercise serves as a tremendous stakeholder engagement tool from start to finish. Evaluations of each exercise yield lessons learned and best practices to be shared with port communities and the PortSTEP staff, who use the information to continually improve the quality of the exercises.

Preliminary Findings

Because the port area is a nexus for all modes of transportation, it is a perfect environment to fully test and vet an exercise program for the transportation network. TSA and USCG efforts to infuse the area maritime security committees with surface transportation experience and expertise has not gone without some challenges. Initial findings of the port security training exercise program showed that more consistent intermodal participation was needed. Three overarch-

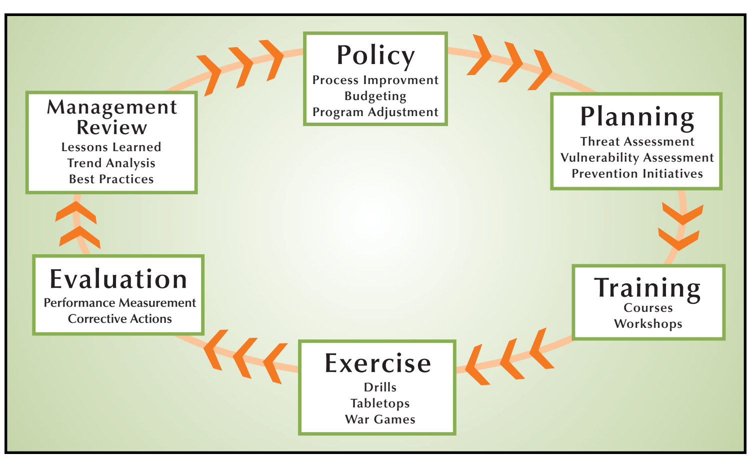


Figure 1: A multifaceted effort that begins with the assessment of risk and progresses through planning, training, testing, and evaluation steps.

ing weaknesses in the port system were:

- **Information sharing in the unified command structure:** The inability to share information or communicate effectively was a trend across the majority of the exercises. The problem was observed most often in the integration of agencies and jurisdictions in the Incident Command System organization.
- **Awareness of ICS/NIMS concepts:** Most people have a basic understanding of Incident Command System and National Incident Management System principles. However, they are not trained in the specifics of organization, structure, section roles and responsibilities, and physical locations of sections relating to ICS. This results in inefficiency and delayed response times.
- **Awareness by all agencies of the guidance and content in area maritime security plans:** Not all agencies or commercial entities are knowledgeable of, or have access to, the area maritime security plan, and are not clear on many items such as communication procedures, maritime security implementation, etc.

These results indicate that some of the vulnerabilities that exist in the port structure do not necessarily exist within the maritime mode, but only become evident when surface transportation issues are introduced to the port environment. A breakdown in communication and coordination can easily be viewed as a vulnerability, posing a risk to the port security environment. Conducting port security training program exercises with an emphasis on surface transportation interactions in the port environment will help resolve these issues.

"The port environment is a difficult place to try out new things. If PortSTEP can make it in port, it can make it anywhere. That's exactly why we decided to do this."

Mr. Jeffrey Graves, PortSTEP program manager

The Way Forward

USCG leadership has created a robust stakeholder framework with the area maritime security committees. However, multimodal industry participation at the local level is needed if AMSC efforts are to fully realize their potential for mitigating risk via prevention, response, and recovery measures. To achieve this potential, TSA has partnered with the U.S. Coast Guard and directed both its federal security directors and its surface transportation security inspectors to engage with the Coast Guard at the local level. Also, PortSTEP and its associated surface transportation-oriented scenarios are driving more inclusive participation with the intent to broaden AMSC membership.

The Transportation Security Administration understands that the linkages between the modal initiatives are critical to the success of TSA and its programs. The port security training exercise program has the capability to integrate any existing TSA program, test program modifications or changes, pilot new ideas, and monitor results. The program's focus on all modes of surface transportation makes PortSTEP "the right program at the right time" to incorporate new or existing TSA initiatives. port security training exercise program managers are working to link the program to other DHS activities relating to port and mass transit security.

At the end of the pilot period in October 2007, the port security training exercise program will be a fully tested and vetted program with a great potential to form the model for a fully integrated multimodal transportation sector network exercise program. Increased Transportation Security Administration intermodal input and participation, integration of TSA programs, and a strong partnership with the Coast Guard and DOT allows PortSTEP to provide the mechanism, tested products, and the documentation to form a robust program that meets future multimodal exercise needs.

About the authors:

Captain Clarkson is the general manager for Maritime Security at the Transportation Security Administration (TSA), where he develops policies, strategies, and plans to determine and mitigate risk in the marine transportation system. While at TSA, he has managed security activities in all transportation modes except aviation. He has also served as senior TSA policy advisor, leading initiatives such as the development of the National Strategy for Transportation Security, participation in supply chain risk analysis, and managing Operation Safe Commerce. He was also selected to join the Supply Chain Security Action Team, a hand-picked group tasked to provide innovative solutions for Secretary Chertoff's Second Stage Review of the Department of Homeland Security.

Mr. Gaudiosi is an associate with Booz Allen Hamilton (BAH), with over 28 years of experience in crisis management, marine environmental protection and response, and preparedness and port readiness. He is currently serving as the project manager for the BAH portion of the Transportation Security Administration's Port Security Training Exercise Program (PortSTEP) to provide programmatic, technical, and information technology design and support for the development of the program. He is a retired U.S. Coast Guard officer with 23 years of experience implementing and managing national-level USCG plans and preparedness programs including the Oil Pollution Act, Invasive Species Act, and port readiness.

Endnotes:

1. Please see "Secure Ports Across the Nation: An overview of security exercises with a special focus on the maritime sector," *Proceedings of the Marine Safety & Security Council*, Vol. 63, No. 4, Winter 2006-07, p. 65.

2. Please see "The Preparedness Cycle: A mechanism to enhance operational response," *Proceedings of the Marine Safety & Security Council*, Vol. 63, No. 4, Winter 2006-07, p. 45.

The National Response Options Matrix for Maritime Security

Mitigating risk in the context of response.

by LT Michael Vega
U.S. Coast Guard Office of Security and Defense Operations, Maritime Homeland Security Division

The genesis of the National Response Options Matrix for Maritime Security (NROM-MS), a senior leadership decision tool, came from a post-9/11 recognition that the attacks that so gravely impacted the nation and aviation industry could have occurred just as easily in the maritime domain.

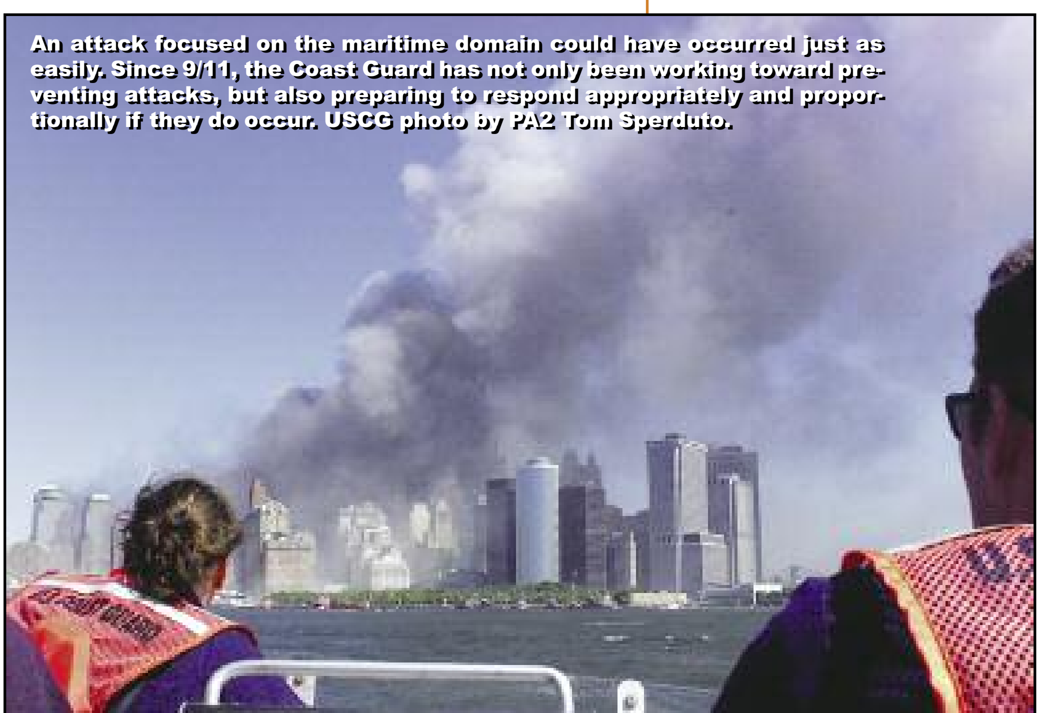
There was growing concern at Coast Guard headquarters that, without having preplanned options, the Coast Guard's response to an attack in the maritime domain might be similar to the Federal Aviation Administration's—the shut down of an entire transportation sector.

Although this response was understandable at the time, the lasting impact it had on our economy was devastating. Given that America relies on its Marine Transportation System for more than 95 percent of its overseas trade—for example, 9,000,000 barrels of oil move though it daily—the "shut down solution" for our nation's ports has even more potential for catastrophic impact.[1]

A Plan of Action

These concerns were translated into a new assignment by then Chief of Staff of the Coast Guard, ADM Allen. He established a work group comprised of a cross section of Coast Guard subject matter experts who met to develop a decision tool for nationwide-level response to terrorist attacks in the maritime domain. The group included experts from all segments of the USCG with an array of operational specialties and detailed knowledge of their respective industry partners.

The work group charter charged participants with



An attack focused on the maritime domain could have occurred just as easily. Since 9/11, the Coast Guard has not only been working toward preventing attacks, but also preparing to respond appropriately and proportionally if they do occur. USCG photo by PA2 Tom Sperduto.

creating a systematic risk-based approach for responding to attacks and helping tackle the questions that senior officials must consider in their decision making before perfect information becomes available. For example:

- Which of the nation's militarily and economically strategic ports are most vulnerable?
- Which attacks carry the greatest consequences?
- Are any maritime threats more likely than others?
- How can protection be maximized, while the impact on our economy and way of life is minimized, following an attack?

The charter further emphasized that the work group should have a national-level focus by adding the premise that local responders would address immediate response and recovery at the point of attack, and that work group efforts should concentrate on protecting and preventing against follow-on attacks at other ports and areas other than the one stricken.

What if?

The work group began by conducting a risk analysis called a "What-If Analysis,"[2] which is commonly used by the Coast Guard when grappling with the enormous scope of national-level responses. The first step is to define the activity or system of interest. In this case, the subject matter experts had a three-component focus when defining their system of interest. Namely, the prevention of follow-on attacks to and protection of the Marine Transportation System (MTS), maritime critical infrastructure and key resources, and high-density population centers.

The second step in the "What-If Analysis" model is to define the problems of interest within the defined system. One of the most challenging problems was deciding which attack scenarios to use. Further complicating the problem was the virtually unlimited number of potential "attack modes" (how the attack is carried out) that terrorists could employ to impact an immeasurable number of "target groups" (who/what the attack is on) within the maritime domain.

The work group relied on its collective expertise as well as the most current risk-assessment data at that time, the Coast Guard's Port Security Risk Assessment Tool (PS-RAT). The PS-RAT data enabled the work group to pare down the total number of target groups and attack modes, making the data more manageable through the lens of threat, consequence, and vulnerability.

Taking into account the PS-RAT data, the group was able to move on to the third step in the "What-If Analysis" and subdivide components of the MTS, maritime critical infrastructure and key resources, and high-density population centers into meta-target groups and attack modes. Once these attack modes and target groups were subdivided and agreed upon, meta-scenarios that encompassed those modes and groups were then generated to be presented to the subject matter experts to "game out."

In the gaming-out step of the "What If Analysis," extensive discourse ensued on what level of response is appropriate and proportional. Certain similar subsets of response began to emerge from the discussion. Looking at existing Coast Guard authorities, the group broke up its responses into cognitive chunks, which included:

THE WHAT-IF ANALYSIS

Step one: Define the activity or system of interest. Specify and clearly define the boundaries for which risk-related information is needed.

Step two: Define the problems of interest for the analysis. Specify the problems of interest that the analysis will address (safety problems, environmental issues, economic impact).

Step three: Subdivide the activity or system for analysis. Section the subject into its major elements (e.g., locations on the waterway, tasks, or subsystems). The analysis will begin at this level.

Step four: Generate "what-if" questions for each element of the activity or system. Use a team to postulate hypothetical situations (generally beginning with the phrase "what if …") that team members believe could result in a problem of interest.

Step five: Respond to the "what-if" questions. Use a team of subject matter experts to respond to each of the "what-if" questions. Develop recommendations for improvements wherever the risk of potential problems seems uncomfortable or unnecessary.

Step six: Further subdivide the elements of the activity or system (if necessary or otherwise useful). Further subdivision of selected elements of the activity or system may be necessary if more detailed analysis is desired. Section those elements into successively finer levels of resolution until further subdivision will (1) provide no more valuable information or (2) exceed the organization's control or influence to make improvements. Generally, the goal is to minimize the level of resolution necessary for a risk assessment.

Step seven: Use the results in decision making. Evaluate recommendations from the analysis and implement those that will bring more benefits than they will cost in the life cycle of the activity or system.

- a consideration of the appropriate maritime security level,
- control actions to be emphasized,
- whether or not to deny entry or expel certain vessels, and
- whether to increase the Coast Guard's own force protection condition following an attack.

These criteria were then used to capture the group's results in a systematic format. The group was careful to assess the national-level response for each meta-scenario, balancing the need to maximize protection and prevention with facilitating the flow of legitimate commerce.

The National Response Options Matrix

The initial product was called National Response Options Matrix or NROM v1.0. It was designed and organized as a simple bound book, indexed by attack mode and target group, which then gave the Commandant a ready reference if an attack ever took place. Since NROM v1.0 several incremental improvements have been made to the matrix.

NROM v2.0, the second version of the product, represented a further refinement and standardization of the above responses and incorporated it into an electronic version for easy distribution and sorting. This refinement process was twofold. First, the work group considered the validity of the response options from NROM v1.0 after an update was made to the PS-RAT. Additionally, the group wanted to provide useful perspective on the location of critical infrastructure and port characteristics so that tailoring where the response options should be carried out would be easier.

A sortable index was added to the tool, which provided the target group characteristics for each of the nation's militarily and economically strategic port locations. Another index was also added to provide an overview of deployable Coast Guard assets available to affect response options, sortable by asset type and location.

Risk communication measures were another valuable update incorporated into NROM v2.0. To give Coast Guard field commanders a better idea of what risk-based decisions they could anticipate if an attack occurred, NROM v2.0 was distributed electronically to all command centers across the Coast Guard via CG Central, the Coast Guard's intranet site.

The National Response Options Matrix for Maritime Security is a new way of thinking about risk-related questions in the context of response.

NROM v2.0 also quickly found a home in the Coast Guard's Critical Incident Communications (CIC) system, which was being developed around the same time that this latest version of NROM rolled out. Part of the CIC system's vertical and horizontal notification timeline is a series of senior Coast Guard leadership conference calls. NROM v2.0 was added to the conference call checklists to be considered when a critical incident involved potential or actual terrorist events.

To determine how useful NROM v2.0's response options were, the product was used in conjunction with exercises of the CIC system on a quarterly basis. NROM v2.0 has been used within the CIC framework in numerous exercises including Top Officials Exercises, Senior Officials Field Training Exercises, and Area Maritime Security Training Exercise Program exercises. It was during these exercises, while working with other DHS partner agencies that the broader, interagency applications for NROM were realized, and the Coast Guard began outreach to other federal agencies with major maritime response roles.

The development of NROM v3.0 began in earnest with another major maritime responder, Customs and Border Protection (CBP). Recognizing the value of having pre-planned response options for their senior leaders, CBP quickly embraced the NROM concept and partnered with the Coast Guard to provide coordinated CG-CBP response options. Customs and Border Protection went through an iterative process similar to what the Coast Guard work group used, but within the sound framework that NROM v2.0 provided.

Like the Coast Guard's NROM work group, CBP's response options were generated by subject matter experts who spanned the breadth of their organization. CG and CBP's NROM work groups collaborated during this process to ensure that there was coordination and alignment of the response options between the two agencies. These coordinated responses allowed for better understanding of what respective senior leadership could expect from their partner agencies in responding to attacks.

In July of 2006, Customs and Border Protection Commissioner Ralph Basham approved the use of NROM v3.0 for CBP. NROM v3.0 was subsequently made available to all Customs and Border Protection headquarters' offices, Field Office port directors, Border Patrol chief patrol agents, and Air & Marine

Branch operations directors, via Coast Guard's Homeport website.

National Response Options Matrix for Maritime Security

Since that time NROM v4.0, which will be called the National Response Options Matrix for Maritime Security (NROM-MS), has been under development. The Coast Guard portion of the NROM work group recently met with Customs and Border Protection representatives from the CBP Office of Antiterrorism, Office of Field Operations, and Office of Border Patrol for a two-day conference in Arlington, Va. to make improvements and further refinements to NROM-MS.

Improvements in Coast Guard risk assessment tools such as the Maritime Security Risk Assessment Model (MS-RAM), which replaced PS-RAT, helped refine and improve the National Response Options Matrix by leveraging its superior quantitative ability to assess risk. Additionally all response options were given a thorough "logic scrub" for clarity, alignment with existing policy, and accuracy. The group also pushed the National Response Options Matrix into new territory and made recommendations that response options for foreign incidents that may have domestic impact be added to the product. Another change recommended by the group was including the words "Maritime Security" to the end of the NROM title as a clarifier.

This close partnering is evidence of Coast Guard Commandant ADM Allen's vision of "working closer than ever with our federal, state and local partners to better prepare to respond and recover from any major disaster, with clear lines of command and control…" [3] and also supports the recent chartering of the Coast Guard and Customs and Border Protection senior guidance team. The senior guidance team is dedicated to coordinating and fostering interagency initiatives between the partner agencies. USCG and CBP have also engaged in additional outreach to the Department of Homeland Security, Transportation Security Administration, Federal Bureau of Investigation, Department of Energy, and the National Maritime Security Advisory Committee to promote NROM-MS awareness and participation.

In a recent meeting the Coast Guard's Office of Current Operations offered NROM-MS up as a potential model and best practice to senior-level Department of Homeland Security representatives. It is hoped that this important ongoing interagency coordination and preplanning for worst case scenarios will contribute to mitigate risk by providing senior leaders with response options that minimize impact while maximizing protection for the United States maritime domain.

About the author:

LT Michael Vega currently serves as a member of the Office of Security and Defense Operations in the Maritime Homeland Security Division at Coast Guard headquarters. Previous assignments include the Office of Port Security Policy and Planning, and Assistant Operations Officer aboard Coast Guard Cutter Diligence.

Endnotes

1. "Our Valuable U.S. Marine Transportation System," Maritime Administration, www.marad.dot.gov/Publications/ValueMTS .
2. "U.S. Coast Guard Risk Based Decision Making Guidelines" www.uscg.mil/hq/g-m/risk/e-guidelines/RBDM/html.
3. Statement of U.S. Coast Guard Adm. Thad Allen before the Senate Committee of Appropriation Subcommittee on Homeland Security, Sept. 7, 2006.

ONLINE VERSION AVAILABLE

The electronic version of the National Response Options Matrix for Maritime Security now allows for easy distribution and data sorting. Additionally, the latest version of NROM-MS has the ability to add other federal maritime responder agencies for better coordination and cooperation.

Where:

NROM-MS is available via the National Response Options Matrix microsite, located on CG Central (the Coast Guard's intranet site) and via Coast Guard's Homeport Website at the National Response Options Matrix community page.
http://cgweb.comdt.uscg.mil/
http://homeport.uscg.mil

To Whom:

As NROM-MS is considered Sensitive Security Information (SSI) under 49 CFR 1520, as such access is limited only to covered persons with a "need to know."

How:

For covered persons, access may be obtained by contacting the Coast Guard's Office of Security and Defense Operations directly. In some circumstances covered persons may be required to sign non-disclosure agreements before being granted access.

Risk Management Post-Katrina

Setting priorities in the largest coordinated wreck- and debris-removal operation in U.S. history.

by LCDR Scott Calhoun, *Naval Architect, U.S. Coast Guard*

and Mr. Joseph J. Myers, *Risk Analyst, U.S. Coast Guard Office of Design and Engineering Standards*

A sector commander's worst nightmare: more than 1,700 people dead, thousands in need of rescue, tens of millions of gallons of pollution, the nation's most critical waterway shut down, entire coastal communities destroyed, and the infrastructure of an entire major city gone. Sounds like something out of a Stephen King novel. Yet, all of it was the real-life outcome of the costliest natural disaster in U.S. history—Hurricane Katrina.

Where to even begin such a massive recovery operation? The most obvious and critical decision was made even before Hurricane Katrina plowed through the Gulf Coast—save lives. Mitigating pollution and re-opening the Mississippi River as quickly as possible were also unquestionable needs. Undoubtedly, saving lives and mitigating large-scale pollution are vitally important and draw massive media attention, but what about the thousands of destroyed, grounded, and sinking barges and fishing vessels? What about the thousands of tons of debris clogging other navigable waterways? How should a sector commander weigh that recovery operation against the others? How should that commander prioritize and execute the recovery operation?

The $100 million recovery operation that successfully removed wrecks and debris from navigable waterways is not a story you were likely to read in any newspaper or hear about on CNN. Neither would one know about the incredibly successful team comprised of personnel from Coast Guard sectors and the Coast Guard's Salvage Engineering Response Team, Navy Supervisor of Salvage (SUPSALV), Army Corps of Engineers, the Federal Emergency Management Agency (FEMA), and senior managers of professional salvage companies represented by the American Salvage Association that partnered to develop and execute the recovery operation. Based on the success of the following approach, we theorize that these issues gathered little media attention because of one simple reason—effective risk management.

There were more companies and major salvage assets on scene for this one effort than anywhere else ever before. Despite the large number of assets available on scene, the massive scale of the problem required careful prioritization to balance competing needs for public safety, environmental protection, community restoration, and local and national economic reconstruction. Therefore, the federal on-scene coordinator had to prioritize the several thousand potential wreck and debris removal operations. To support this decision, the wreck and debris removal group established

Figure 1: Dozens of affected barges near mile marker 57 on the lower Mississippi River. USCG photo.

Type of Effects	Impacts on People	Property Damage	Environmental Impacts		Public Reaction
6-Catastrophic	>1000 deaths or serious injuries	>$3 billion	Spill of more than 150,000 bbls (6.3 million gallons) of oil. Catastrophic HAZMAT spill.	Complete collapse of multiple living marine species over a large area	
5-Major	100-999 deaths or serious Injuries	$300 million - $3 billion	Spill of 15,000 bbls to 149,000 bbls (63,000 gallons to 6.29 million gallons) of oil.	Long-term collapse of at least one living marine species over a large area	Long-term national attention that results in shift of resources and permanent change in organizational policy
2-Moderate	More than one life-threatening injury	$300,000 to $2.9 million	Spill of 15 bbls to 149 bbls (63 to 629 gallons) of oil. Major HAZMAT spill. Becomes an illegal dumping site for oil & hazmat.	Cumulative effect could cause a living marine species to become locally endangered	Short-term local attention to which USCG applies resources
1-Minor	More than one significant but non-fatal injury	$10,000 to $299,999	Spill of 1.5 bbls to 14.9 bbls (84 to 62.9 gallons) of oil.	Environmental nuisance	Short-term local disruption to normal passenger transportation operations

Figure 2. A portion of the severity index.

a risk-based approach towards prioritizing salvage cases.

Approach

The team applied a relative ranking/risk indexing approach to support these decisions. This method of risk-based decision making (RBDM) generates index numbers that provide ordered lists of priorities. The index numbers are the product of a projected consequence (how bad it can be) and probability (how likely it is to occur). Values of probability and consequence are determined based upon expert judgment against established indices. Given the vast number of issues and stakeholders, it was important to consider all relevant factors in assessing the risks.

The tool the team developed helped them consider multiple criteria and enabled the group to prioritize the thousands of cases. It provided a framework for the on-scene subject matter experts and stakeholders to weigh these risks and make timely decisions. The team created and deployed the risk assessment process within days of the storm's landfall. To frame the decisions, the subject matter experts were asked to assess the consequences that could occur, should a wreck and debris removal operation not be performed, and then approximate the probability of experiencing those consequences. The team considered both individual wrecks and also more large-scale effects of devastated regions such as the ports of Fourchon, Empire, and Venice, La.

Pain Points

The severity index (Figure 2) is a measure of consequence of an undesirable outcome. Given the multiple criteria of concern, this matrix considers the impact to people, the environment, the recovery effort, commerce, public reaction, national defense, and homeland security.

The team based the scale on the severity index used as part of the Coast Guard's 2004 National Strategic Assessment and other risk assessment tools used by the Coast Guard. The team adapted the index to address issues previously identified by the Government Accountability Office to better address the unique needs of the immediate situation. The general assessment process involved subject matter experts, including representatives from the Coast Guard, Navy SUPSALV, and salvage companies, estimating a "worst probable case" for each of the seven impact areas. The severity scale ranged from a low of "minor," to a high of "catastrophic," with a nominal estimated impact of $3 billion. This provided a relative amount of "pain points," or equivalent dollar amount, for each area. The results for each category were then added, to give an overall consequence value.

One particular challenge for the team was ensuring equivalent levels of severity when comparing health and safety impacts with environmental, social, and economic effects. To illustrate, consider the pollution scale under the environmental category. Basically this issue came down to asking, "What does an oil spill cost?" Historically, cleanup costs per barrel of oil spilled have averaged $20,000. Based on this measure, the team was able to develop a pollution scale. According to this scale, events such as the loss of an entire tank barge (approx. 30,000 barrels) ranked as a "major" event. Events such as the grounding of the *Exxon Valdez* (resulting in a spill of 257,000 barrels) would have ranked as "catastrophic." The team used similar considerations to establish the severity levels of things such as the impact on or loss of a living marine species.

The experts considered the level of consequence against the backdrop of the existing damage from Katrina. For example, if a fishery was already considered damaged or collapsed, they only considered the effect of additional pollution from delaying the removal of a vessel. Or, as another example, if vessel traffic was nonexistent because all the vessels from a harbor were destroyed, the experts acknowledged that clearing the channel leading into this harbor would do little to restore commerce in that area in the short term. In the long term, however, clearing the channel was essential to revitalizing that port.

Probability

The team adopted a modified Kent scale [1] for the purpose of this analysis (Figure 3). This generally accepted scale is rooted in intelligence assessments, but it helps quantify qualitative judgments where uncertainty is high, but consistency is important. It provides broad enough bands with practical descriptions to allow subject matter experts to estimate the likelihood of an undesirable event.

This scale was well-suited for the types of hazards being considered and the high level of uncertainty associated with estimating the stability of each situation. The general process was to have subject matter experts estimate the likelihood that any or all of the consequences identified from the severity index would occur. The tool allowed consideration of both near-term (less than 90 days) and long-term (up to a year) probabilities. The tool then multiplied the probability with the consequence value to determine the overall risk associated with not performing the removal or salvage of a vessel.

Resource Allocation and Defensible Spending

The tool also enabled the team to consider what salvage equipment was necessary for each case and to estimate the projected duration of the wreck and debris removal job. With this information and the location of the wrecks, the team successfully developed

KENT SCALE

Bin No.	Probability	Lower Bound	Upper Bound	Description
6	99.00%	99	100	Virtually certain to occur
5	93.00%	87	99	Event is almost certain to occur
4	75.00%	63	87	Event is probable
3	50.00%	40	60	Chances of the event are about even
2	30.00%	20	40	Event is probably not going to occur
1	7.00%	2	12	Event is almost certain not to occur
0	1.00%	0	2	Virtually impossible to occur

Figure 3: The Kent scale considers that experts will generally not know precise probabilities and that an estimate within a broad probability range is often adequate.

work plans that ensured the efficient use of the limited salvage equipment available (Figure 4). In addition, the opportunity costs associated with committing equipment for an estimated time period were considered as part of the overall decision, so that maximum efficiency could be obtained.

Results

The risk-based decision making process provided field commanders with valuable information and an understanding of the risks posed by Hurricane Katrina-related wrecks and debris. Armed with this knowledge, they were better able to manage the risks. The tool allowed the team to efficiently prioritize cases and optimize the allocation of limited resources.

The wreck and debris removal group evaluated more than 2,500 cases and executed more than 750. The risk tool helped to filter out numerous low-risk cases. While many of the casualties were directly dealt with by owners and responsible parties, a large number of remaining casualties were prioritized with the risk tool and executed in hierarchical manner using FEMA disaster relief funding. This allowed decision makers to go for the "low-hanging fruit" and execute cases that provided the greatest risk reduction per dollar spent.

The removal of vessel casualties required the use of specialty equipment such as shear leg cranes, derrick barges, salvage masters, etc. In the initial stages of response, the equipment was very scarce. This was due to their limited availability, long mobilization times, and extremely high demand from organizations other than the Coast Guard. The risk tool aided in determining how to effectively employ the equipment and optimize its use.

The response environment post-Katrina was highly political and emotionally charged. It was paramount for the Coast Guard to communicate its goals and objectives in removing wrecks and debris within areas that had multiple jurisdictions and agendas.

RBDM provided a fact-based, rational, and defendable process that included federal, state, and local stakeholders. Working with the stakeholders and developing a structured approach to response efforts

Figure 4: An offshore rig crew boat is returned to the water. USCG photo.

helped garner support and trust in the local communities. This created a strong team-oriented environment that allowed the Coast Guard to work across political boundaries and accomplish the mission. In addition, a risk-based approach to rank casualties in varying geographic areas helped the Captain of the Port justify decisions. It also helped expedite decision making by providing facts and analyses that showed where resources should and could be expended.

The tool provided critical information needed to effectively manage risk and safely re-open vital waterways. Wrecks and debris caused by the storm initially closed the Mississippi River—a waterway vital to U.S. commerce—and devastated local communities that relied on maritime commerce for their economic livelihood. Re-opening these waterways safely and quickly was essential to ensuring safety, health, well-being, and the prompt restoration of local infrastructure.

The risk prioritization process helped characterize the risk posed by casualties in vital waterways. It provided the data needed by decision makers to determine what wrecks needed to be cleared and which could remain. More importantly, it allowed the Captain of the Port to develop measures that managed the risk of those vessels that could not be immediately removed. For example, there were numerous barges that sunk or capsized in the Mississippi River. Due to the limited available resources, these barges were not able to be removed for weeks after the storm, yet they threatened safe navigation. Wake from passing vessels, Hurricane Rita, and other environmental factors may have shifted sunken vessels into the channel or sunk capsized vessels. Appropriate hazard mitigation measures were implemented (i.e., requiring owners to adequately anchor the barge), which reduced the risk posed to the Mississippi River. This, in turn, allowed the application of limited salvage equipment to more critical cases.

Finally, the tool helped ensure compliance with laws regulating expenditures under the Robert T. Stafford Disaster Relief and Emergency Assistance Act. This establishes the basis for federal assistance to state and local governments impacted by a significant disaster or emergency. The Federal Emergency Management Agency is primarily responsible for administering such assistance. The purpose of the assistance is to mitigate hazards to ensure safety of human life, minimize health risks, and protect and repair public infrastructure. Expenditures for relief, while essential to recovering from a major disaster, are subject to close scrutiny. By employing a risk-based approach, the team was able to identify the hazards and infrastructure effects to secure the needed funding and, ultimately, to justify expenditures. The tool helped decision makers understand where they could and should apply FEMA funds, thereby ensuring "defensible spending."

Conclusions

During any crisis, there's a lot of pressure to start responders working on the first issue identified. However, doing so may commit scarce and expensive resources to an effort that does very little to reduce overall risk, while allowing other serious risks to remain. As demonstrated by this effort, the application of RBDM to assess and manage risk and better inform decisions does not have to interfere with urgent operations. In addition, it can be used to continuously improve the quality of a decision-making process. Further, this effort demonstrates how risk-based decision making provides a reliable, repeatable, and defendable approach that helps Coast Guard personnel involve stakeholders; make complex, real-world decisions; and communicate those decisions effectively.

About the authors: *LCDR Scott Calhoun formerly assisted with the implementation of risk-based decision making as part of the Human Element & Ship Design Division at Coast Guard headquarters. He went on to become a qualified marine inspector at Sector New Orleans, where he also headed up the implementation of the Marine Transportation Security Act and the International Ship and Port Facility Code for U. S. commercial vessels. He completed his tour there as the Chief of Maritime Security Planning and Preparedness. LCDR Calhoun is currently stationed in Washington, D.C., as a naval architect at the Coast Guard Marine Safety Center.*

Mr. Joseph Myers is a risk analyst in the Office of Design and Engineering Standards at Coast Guard headquarters. He helped develop the Coast Guard approach to risk-based decision making. He currently works to apply risk analysis techniques to myriad issues facing the Coast Guard, including pollution prevention and response, commercial fishing vessel safety, and homeland security issues.

Endnote:

[1] Kent, S., "Words of Estimative Probability," *Studies in Intelligence*, Fall 1964.

Shiver Me Timbers!

You want to do what?

by LCDR Peter Gooding
Chief, Waterways Management Division,
U.S. Coast Guard Sector Los Angeles/Long Beach

CGC *Halibut* provides safety assistance to the filming of "Pirates of the Caribbean III." USCG photo by LT Nathan Swardson.

Pirates of the Caribbean sailed their way to the Pacific Ocean recently, and Coast Guard Sector LA/LB found itself in the unique position of aiding rather than arresting the pirates.

Sector Los Angeles/Long Beach Marine Event and Movie Shoot Approval

Very few words are used to describe the regulations for an applicant to hold a marine event. As Title 33 Code of Federal Regulations Part 100.15 states, "an individual or organization planning to hold a regatta or marine parade which, by its nature, circumstances or location, will introduce extra or unusual hazards to the safety of life on the navigable waters of the United States, shall submit an application to the Coast Guard District Commander having cognizance of the area where it is intended to hold such regatta or marine parade."

Even fewer words are used to describe the Coast Guard's responsibility once it receives this application. The following examines risk assessment and risk management strategies employed by Sector Los Angeles/Long Beach in approving and overseeing marine-related filming activities to ensure marine safety and security during unusual events in the largest container port complex in the United States.

Sector Los Angeles/Long Beach has oversight of more than 320 miles of the California coastline, bounded by the San Diego/Orange County line to the south and the San Luis Obispo/Monterrey County line to the north, including the Channel Islands National Marine Sanctuary. The sector has four 87-foot coastal patrol boats, three small boat stations, a marine safety detachment, a vessel traffic service, and an aids to navigation team.

The ports of Los Angeles and Long Beach receive more than 5,700 commercial vessels a year, including 2,800 container ships, carrying approximately 14 million 20-foot equivalent unit containers. The sector is

> "Fortunately for the sector, we see more than 150 movie shoots a year and are quite familiar with the usual locations that filming companies use. Unfortunately, such familiarity can affect your viewing enjoyment. As a matter of fact, my wife no longer enjoys watching television with me, as I repeatedly point out locations in Los Angeles or Long Beach, even though the show is supposedly taking place in another city."
>
> **LCDR Peter Gooding**

also home to the motion picture capitol of the world. The waterways management staff reviews applications for more than 150 movie shoots and approximately 75 marine events each year. The majority of non-movie-related events are holiday boat parades and Fourth of July fireworks.

In the past year, the sector has been involved in approving applications for several movie and television films, including:

- "CSI: Miami,"
- "Daybreak,"
- "Déjà Vu,"
- "Next,"
- "Vanished,"
- "Without a Trace,"
- "Pirates of the Caribbean III."

For any proposed marine event other than a movie shoot, the applicant must submit a Coast Guard Form 4423 to the appropriate district office or sector at least 135 days in advance of the event. In addition to the form, it is requested that the applicant submit a chart or map that depicts the location of the marine event. Items that are included on the form are related to the number of participants, number of boats and their sizes, impacts to navigation and waterway safety, number of safety boats, and whether the event coordinator needs additional assistance to maintain event safety. The 135 days' notice is necessary for the sector office to review the proposal and coordinate various marine activities.

For movie shoots, Sector Los Angeles/Long Beach uses a questionnaire instead of Coast Guard form 4423. The questionnaire asks for information related to names of the production manager, production company, location manager, and the marine coordinator. Based on past experiences with film shooting, the questionnaire also asks about the number of boats and types of any Coast Guard documentation the boats may have, the special effects that will occur during filming, and a diagram depicting the location of the filming event.

Who's Who and What Does This Mean for the Coast Guard?

So who are these people—the production manager, the location manager, and the marine coordinator? In the filming industry, these people are the ones the sector usually works with to obtain details of the filming activities and develop associated safety measures. The production manager assembles the budget, organizes the shooting schedule, and authorizes expenditures. The location manager scouts locations and negotiates use agreements with property owners and permitting agencies. He or she also works with local officials to coordinate shooting schedules, and is responsible for the condition of the locations after shooting is finished. The marine coordinator synchronizes people, safety, and other things such as equipment, vessels, cameras, and special effects that make water scenes possible.

Once the sector receives an application for a marine event or movie shoot application, the first step is to do a site evaluation. The sector then fills out the environmental checklist found in Commandant Instruction M16475.1. We are concerned about the impact of the event on public health and safety, unique characteristics of the geographic area, impact on the highly sensitive environmental systems, and the potential for effects on the human environment that are hazardous or highly uncertain. We also consider whether the event will set a precedent for future actions with significant effects that could impact a cultural or historic resource; have an impact on a species or habitat protected by federal law; or violate a federal, state, or local law for the protection of the environment.

Special Effects Mean Special Consideration

The sector is also concerned with compliance with the Passenger Vessel Safety Act of 1993. Since most vessels used in movie shoots are charters, that is, they do not belong to the filming company, they are conducting an operation of "passenger for hire." Under the requirements of Title 46 CFR Subchapter T, a vessel is regulated if it (1) carries more than six passengers, including at least one for hire; (2) is chartered with a crew provided or specified by the owner or the owner's representative and is carrying more than six passengers; (3) is chartered with no crew provided or specified by the owner or the owner's

Continued on page 64

Coast Guard Cutter *Osprey* and two 25-foot small boats on patrol. USCG photo by PA2 Robert K. Lanier.

representative and is carrying more than 12 passengers; or (4) if a submersible vessel, carries at least one passenger for hire.

CGC *Halibut* provides safety assistance. USCG photo by LT Nathan Swardson.

As such, the sector ensures that either the vessels do not violate this section of the CFR or ensure that each vessel is certificated in accordance with Subchapter T. When you consider actors, directors, lighting technicians, sound crew, makeup people, special effects technicians, stuntmen, and camera operators in a filming operation, it can be very easy to put more than 12 people on even a small vessel.

After the sector conducts these preliminary evaluations, we determine the appropriate safety or mitigation measures that are necessary for the marine event or movie shoot. Some of the movie shoot effects that have recently impacted navigation safety include smoke that has been thick enough to completely restrict the navigation visibility of the main channel of the Port of Los Angeles and high-speed boat chases near large commercial tankers and container vessels. In these cases, the sector then applies appropriate management strategies to ensure that the locations of these marine events are clearly identified, and that the public is aware of the impact.

Another event that the sector was involved in was the shooting of the television show "Moochers." During the filming, the company wanted to explode an empty container over the water.

Since we needed to ensure that all of the pieces of the container were removed from the waterway, we worked with the production company to do the filming in a drydock. Thus, we removed the explosion hazard from the navigable channel and also ensured that none of the debris would be placed in the waterway.

Pirates of the Caribbean III

An example of this process is clearly evident in the recent filming of "Pirates of the Caribbean III." The sector received a request 60 days in advance of filming from the location manager. For the entire process, the sector worked with the location manager and marine coordinator to discuss the impact to the public and ensure safety during the filming.

The 45 days of filming activities in Sector LA/LB's area of responsibilty included "actors overboard" from the *Black Pearl*, several scenes of the vessel sailing in man-made "Hollywood fog," numerous canon fights, and the simulated capsize of the vessel in the middle of the ocean.

In order to ensure public awareness, the sector conducted daily broadcasts and sent informational faxes to the pilots and vessel traffic service. The sector worked with the local police to provide waterside safety for the shooting operations. Because filming of "Pirates of the Caribbean III" coincided with the release of "Pirates of the Caribbean II," there were more than 1,000 spectators a day at some of the shooting locations. As a result of proper planning, appropriate safety resources, and the daily public notices, all of the shooting events were successfully completed on schedule. In addition, the sector was able to ensure the safety of the movie company personnel and the public.

About the author:
LCDR Peter Gooding has served in the U.S. Coast Guard for 10 years. LCDR Gooding is currently the chief of the Waterways Management Division at Sector Los Angeles/Long Beach, overseeing marine events, movie shoots, port construction projects, a vessel traffic service, and an aids to navigation team. His awards include two Coast Guard Commendation Medals and the Coast Guard Achievement Medal.

Tragedy-Driven Change

Plan consolidation and revision to address a river system.

by CAPT Timothy Close
Chief, Western Rivers Division, Eighth Coast Guard District

LCDR Wayne Arguin
Chief, Prevention Department, Sector Lower Mississippi River

and LTJG Allison Cox
Western Rivers Division, Eighth Coast Guard District

On the morning of January 6, 2005, the towboat *Jon J. Strong* lost control of nine out of 12 barges while exiting Belleville lock and dam in Reedsville, Ohio, due to strong Ohio River currents. Four of those nine barges

Barges that had broken free from towboat *Jon J. Strong* were damaged and sank, which obstructed the dam at Belleville lock and dam, mile marker 203, Ohio River. USCG photo by MST1 Kyle Chapman.

sank above the dam and prevented the U.S. Army Corps of Engineers (USACE) from using the dam to control river levels. Fortunately, no casualties resulted, but the negative economic impact to the towing industry, facilities, and marine transportation system was significant and long lasting.

Three days later, in an incident that attracted national attention, the towboat *Elizabeth M* was overpowered and swept over the Montgomery lock and dam, which resulted in the death of four crew members. This tragic accident also occurred on the Ohio River, while the towboat was exiting the lock, 30 miles northwest of Pittsburgh, Penn. The two lead barges were pushed laterally by the eddy currents, and the towboat was unable to overcome this force.

Risk Can be a Moving Target

The U.S. Coast Guard (USCG) focuses on analyzing, managing, and mitigating risk, but often a mishap or tragic event happens before risk-mitigation changes occur. River conditions are fluid; river levels and conditions can change daily and rapidly. Seasonal high and low water levels are expected, yet accidents frequently occur during the transition from high to low and low to high river levels. The high water on the upper Mississippi River and Ohio River in January 2005 had deadly results that required immediate re-evaluation of our risk management processes.

Towboat *Elizabeth M* sinks after being swept over the Montgomery lock and dam, mile marker 32, Ohio River. USCG photo by LTJG Jesse Garrant.

Sector Lower Mississippi River High Water Task Force Members

CAPT Dave Stalfort
(commanding officer, MSO Memphis)

LCDR Wayne Arguin
(executive officer, MSO Memphis)

LT Leon McClain
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Mr. Neil Shoemaker
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Mr. Tom More
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(co-chairman, LOMRC/Ingram Barge Co.)

Mr. Jerry Stewart
(USACE Vicksburg, MS District)

Mr. Tony Johnson
(*USACE Memphis, TN District)*

Despite navigation warnings, radio broadcasts, and predicted river levels, confusion and miscommunication resulted in several navigation accidents. Resolving a problem on a specific portion of the upper Mississippi River was not difficult when the issue was isolated to that area; however, there were concerns with the confluence of multiple rivers, overlapping operational areas, and differing plans between the various sectors and Captain of the Port (COTP) zones. In addition, the action plans in place at the time were not interoperable when the incident involved multiple rivers, government agencies, or states. They were especially cumbersome for the towing companies that operate towboats on all of the major rivers at the same time. Also not all plans included all of the critical river conditions: high water, lower water, high velocity, and ice.

Working Together to Find a Solution

To address these problems, the Eighth Coast Guard District commander led the creation of a joint working group of USCG, USACE, and towing industry representatives to review existing action plans and develop more proactive plans that were specific to individual rivers and areas of responsibility. These plans would focus on limiting casualties and on aiding cohesive response operations under all river conditions. The final result is a waterways action plan (WAP) for the entire western rivers system that addresses all of the major river conditions.

River Fact

The Ohio River supplies most of the water to the lower Mississippi River, and the confluence of the Ohio, upper Mississippi, and lower Mississippi Rivers around Cairo, Ill. dynamically impacts river levels, currents, and velocities.

The western rivers are a fluid system that must be viewed as one entity. A lock closure on the Ohio River can severely impact navigation and commerce on surrounding rivers.

A precursor to the WAP, the original river crisis action plan, was developed in the late 80s and early 90s as a standardized way to control the flow of lower Mississippi River traffic during periods of low or high water. Other river plans were developed throughout the past decade to address navigation concerns on other specific inland rivers. These basic plans incorporated a series of broadcast notices to mariners, with infrequent COTP restrictions, to which the towing industry had limited input.

During the most extreme river conditions, meetings were held with key USCG, USACE, and industry stakeholders to discuss risk management measures, such as limitations to tow sizes and establishing safety zones. While such measures are often necessary, they were purely reactive in nature and were applied inconsistently along the river system. The most glaring concerns raised by stakeholders throughout these meetings were ineffective communications, confusing terminology, and a lack of interoperability among different agencies and on different rivers or multiple COTP zones.

The Waterways Action Plan

Correcting these discrepancies was among the objectives for the waterways action plan. USCG Sector Lower Mississippi River, previously Marine Safety Office Memphis, approached this tasking in detail. A high water task force working group was created to ascertain shortfalls in the existing plan, and identify the most likely hazardous river conditions, using a risk-based approach. The working group analyzed seven years of Marine Information for Safety and Law Enforcement (MISLE) marine casualty data, including collisions, allisions, and groundings and eliminated casualties that did not result from river conditions, such as mechanical or operator errors.

Casualty trends indicated areas of higher risk that needed to be addressed, and the working group identified the following risk factors as contributing to navigation risks:

1. Navigational complexity, which includes issues such as:

- **Obstructions to navigation:** objects, structures, or natural features that require more precise navigation and control of vessel movement.

- **Channel width:** the width of the channel directly relates to the speed of the current for a given river stage. This may include rapid narrowing or widening of the channel.
- **Bend radius:** the degree with which the direction of the river (and the resulting current) changes.

2. Traffic congestion: the volume of traffic for a given location. More traffic requires more precise control and creates less margin for error.
3. Rate of change in river stage: the measure of how quickly the river rises or falls contributes to unknown changes in bottom scouring, eddy currents, etc.
4. Current: the measure of the current flow of the river and the force required to move and control a vessel and its tow through the water.

Need for precise control	Navigational Complexity			Congestion	Change in flow rate	Current
	Obstructions to navigation	Channel width	Bend radius			
High	Multiple obstructions	Narrow - single vessel passage	Sharp bend >180 deg	Traffic always present	Change greater than 1 ft/day	Greater than 8 kts
Medium	Single obstruction	Medium - dual passage possible or likely	Gradual bend > 90, less than 180 deg	Traffic sometimes present	Change > 0.5 ft/day, less than 1 ft/day	Greater than 5 kts, less than 8 kts
Low	No obstructions	Wide - > 2 vessel passage possible	No bend, < 90 deg, or no river crossing	Traffic rarely present	Change less than 0.5 ft/day	Less than 5kts

Figure 1: Risk-based approach guidance.

Figure 1 shows how the risk factors were developed and evaluated in terms of the needed level of control. Figure 2 illustrates how the risk factors were used to rank segments of the river, and determine the highest risk areas.

In order to encourage broad industry support and obtain sufficient feedback, a public meeting was held to address concerns regarding navigation recommendations and restrictions, prior to publishing the WAP.

Risk-Reduction Measures
Once the Coast Guard, U.S. Army Corps of Engineers, and industry stakeholders agreed upon these risk factors, they were used to develop risk-reduction measures for areas that scored above an acceptable risk threshold (80 percent of the maximum score of 600). The river system was divided into five-mile segments, and risk factors were analyzed for each segment and scored to highlight the areas with the highest probability of an accident.

Trigger points, based on river stages, were developed for each location of interest for the proactive implementation of risk mitigation measures. Some of the prevention and mitigation measures included the use of safety zones and COTP orders to prevent casualties during hazardous conditions, as well as considering operational constraints, such as:

- horsepower requirements,
- the use of assist tugs,
- daylight-only transits, and
- limiting the number and configuration of barges and their drafts.

Navigation and operational recommendations or limitations were based on river levels and flow rates. Barge fleeting areas were also considered during periods of high water and high flow rates, to prevent barge breakaways.

Each river condition has three phases: watch, action, and recovery. Navigation recommendations and restrictions are implemented, depending on the dynamics of the situation. In the "watch" phase, lines of communication are established to identify existing

Location	Factors to increase likelihood of casualty					
	Obs to Nav	Channel Width	Bend Radius	Congestion	Casualty History	Risk Score
MM834-840 (I155 Bridge)	High	High	High	High	High	600
MM530-535 (Greenville Bridge) RNA	High	High	High	High	High	600
MM730-735 (Vice Presidents Island bend)	High	High	High	Medium	High	510
MM595-600 (Victoria bend)	Low	High	High	High	High	501
MM800-805 (Forked Deer bend)	Low	High	High	Medium	High	411
MM765-770 (Reverie Lt bend)	Low	High	Medium	High	High	411
MM735-740 (Memphis Bridges)	High	Medium	High	High	Medium	330
MM775-780 (Driver Cutoff bend)	Medium	High	Medium	Medium	High	330
MM590-595 (South of Victoria bend)	Low	High	High	High	Medium	321

Figure 2: High water assessment for a portion of the lower Mississippi River.

CRITICAL AREA DESCRIPTION	TRIGGER READING	TREND	DESCRIPTION	PHASE	ACTION
CRITICAL AREA DESCRIPTION: Caruthersville to Memphis LOWER MISSISSIPPI RIVER MM 869-730 Reference Gages: Cairo, Ill. Memphis, Tenn.	18 feet	Rising	Normal Operations	Watch	• Initiate communications plan. • Issue advisory; indicate high water, exercise extreme caution; discuss voluntary horsepower and tow size restrictions.
	25 feet	Rising	High Water	Action	• Assess need for daylight/visibility/one-way traffic restrictions. • Activate pre-established safety zone, limiting upbound transits to minimum of 3.0 mph; downbound transit to: UTV Horsepower / HP/Barge / Max Tow Limit Less than 6000 hp / 240 hp/loaded barge (ALL) / 25 6001-7200 hp / / 30 7201-8400 hp / / 35 Greater than 8401 hp / / 36
	30 feet	Rising	Extreme High Water	Action	• Assess need for "expert vessel." • Reduce tow sizes based on following constraints, not to exceed 36 total: UTV Horsepower / HP/Barge / Max Tow Limit Less than 6000 hp / 280 hp/barge / 20
	35 feet	Rising	Extreme High Water	Action	• Assess further tow restrictions/river closure options.
	35 feet	Falling	Extreme High Water	Action	• Test tow verification to confirm channel integrity.
	30 feet	Falling	Extreme High Water	Recovery	• Relax hp/loaded barge restriction. UTV Horsepower / HP/Barge / Max Tow Limit Less than 6000 hp / 240 hp/loaded barge (ALL) / 25 6001-7200 hp / / 30 7201-8400 hp / / 35 Greater than 8401 hp / / 36
	25 feet	Falling	High Water	Recovery	• Test tow verification to confirm channel integrity.
	18 feet	Falling	Normal Operations	Normal Ops	• Cancel safety zone and resume normal traffic patterns and tow sizes. • Hotwash actions and update annex as appropriate within 48 hours.

Figure 3: High water phases: watch, action, and recovery.

conditions and to assess the need for further intervention. Industry representatives provide detailed information on specific hazardous locations, missing aids to navigation (AtoN) equipment, and known navigation challenges. USCG representatives provide information on current operational restrictions or limitations, known AtoN discrepancies, and buoy tender activities. The U.S. Army Corps of Engineers provides information on current dredging operations and known areas for channel integrity surveys during periods of low water. Collectively, the group determines whether additional action is required to preserve channel integrity.

In the "action" phase, predetermined operational controls (including safety zones, tow size or draft reductions), or dredging operations are implemented. Operational controls are focused on performance-based standards, such as requiring towboats to demonstrate the ability to achieve greater than three knots when transiting bridges, rather than requiring one-size-fits-all prescriptive requirements. In the "recovery" phase, operational restrictions are lifted as predetermined trigger points, or river stages are achieved.

The waterways action plan was designed to remain flexible, to allow for changing river conditions. While it is too early to claim that the WAP has reduced the number of casualties on the western rivers, it has dramatically improved our understanding of the marine transportation system by enhancing communications efforts throughout the area. Although not every situation can be predetermined, communication, planning, drills, evaluation, and revision can ensure continuous improvement and mitigate negative outcomes.

Although the waterways action plan is awaiting final approval, it is currently being utilized throughout the western rivers on a trial basis. This plan is a proactive document that is under constant review and revision to incorporate lessons learned, so that we may better manage risk and ensure safe navigation.

About the authors:

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Stakeholder-Driven Risk Management

The Ports and Waterways Safety Assessment: a risk-based decision making tool for waterways management.

by CDR Brian Tetreault
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and LT Keith Pierre
VTS Systems Manager, U.S. Coast Guard Office of Navigation Systems

The Ports and Waterways Safety Assessment (PAWSA) process grew out of the tremendous changes that took place during the 1990s in the United States Coast Guard's Vessel Traffic Services (VTS) program. In late 1996, following several major marine casualties and subsequent efforts to modernize Coast Guard VTS installations and equipments, Congress directed the Coast Guard to identify minimum user requirements for new VTS systems. This was to be done in consultation with local officials, waterways users, and port authorities and also to review private-public partnership opportunities in VTS operations.[1]

As a result of this congressional direction, the Coast Guard established the Ports and Waterways Safety System project to address waterway user needs. It placed a greater emphasis on partnerships with industry to reduce risk in the marine environment. As part of the project, USCG convened a national dialogue group comprised of maritime and waterway community stakeholders to identify the needs of waterway users with respect to vessel traffic management and vessel traffic service systems.

An Open Dialogue With Stakeholders

The national dialogue group recommended that the process used to determine the appropriate vessel traffic management measures needed for a particular port should include input from the Coast Guard, port users, and stakeholders, and it recommended some general criteria that should be evaluated by these stakeholders.[2] From this recommendation came the development of the Ports and Waterways Safety Assessment process.

The primary purpose of a Ports and Waterways Safety Assessment is to open a dialogue with waterway users and stakeholders, in order to best identify needed vessel traffic management improvements and determine candidate waterways for establishment of vessel traffic services. PAWSA provides a formal structure for identifying risk factors and evaluating potential mitigation measures.

The Ports and Waterways Safety Assessment process requires the participation of professional waterway users with local expertise in navigation, waterway conditions, and port safety. In addition, stakeholders are included in the process to ensure that important environmental, public safety, and economic consequences are given appropriate attention as risk interventions are selected. A number of experts and stakeholders have participated in the PAWSA sessions, including:

- vessel officers or operators;
- pilots;
- tow boat operators;
- ferry operators or operators of other small passenger vessels;
- representatives of recreational vessel operators;
- spokespersons for the commercial fishing or fishing charter industry;
- terminal operators;

- port authorities, harbor police, and firefighters;
- subject matter experts from environmental interest organizations;
- municipal, county, state, and federal officials or their agency employees having waterways management responsibilities;
- U.S. Army Corps of Engineers project planners;
- U.S. Navy afloat community representative;
- Coast Guard buoy tender or other afloat unit commanding officers; and
- shareholders who provide the funds for the port's utility and transportation infrastructure.

The PAWSA methodology developed by the Coast Guard uses a generic model of waterway risks. That model was built upon the general criteria developed by the national dialogue group. Risk factors were put into model form by Dr. Jack Harrold of George Washington University and Dr. Jason Merrick of Virginia Commonwealth University.[3]

Mitigation Measures Implemented as the Result of PAWSAs:

- **Port Arthur, Texas:** A Ports and Waterways Safety Assessment identified risks associated with increased vessel traffic and new liquefied natural gas facilities. The major mitigation was the establishment of VTS Port Arthur.
  Additional specific actions included:
- realigning aids to navigation;
- implementation and modification of traffic separation schemes and other traffic routing measures;
- establishment of regulated navigation areas; and
- consideration of other technical solutions such as hydro/meter sensors, bridge clearance sensors, and enhanced communications services.
- Outreach programs aimed at the recreational boating community were also been established.

- **Houston, Texas:** The Ports and Waterways Safety Assessment identified risks associated with dock congestion and limited lay berths.
- An additional anchorage area was established and better monitoring and control of existing anchorages increased their efficient use.
- Additional aids to navigation were established to better mark the channel.

- **Sault Ste. Marie, Mich.:** As a result of a PAWSA that better quantified weather risks, VTS Sault Ste. Marie incorporated low-visibility procedures. These procedures assist recreational, commercial, and public vessels in dealing with conditions of one-quarter-mile-or-less visibility that can occur approximately 150 days per year in this area.

Risk Factor Model

During the course of more than four years of PAWSA workshops throughout the United States, the model has been substantially revised to more accurately reflect the nature of waterway risks being experienced.[4] The only safety-related issues that have been deliberately excluded from the model are those that relate to port, facility, and vessel security. Security-related issues are not covered during a Ports and Waterways Safety Assessment because the workshop is usually open to the public and unclassified. Often discussions of security issues quickly delve into sensitive topics that could be treated as classified information. Security-related threats are assessed using separate risk-based decision tools (See earlier article, "The Maritime Security Risk Analysis Model").

Since risk is defined as the product of the probability of a casualty and its consequences, the waterway risk model includes variables that deal with both the causes of waterway casualties and their effects. The six risk categories used in the model are:

1. Vessel conditions – the types and the quality of vessels and their crews that operate on a waterway.
2. Traffic conditions – the number of vessels that use a waterway and their interactions.
3. Navigational conditions – the environmental conditions that vessels must deal with in a waterway relating to wind, water movement (i.e. currents), and weather.
4. Waterway conditions – the physical properties of the waterway that affect how easy it is to maneuver a vessel.
5. Immediate consequences – the immediate impacts of a waterway casualty. People can be injured or killed, petroleum and hazardous materials can be spilled and require response resources, and the marine transportation system can be disrupted.
6. Subsequent consequences – the long-term effects of waterway casualties that are felt hours, days, months, and even years afterward. These include shoreside facility shut-downs, loss of employment, destruction of fishing areas, decrease or extinction of species, degradation of subsistence living uses, and contamination of drinking or cooling water supplies.

Once risk factors have been assessed and prioritized, the next phase of the Ports and Waterways Safety Assessment is to determine the appropriate mitigation of the identified risk. Based on the analysis, the participants now have a better idea of the nature of the risk factors. They are presented with general strategies that may be used to mitigate these risks. These can range from relatively simple efforts, such as publication of voluntary standards of care, to more substantial efforts, such as the implementation of new regulations or acquisition of navigation safety equipment.

Vessel Conditions	Traffic Conditions	Navigational Conditions	Waterway Conditions	Immediate Consequences	Subsequent Consequences
Deep draft vessel quality	Volume of commercial traffic	Winds	Visibility impediments	Personnel injuries	Health and safety
Shallow draft vessel quality	Volume of small craft traffic	Water movement	Dimensions	Petroleum discharge	Environ-mental
Commercial fishing vessel quality	Traffic mix	Visibility restrictions	Bottom type	Hazardous material release	Aquatic resources
Small craft quality	Congestion	Obstructions	Configuration	Mobility	Economic

Table 1: The final form of the six risk categories and corresponding risk factors in the waterway risk model.

From these general strategies the participants develop specific actions that are closely matched to the risks identified and appropriate for the area under study.

Risk Factor	General Strategy	Example of Specific Action
Small craft quality	Rules & procedures	License boat operators
Petroleum discharge	Coordination / planning	Update subarea contingency plan (SCP) logistics section
Water movement	Navigation / hydrographic information	Enhanced vessel reporting system Wind / water circulation study
Aquatic resources	Coordination / planning	Develop additional geographic response strategies
Bottom type	Navigation / hydrographic information	Update charts and *Coast Pilot*
Winds	Navigation / hydrographic information	Put more wind sensors in passes
Visibility restrictions	Navigation / hydrographic information	Require AIS on all commercial vessels > 26′
Hazardous materials release	Coordination / planning	USCG receive all dangerous cargo manifests
Environmental	Coordination / planning	Include biological release (non-indigenous species) in SCP
Mobility	Coordination / planning	Better coordination during response
Commercial fishing vessel quality	Rules & procedures	Mandatory inspections for F/V > 26′

Table 2: Examples of identified risk factors, general strategies that may mitigate those risks, and specific examples of mitigating actions.

Currently 40 ports and waterways have completed the PAWSA process. In addition to its use in the U.S., the International Association of Marine Aids to Navigation and Lighthouse Authorities has endorsed the Ports and Waterways Safety Assessment process for use in assessing waterway risk in ports around the world. The PAWSAs have been well received by local maritime communities and have resulted in some notable successes (see sidebar). Each Ports and Waterways Safety Assessment final report includes a summary of the identified risks and potential mitigations. Entities are identified to implement these actions.

The ultimate goal of PAWSA is to provide the local waterway community with an effective tool to evaluate risk and work toward long-term solutions tailored to local circumstances.

About the authors:
CDR Brian Tetreault has served in the Coast Guard for 19 years aboard several ships, at two vessel traffic services and on the headquarters and Pacific Area staffs. He graduated from the U.S. Coast Guard Academy in 1987. He holds an Unlimited 2nd Mate license and a 1600-Ton Master license.

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Endnotes:

1. 1997 appropriations bill.
2. "Summary of Guidance from the National Dialog on Vessel Traffic Services," April 1997.
3. A detailed description of the development of the model is contained in the paper "Development of a Decision Support Tool for Assessing Vessel Traffic Management Requirements for U.S. Ports," John R. Harrald and Jason Merrick, Proceedings, 7th Annual Conference of The International Emergency Management Society, May 16-19, 2000.
4. Substantial information on the PAWSA background and methodology can be found at http://www.navcen.uscg.gov/mwv/projects/pawsa.

Strategic Risk Management

An overview of selected commercial initiatives.

by Mr. Marcus Burgmann
Teekay Shipping (Canada) Ltd

Oil and gas transportation companies are exposed to a number of potentially high-impact risks. Though some of these risks are not necessarily specific to the shipping industry, they do have the potential to have significant consequences for individual companies.

Teekay Shipping has established a regular review process by which significant risks are identified and assessed. On the highest level, the most significant risks are related to:

- major oil spill / gas leakage,
- legislative compliance,
- poor operational performance, and
- reluctance of staff to identify significant issues.

In order to manage any risk effectively, it is important to have a clear understanding of those hazards that pose the greatest threat.

An Operational Strategic Framework

Teekay Marine Services (TMS) is responsible for the safe and effective operation of Teekay's assets and has created a uniform approach as to how vessels and staff are managed. The key strategies are:

- Leadership in risk management – we need to understand the risks we are exposed to and develop appropriate tactics.
- World-class asset base – we need to build good vessels and maintain them throughout their lives.
- First-class customer service – we need to be aware of our customers' requirements and be responsive to them.
- World-class staff onboard and ashore – without this nothing else is possible.
- Cost-effective operations.

Each strategy has a number of initiatives and programs associated with it, as well as key performance indicators that allow for continuous monitoring.

The strategic framework contains an organizational structure that distinguishes between dedicated operations teams that are responsible for the day-to-day operation of vessels, and standards and policy groups that are tasked with enforcing operational standards globally. Strategic projects and initiatives are typically run by these standards and policy groups, allowing them to focus on continuous improvement without being distracted by daily operational matters.

A marine operations management system combines four standards, namely ISO9001, ISO14001, OHSAS18001, and ISM. This system has been developed, based on the W. Edwards Deming/ Walter Shewhart cycle of "Plan – Do – Check – Act," which as well as ensuring a standard risk-based approach, drives a culture of continuous review and improvement.

The Environmental Leadership Program

Adherence to marine regulations has always been a top priority for Teekay; hence its focus on legislative compliance and on environmentally safe practices. These resulted in a long-term management initiative, the environmental leadership program (ELP) in 2005.

As part of the ELP, the problems associated with disposal of oil and water residues from machinery spaces were reviewed. All Teekay vessels' waste oily water treatment and disposal systems are built to comply with MARPOL regulations. Compliance however, does not address subjects like equipment quality, ease of use, reliability, maintenance, and prevention of mishandling.

To address this, Teekay retrofitted all vessels with identified upgrades. This element of the environmental leadership program is called shipboard effluent control and treatment (SECAT). The basis of SECAT is to separate the various waste streams so that they can be effectively treated by their respective equipment.

The main elements of the upgrades included:

- fitting of a tamper-proof oily water separator (OWS) oil content meter ("white box");
- tagging and logging all overboard connections to prevent unauthorized engineering changes;
- addition of a primary bilge tank to pre-separate waste and oil streams before entering the bilge holding tank;
- rerouting all drains and scuppers into dedicated tanks, instead of open bilges;
- fitting additional capacity soot collection tanks for economizer washing;
- fitting a settling tank to the incinerator system to improve pre-separation and combustion;
- fitting of mechanical seals to pumps with packed glands to reduce or eliminate the leakage water entering the bilge;
- replacing inefficient OWS with high-end centrifugal units;
- installing pre-filters to reduce the amount of solid particles entering the OWS;
- installing polishing filters after the oily water separator to further reduce the oil content of the effluent prior discharge overboard;
- upgrading existing vessels' OWS piping layouts to meet the latest MEPC107 requirements;
- replacing old inefficient incinerators with modern units with garbage handling as well as sludge-burning capacity.

Seals and tags for overboard lines and flanges prevent unauthorized engineering changes.

The above was developed and is being implemented with the close cooperation of classification societies. The primary focus at inception for SECAT was to deal with water and oily waste treatment.

It was envisaged that the program would be expanded into other areas of environmental compliance. This includes the efficient handling of garbage on board. The aim is to significantly reduce and eventually eliminate the disposal of garbage at sea. The main elements of these further upgrades include:

Oily water separator oil content meter.

- installing large-capacity compactors located outside the accommodation;
- supplying multiple compaction bins to enable separation of different waste streams;
- replacing incinerators to handle garbage;
- working with suppliers to reduce the amount of packaging delivered to the vessel.

To tie all the elements of shipboard effluent control and treatment together, a comprehensive manual is in development.

The Structural Integrity Management System

Actively managing the structural integrity of one's fleet is imperative to mitigating risks. Teekay has therefore developed a management system for hull integrity in excess of class requirements. The structural integrity management system (SIMS) has been implemented through a standardized process for structural inspections, comprehensive reports on each ship's structural condition, as well as a stringent follow-up mechanism that focuses on the close-out of necessary corrective actions.

The structural integrity management system is built upon:

- Ship inspection manuals: These manuals contain information on service experience and the results from fatigue analyses, and are specifically created for each ship in the fleet. The main purpose is to provide clear guidance on areas that require specific attention during tank inspections. Based on schematic tank plans, generic and ship-specific "hot spot" inspection areas are documented and highlighted.

Together with a set of standard inspection forms and hands-on guidelines on how to evaluate the condition of coatings, corrosion, damages, sedimentation, anodes, and outfit items; the manuals form the basis for a repeatable standard approach to inspections that helps manage risk and ensure a high level of data quality.

Ship inspection manuals are made available to all external parties that are required to inspect Teekay ships, including classification societies and port state authorities.

- Cell concept: Onboard the ship, each cell is identified by stencilled markings, which serve a dual purpose. First, they speed up the inspection process. Second, when combined with exit route markings, they enhance the safety of inspectors in complex double-hull arrangements.

The idea behind applying a cell concept to ship inspections allows each tank to be systematically broken down into logical and manageable pieces. Not only does this approach facilitate the inspection of higher-risk areas, it also allows for effective condition reporting.

- Training and service agreements: Structural inspections are carried out by both Teekay's own shipboard and shore personnel, as well as by a carefully selected cadre of specialist third-party inspectors. Third-party inspectors typically visit the ships at times of intermediate and special surveys to conduct in-depth investigations (often including thickness measurements) following standard inspection procedures.

The key to the successful implementation of SIMS has been the active involvement of sea staff in the inspection process. Senior officers are continuously being trained by third-party inspectors and through specifically developed computer-based training modules for inspections and hull structures. Increased knowledge about structural design and improved inspection skills have resulted in a strong sense of ownership and accountability for the structural condition of the ships among sea staff.

In addition, the structural integrity management system has proven to be an integral part of effectively minimizing dry-dock overruns, unscheduled dockings, and downtime due to structural reasons. This in turn builds customer confidence through strong operational performance.

Seafarer Competence for Operational Excellence
Maintaining a world-class workforce has been given a top priority in Teekay. Human error, to varying degrees, has contributed to the majority of operational incidents and accidents. With that in mind it was decided to develop and implement our own competency scheme.

The Seafarer Competence for Operational Excellence (SCOPE) program was designed to encourage continual improvement and establish a clearly defined career management structure. It conforms to DNV's ISO 9000 based SeaSkills Program, and prescribes the responsibilities and procedural methods for developing and evaluating the competence standards of Teekay seafarers beyond basic requirements.

It introduces a "continuing professional development portfolio" for all sea staff at Teekay. The industry recognized SCOPE by awarding it the Annual Lloyds List Training Award 2005.

Competencies can be broadly categorized among:

- industry-regulated (STCW) competencies;
- Teekay-specific competencies; and
- management and leadership competencies.

Currently 424 competencies, targeting 2,686 knowledge areas for tanker and liquefied natural gas operations, are applicable to every sea-going position in the fleet. Additional shuttle tanker competencies have also been developed. Since rolling out SCOPE to three ships in 2004, it is now embedded in the organization and established on 40 vessels. Plans call for it to be in place across the entire fleet by early 2008.

Considering the technical complexity of today's ships, as well as commercial and legislative constraints, the people onboard remain the critical path to managing risk by reducing probabilities of unplanned events and limiting subsequent losses.

Hence, continuously developing competencies and skills, and ensuring high levels of risk awareness will continue to be imperative. A successful risk management strategy will always have individual accountability and a sense of ownership at its core.

About the author:
Mr. Marcus Burgmann joined Teekay Shipping (Canada) Ltd. in Vancouver in 2002. During his time in Teekay's ship operations arm, Teekay Marine Services, he has worked in various roles related to technical, knowledge, and performance management. Since 2006 he has been responsible for Teekay's marine operations management system and the performance management group within the health, safety, environment, and quality department.

The Way Ahead

Operating on the Edge

With new missions, new aircraft, and new people, Coast Guard aviation is about to embark on a period of significant risk. Are we ready for it?

by LCDR Brian C. Glander, *Flight Safety Office Program Manager, U.S. Coast Guard Office of Safety and Environmental Health, Aviation Safety Division*

The history of aviation, with specific emphasis on aviation accidents and accident rates, is well documented. Whether you are looking at general aviation, the airline industry, or military statistical data, it is easy to see that the beginning of aviation was marred with frequent, tragic accidents. It doesn't take a rocket scientist to quickly come up with a few generalized conclusions to explain why the rates were so high. Aviation was new. It was untested in most areas, and was often driven with the purpose of developing new capabilities with new equipment to combat new threats.

During World War II, for example, the Coast Guard was one of the principal government agencies responsible for the testing and development of military applications for a new and experimental aircraft called the helicopter. It sounds strange to say now, but somebody had to figure out if this thing could take off and land on a ship at sea, act as an effective search and reconnaissance platform, and aid in marine rescue.

Was this a safe operating environment? No. Was it filled with significant risk? Yes. Was it something that had to be done? Absolutely! The neophyte aircrews simply marched onto the aircraft, took off from historic Coast Guard Air Station Brooklyn, learned from their successes and failures, and moved on. They were operating on the edge of their newly acquired skills, using new equipment to perfect a new mission. In so doing, they established the backbone of the service's core aviation search and rescue capability.
If these circumstances sound familiar, that's because they are. Not too long ago, Coast Guard helicopters sat on the ramp in Brooklyn, N.Y., underneath the smoke of the World Trade Towers, at the very same location where Coast Guard aviators pioneered a new capability years earlier. It became evident to our organization that the service's capabilities needed to change to protect our nation. Under the Department of Homeland Security, Coast Guard aviation is again being called upon to deliver new capabilities. This time, they are so new and so different, that they are not just being called new missions, but "special" missions. At the forefront are things such as rotary wing air intercept (RWAI), airborne use of force (AUF), and vertical delivery/vertical insertion (VDEL/VI). They are already being deployed with great success in limited capacities, but in some cases are operating concurrently with development.

In addition to the challenges of developing and remaining proficient in the new mission profiles, aircrews in the not-too-distant future will also have to do so with new aircraft. Major acquisitions across the aviation fleet within the next few years will either provide aircrews with completely new aircraft or change the existing assets to the point that they will operate "like" new. These factors, combined with the need to increase the overall size of the workforce and provide them with more specialized training, point to the simple fact that this is a period of significant risk for Coast Guard aviation.

New Missions
For decades, Coast Guard aviators have been called upon to perform legacy missions. They are the experts

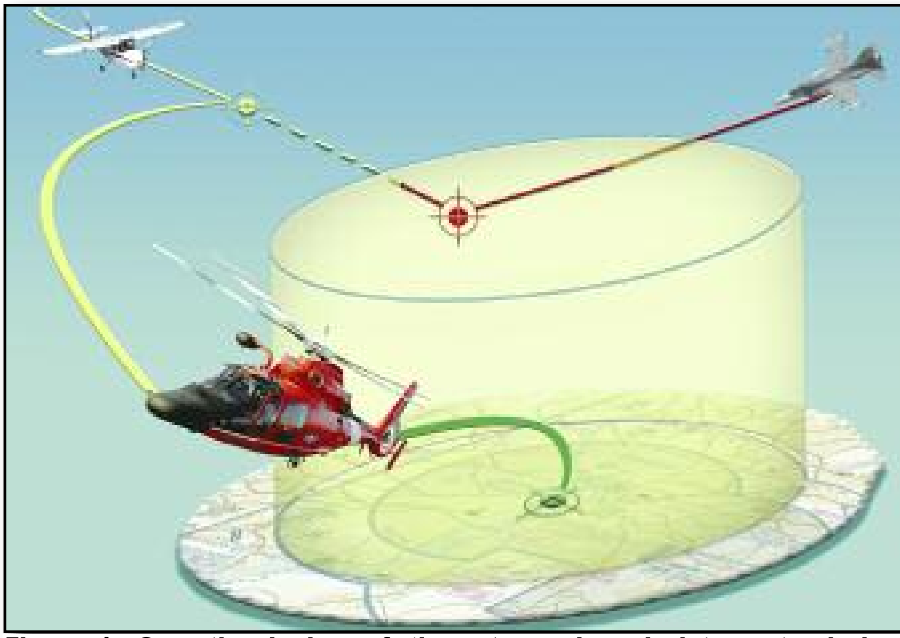


Figure 1: Operational view of the rotary wing air intercept mission. Conceptual image developed for USCG by Chris Hill of Booz Allen Hamilton.

in their field. They are proficient and confident in their skills because they are the product of proven risk-mitigation practices like centralized training and qualification and standardization. Patrolling a coastline for illegal activity, moving mission-essential equipment on a logistics run, locating a mariner in distress, or even rescuing someone from the sea would all be considered part of an exciting day's work. In the end, however, it was a somewhat finite list of things they were called upon to do. They will now be required to learn and do more. Some examples:

Rotary wing air intercept: In 2004, Admiral T.H. Collins informed the U.S. Secret Service that the use of Coast Guard helicopters to perform aerial surveillance; interceptions; queries; and escorts of low, slow-flying aircraft; as well as employment of maritime safety and security teams in our country's waterways are clearly Coast Guard core missions that will be performed when needed. After two years of successful testing, evaluation, qualification, and execution of actual rotary wing air intercept missions at several events of national significance, the Coast Guard has fully deployed the capability in the national capital region as well as several other select units around the country.

Figure 1 illustrates a simplified operational view of the overall concept of an air intercept mission. It does not, however, remotely attempt to convey the complex and demanding aerial maneuver the aircrews are required to carry out on a moment's notice within minutes of launching to intercept an airborne target. The risks associated with flying the maneuver are mitigated by a highly specialized training and qualification curriculum that is flown both in the aircraft as well as the simulator at the Aviation Training Center (ATC) in Mobile, Ala. Despite these organizational risk management mechanisms, however, the fact still remains that this is a very new mission, a very demanding mission with extreme consequences if done incorrectly.

AUF: Airborne use of force is the employment of Coast Guard aircraft weapons (Figure 2) to support counter drug; counterterrorism; and ports, waterways, and coastal security missions. It is not an entirely new concept for the organization, but in the past it was limited to two highly specialized units, the helicopter interdiction tactical squadron in Jacksonville, Fla. and the marine safety response team in Elizabeth City, N.C. Regular units are now beginning to receive a lower level of the scaled AUF qualification, and the intent is to provide the same level of qualification to the rest of rotary wing aviators in the future. It is being implemented under a deliberate and monitored training and qualification timeline, but in the end it is similar to rotary wing air intercept. The workforce will be qualified, but it will not have years of experience completing the complex tactical and gunnery maneuvering to fall back on.

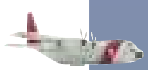
VDEL/VI: Vertical delivery (VDEL) of personnel with normal hoist procedures is a capability that all Coast Guard helicopters currently employ. The use of vertical insertion (VI) via fast roping, however, is a newer Coast Guard capability that is only being used by maritime safety and security teams in conjunction with specially qualified HH60 aircrews (Figure 3). The technique allows specialized personnel to be delivered quickly to potentially hostile environments. It is a subset of the airborne use of force capability and, as such, has the same concerns regarding risk as the new capability is expanded to more and more units. Very precise and complex maneuvering is required for vertical insertion to be completed safely, and although the qualification process is managed under a specialized syllabus developed by ATC's Aviation Special Missions Branch, it is another example of a new skill our aviators are required to master along with their standard proficiency skill base.

New Aircraft

With major acquisition plans for all Coast Guard aircraft currently underway or planned, the next few years will be the most dynamic time in recent history

Some of the Major Changes That Will Affect the Face of Coast Guard Aviation

CASA: This is a completely new fixed-wing maritime patrol aircraft for the Coast Guard inventory. All training, standardization, and implementation plans are currently being developed.



C130J: Advanced avionics and aircraft systems make this C130 a completely new aircraft for our aircrews. The process of outfitting it for Coast Guard use is almost complete.

HH60J: Major modifications to this asset include a glass cockpit that will make it seem like a completely new aircraft to the aircrew. Pending Deepwater upgrades to sensors and electronics have yet to be determined.

HH65: Currently in a major re-engining project to convert the aircraft from the HH65B to the HH65C. Pending AUF modification and Deepwater modifications to sensors and electronics have yet to be determined, but will occur within the next year.

for asset management. The deployment of new assets will be carefully orchestrated with training provided from ATC Mobile, but, as with any major changes in aircraft systems or design, the aircrews will be operating at a degraded comfort level commensurate with their time and experience in the new aircraft. That doesn't necessarily indicate they will have a slow learning curve, but it is still something that needs be considered when measuring the cumulative risk of the organization.

New People/Training

Not only will the Coast Guard be getting new aircraft, but it will also be getting more of them. Current acquisition plans call for the addition of 13 HH65 helicopters. This means that the organization will also need more aircrews.

In the enlisted workforce, more personnel can be trained and advanced faster to fill vacancies, but at some point the overall experience and time each member has working on a particular aircraft or system will be impacted. This, combined with increasingly complex systems, will make managing the workforce potentially more difficult. In the pilot world, the direct commission aviator program, which hires previously trained military aviators from other services, has usually been the mechanism for quickly incorporating new pilots into the cockpits. Although this works extremely well, it still requires years of training to produce an aircraft or mission commander, so the lag in experience will have to be managed.

Figure 2: Aviation gunners like the one pictured here will become more common in Coast Guard aircraft. USCG photo.

Training will also have to be considered within the new workforce, not only for aircraft maintenance of new systems, but also for maintaining proficiency on all of the operational missions (both new and old). The air operations manual says that realistic training within the bounds of safe propriety is essential to the successful completion of aviation missions. Coast Guard pilots and aircrew must maintain sound

Figure 3: Coast Guard members employ vertical insertion tactics from an HH60. USCG photo.

knowledge of operational hazards, emergency procedures, and aircraft systems, along with a high level of psychomotor skills to operate complex platforms safely and successfully. It goes further to explain that skills deteriorate rapidly if not exercised regularly, and it requires 40 percent of aircraft hours to be devoted to training. Will this be enough in the future? Will aircrews be required to remain proficient in legacy missions concurrently with the new special missions? The final policy decision has not been made yet, but some units are already facing the challenges of managing training and qualification of both new and old missions.

So Where Do We Go From Here?

Similar to the historic aircrews that pioneered new equipment in the development of new capabilities, the men and women of Coast Guard aviation today need to answer the call of our nation. There is no avoiding the issue. They will be required to provide homeland security, and they will have to live with all of the associated risks of new missions, new aircraft, and new people. This is not a cry of alarm, but merely a statement of fact. It is important for every member of the organization, from the top leadership to the newest member, to understand this fact before anyone goes further.

What is different this time is our aircrews are offered some protection under an umbrella of built-in organizational risk mechanisms. Whether the aircrews know it or not, things like centralized training and standardization were not always the norm. They were lessons learned over years and years of incidents and accidents. Each of the new missions is being designed and implemented with these concepts in mind. The aircrews of today are also armed with a slew of organizational risk management techniques to choose from. Whether it be a formalized risk-based decision making process to manage a new project, or a mid-mission operational risk management decision to cancel a sortie because too many factors have gotten out of their control, these are tools that have not always been around, and should not be taken for granted.

In this time of highly dynamic change within Coast Guard aviation, the traditional institutional mechanisms of managerial oversight will not always be there to watch over every decision each member makes. The workforce will also not have the years of operational experience in the new mission categories to fall back on, so it is imperative that the workforce revisit and bolster their knowledge of the tools they have already been given. Aircrews must understand the basic tenets of crew resource management and operational risk management, and be empowered to use them often enough to become ingrained in every decision they make. If they can't articulate their risk analysis for every decision they make, then they need to learn. They have the tools to stop the next accident; they just need to be assertive enough to use them.

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The Way Ahead

Protecting our Homeland

Managing terrorism risk in the maritime domain.

by LCDR James Moran
U.S. Coast Guard Office of Mission Analysis

Federal security planners are all too familiar with the critique of the *9/11 Commission Report* that noted a clear "lack of imagination" on the part of the government leading up to the terrorist attacks on September 11, 2001.[1] Although no one expects a "crystal ball" solution to predicting future terrorist attacks, federal risk managers are deeply involved in creating programs aimed at reducing this risk to our nation. A look at the Coast Guard's efforts to understand and manage terror-related risk in the maritime domain reveals a telling picture of the challenges associated with safeguarding our nation from future terrorist attacks.

The Challenges of Understanding Terror-Related Risks

The primary role of government organizations like the U.S. Coast Guard is to help protect our nation from a variety of risks. In their most basic form, risks are defined as future events that will occur at some frequency and will result in undesirable outcomes or losses. Because it is difficult—if not impossible—to eliminate certain risks, the goal of organizations like the Coast Guard is to manage them.

The Coast Guard manages many risks where historical data gives us a fairly deep understanding of expected frequency and loss. The risk associated with boating accidents in a given year, for example, is a relatively stable risk that the Coast Guard understands and manages quite well. The Coast Guard does not, however, enjoy such clarity when it comes to understanding terrorism risk.

For Coast Guard planners whose goal it is to understand the trajectory of future risks, the terrorism problem is particularly complex. The type of attack an adversary might plan today is likely much different from an attack that might be attempted in 10 or 20 years. The Coast Guard, like other government stewards, must address current and more probable threats, as we simultaneously contemplate a future landscape where terrorist capability and intent to carry out more catastrophic attacks may increase. In the final analysis, we will probably never be able to make such assessments without a fair—if not significant—degree of uncertainty.

The scale of damage that would result from a given terrorist attack is another significant challenge in understanding terrorism risk. Although localized assessments and sophisticated models go a long way in shedding light on some of these consequences, it is often most difficult to predict the secondary, or "cascading" damage that an attack might render. Damage to our national economy and broad-based impact on our larger national systems, such as our maritime transportation system, for example, are often difficult to foresee. That being the case, overall consequence analysis can be helpful in deciding what terror-related risks should draw the focus of our national priorities.

Weighing the relative importance of the different consequences of a terrorist attack is also a difficult undertaking. Comparing expected losses of life with other consequences such as economic loss or environmental damage requires a detailed understanding of national values or "risk preferences." Currently, it is not even clear how much an agency should pay to eliminate the risk of a lost life due to terrorism—a key figure in performing cost-benefit analysis. Agencies historically assign different monetary values to such losses, largely because society has shown a willingness to assume different costs for different types of loss. Historically, these preferences evolve over time, but values for losses associated with terrorism are not yet available.

The Challenges of Managing Terror-Related Risks

An imaginative approach to managing terror-related risk in the maritime domain does not mean the Coast Guard can service every imaginable terrorist risk with all imaginable means. Of course, the realities of limited government budgets and our faithful commitment to support free and open markets—not to mention the personal civil liberties of our citizens—severely limit our options for such an approach. Instead, risk managers must balance competing demands with a well-informed picture of the relative value of servicing some risks over others.

When choosing between the potential programs that would reduce terror-related risk, the expected effectiveness of one investment versus another further complicates our goal of managing risk. One issue in judging effectiveness centers on the adaptive nature of terrorists. Even if a given measure is initially deemed effective, how long would it remain so before terrorists are able to defeat or avoid the measure? Some investment choices might be expected to retain effectiveness for longer periods than others. What are the critical questions that we should be asking? Clearly, some of the questions cannot be answered until we have a clearer understanding of several factors.

The issue of effectiveness is also inextricably linked to the concept of deterrence. In one sense, a given security program or measure can be effective by either directly intervening to halt the progression of an attack already in progress, or reducing the consequences of the attack once it occurs. In another sense, a program or measure may be effective in that the mere presence of it deters a terrorist from actually choosing to attack. The U.S. Office of Management and Budget, however, has been quite critical of many government efforts that have tried to quantify effectiveness due to deterrence. This is because there are many complex factors involved in the practical application of such theories, not the least of which includes the requirement of having a detailed understanding of terrorist behavior, goals, and the terrorists' tolerance for accepting risk of failure.

We know, for instance, that many terrorists are willing to give their lives while carrying out an attack. However, what attacks would they be willing to attempt if they feared they would not succeed in their objective? What parts of their objectives are most important? Is it foolishly myopic to assume there is some calculable "center of mass" of the risk tolerance we can assign to individual terrorists? Does that tolerance change for different types of attacks? Is it dependent on the intended target? Does it vary by terrorist organization? If we can somehow understand these issues, do we have to assume that the same terrorists will just find another type of attack to carry out? If we cannot take all of their options off the table can we absolutely deter terrorists anyway? There are many social science and "game theory" methodologies that might be effective in answering these questions. Getting the right mix of experts or focus groups together to employ some of their approaches is indeed challenging.

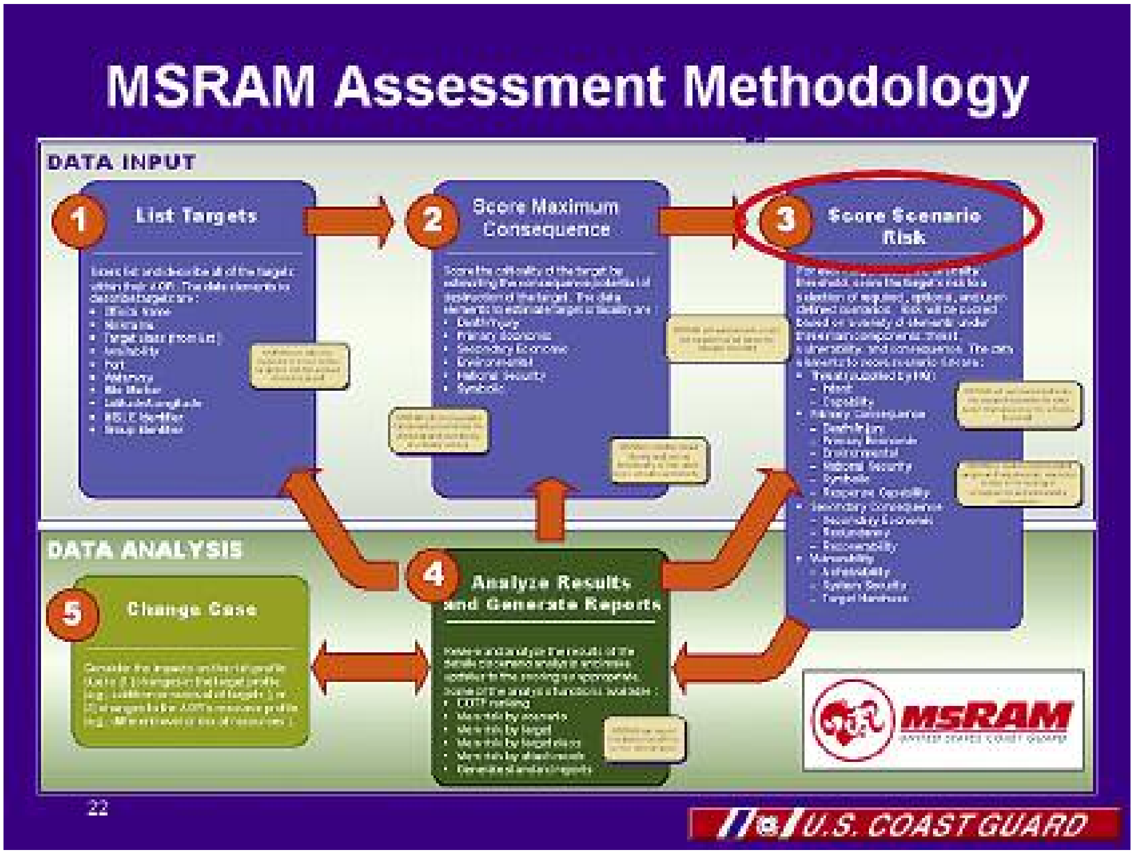
Another significant challenge in combating maritime terrorism is the time it takes to implement new programs, partnerships, authorities, and technologies that are deemed effective in reducing terror-related risk. Landmark legislation such as the Maritime Transportation Security Act takes several years to develop and implement, even in the exigency that exists in the post-9/11 era. Even greater time is needed to fully support programs that call for the construction of new assets.

When making investment choices, the Coast Guard faces significant uncertainty due to rapidly evolving, and, at times, untested technology. Aside from the uncertainty of future system effectiveness, there is also the added challenge of determining the ultimate costs of these alternatives. Such is the case with certain weapons of mass destruction detection technologies, biometric devices, and national sensor and integration systems.

Embracing Challenges

Despite the significant nature of the challenges associated with understanding and managing terror-related risk in the maritime domain, the Coast Guard is recognized as an innovative and proactive agency in the Department of Homeland Security. With the rich history and culture of risk management expertise developed and employed for its legacy missions before 9/11, the Coast Guard was relatively well positioned to make substantial strides in strategic terrorism risk management.

To better understand terrorism risk, the Coast Guard has convened multiple subject matter expert groups to perform strategic risk assessments for the maritime domain. Utilizing the rich data collected from the Maritime Security Risk Assessment Model (MSRAM), as well as strategic threat data (specifically developed and requested for this purpose) from the national intelligence community, the Coast



MSRAM assessment methodology.

Guard has identified a comprehensive group of terrorism planning scenarios that serve to guide ongoing strategy development and planning.

This effort effectively annualizes near- and longer-term risks, using appropriate sensitivity analysis to understand what scenarios should dominate our strategic planning efforts. In addition, the Coast Guard is currently developing a terror-related risk map, which will geographically represent the relative risk densities associated with these planning scenarios, in order to better understand and manage terror-related risks.

The Coast Guard has also recently convened subject matter expert groups to judge the expected effectiveness of various risk management alternatives, for both near- and long-term planning horizons. Alternative programs and investments were rated for effectiveness across the suite of planning scenarios, showing meaningful differentiations between varieties of alternative investments. Although more precise costing information has yet to be obtained for some of these alternatives, future iterations of this approach should yield a clearer picture of where the Coast Guard should focus its strategic efforts to combat maritime terror.

The Ultimate Goal

Unlike the traditional risks the Coast Guard has managed so well for so long, terrorism will continue to change as terrorists adapt. Although the Coast Guard has made great strides in reducing terror-related risk in the maritime domain, the ultimate goal of strategic planners will be to create an ever-improving process to understand and manage this problem.

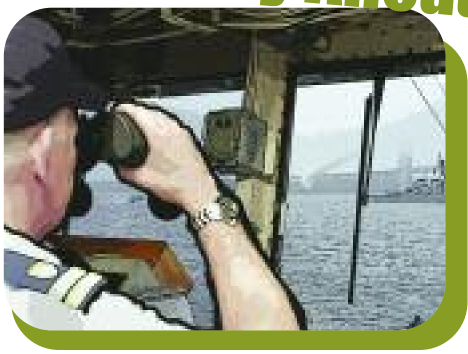
In order to meet this changing threat, the Coast Guard must continue to combine its traditional strengths with innovative approaches and imagination. Indeed, to make the nation safer today means that we must continually endeavor to understand and manage the dangers of tomorrow.

About the author:

LCDR James Moran is a graduate of the U.S. Coast Guard Academy and is a Coast Guard cutterman. He has also served on special assignment to the CIA, and earned his M.S. with a focus in Risk Management from George Washington University. Currently he is an analyst in the Coast Guard's Office of Mission Analysis.

Endnote

1. http://www.9-11commission.gov/



The Three Rs of Management

Risk, readiness, resources.

by Mr. Frank Wood
Deputy Chief, U.S. Coast Guard Office of Performance Management and Decision Support

Education in 19th century America focused on the three "Rs"—"reading, 'riting, and 'rithmetic." The fundamentals of Coast Guard management in the 21st century are also the three Rs, but in this case they stand for risk, readiness, and resources.

A main focus of our maritime strategy is minimizing or managing risk in the maritime domain. To do so, we must maintain operational readiness by recruiting and training people; acquiring and maintaining operating and other capital assets; and providing policy, plans, and guidance. All of these activities consume resources for which we are accountable to the American public. Managing these three Rs is fundamental to continued success delivering public services.

Goal-Focused Management

Risk is an expectation of loss over time. As an anticipated loss, it is relative to a goal or desired outcome. Where goals are fuzzy or poorly articulated, risks are hard to define and measure.

Risk is always expressed in terms of the likelihood, or probability, that a bad event will occur and the expected consequences, or severity, of the outcome when it occurs.

Risk is an expectation of loss over time.

The phrase "risk management" suggests a process that prevents adverse events from occurring or minimizes the adverse effects of those events when they do occur, despite our best efforts to prepare for or prevent them. Risk management, however, is not so much a process as it is good performance management. To use an analogy, if a person tried to "manage" his weight, he could change his diet to eat more, less, or different foods; exercise more or differently; and then climb on the scale to see if he is successful. It is the work we do that influences weight, risk, or any other goal.

Similarly, much of what we do as members of the Coast Guard to manage risk is actually performance management with a risk-sensitive purpose. We work to prevent events that would diminish the achievement of our goals (thereby reducing the likelihood we will achieve them) and to minimize the consequences when they occur, despite those efforts.

Readiness is related to risk. It is a measure of the authorities, capability, and capacity to perform work. During and after implementation of the Government Performance and Results Act of 1993, the U.S. government's focus on performance has generally been on outcome-oriented public goals such as maritime safety, environmental protection, national defense, etc. When talking about goals, however, the Government Performance and Results Act specifically refers to "general goals and objectives, including outcome-related goals and objectives, for the major functions and operations of the agency."[1] While not a public outcome goal, readiness is still a general goal of an agency. If we're not ready to deliver public services, how can we do so?

As citizens, we pay taxes that support local fire departments by maintaining their ability to respond to and extinguish fires that threaten our lives and property. Even while doing so, however, we simultaneously hope the fire department never has reason to visit our homes. We are willing to pay for the fire department's readiness, because we recognize there is some probability (even if small) that our home might burn. We buy automobile and catastrophic health insurance and hope we'll never need them. Similarly, the public is ready to pay for the federal government's readiness, particularly military readiness, so long as our services may be needed.

Commandant of the U.S. Coast Guard ADM Thad W. Allen has committed the Coast Guard to "source to strategy." [2] He has thereby linked Coast Guard strategy to readiness.

Linking Resources to Goals
To improve the way we do our business, we must understand how the work we do consumes resources, influences public outcomes, and creates public value.

Aligning work activities to their purpose. Several years ago, the U.S. Coast Guard Office of Planning and Resources began an effort to identify the data and measures needed to improve management of the maritime safety, security, and environmental protection programs. This effort led to the adoption of a performance logic model (PLM) to establish the relationships between Coast Guard goals and the work we do to achieve them.

Performance logic models define and establish the relationships between resource consumption, work processes, and activities; the outputs (products and services) they produce; and the outcomes those outputs influence. The process of building a PLM (Figure 1) requires us to ask and answer questions about what we do as well as why and how we do it.

An "activity" begins with a verb, has a definable beginning and end, and contributes to an identifiable output.

The foundation elements of the performance logic model are discrete work activities. An "activity" begins with a verb, has a definable beginning and end, and contributes to an identifiable output. Activities include: inspect, board, interdict, prepare, train, recruit, purchase, manage, respond, communicate, etc. The list of discrete work elements is an activity dictionary. Work activities and processes produce outputs in the form of goods and services. An "output" is a noun—a plan, report, license, certificate, completed response, or other product or service. The output dictionary is called the catalog of products and services.

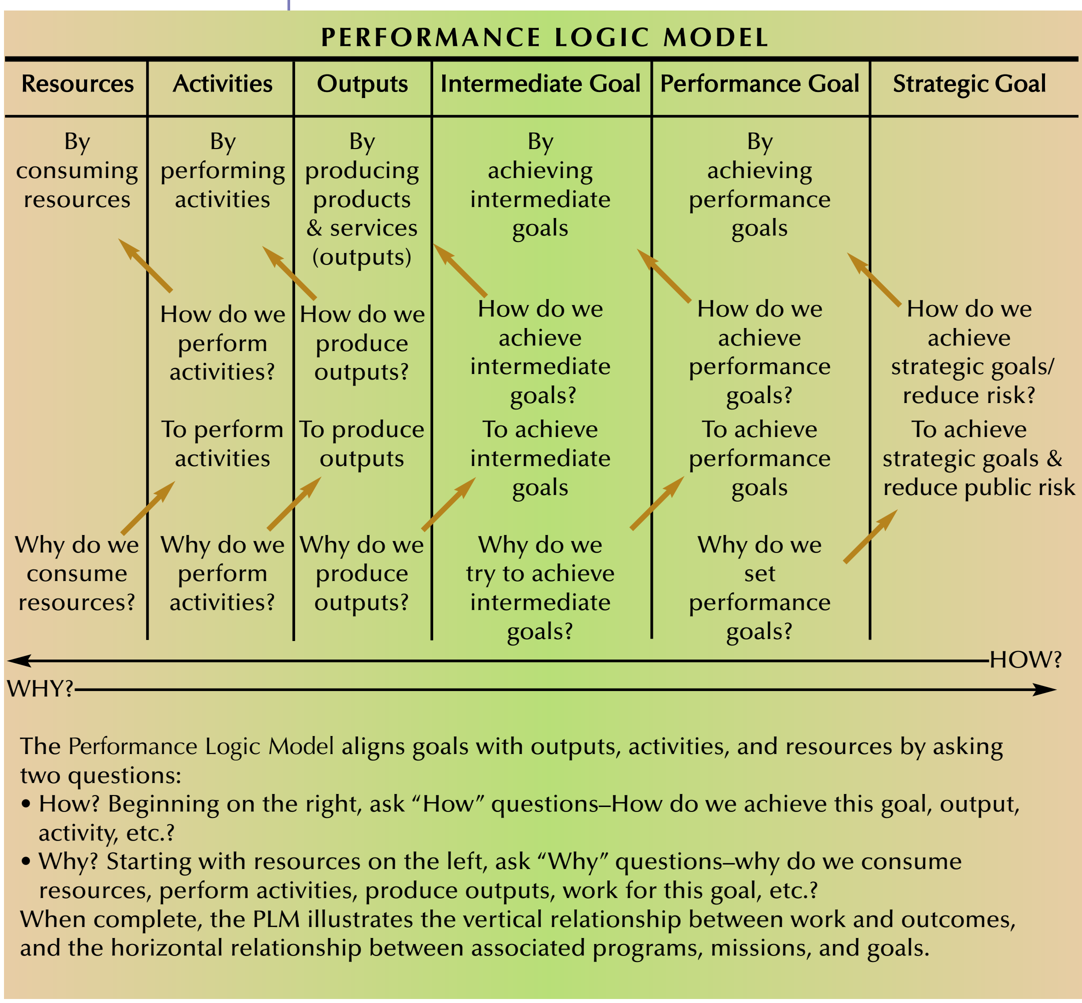


Figure 1: The performance logic model aligns goals with outputs, activities, and resources by asking two questions: • How? How do we achieve this goal, output, activity? • Why? Why do we consume resources, perform activities, produce outputs, work for this goal?

To use the PLM, begin from the right side by asking "how" questions. For instance: How do we achieve strategic goals? Answer: by achieving performance goals established by the organization. Or begin from the left side, and ask: Why do we consume resources? Answer: to perform purposeful activities. Establishing the cause-and-effect relationships between work and purpose is necessary for authoritative strategy development.

The next step is to measure the work we do and its influence on outcome.

Activity-based management and costing. Activity-based management (ABM) and activity-based costing (ABC) are techniques that enable systematic, transparent, and goal-focused management. The ABM/C cross (Figure 2) developed by the Consortium for Advanced Manufacturing International, shows the relationship between ABM and ABC. ABC is the vertical component, ABM the horizontal. The "hub" is activities—the work our organizations do.

Cost is a performance metric; it measures resource consumption per work activity or unit of output.

Cost is a performance metric It measures resource consumption per work activity or unit of output. No management decision is fully informed without an understanding of relevant cost, or the resources associated with taking some action. Costs alone, however, are not sufficient.

Implementation of an activity-based costing methodology has failed in most of the organizations that have attempted it. The primary reason for this appears to be a focus on cost management, unrelated to other nonfinancial performance metrics. The phrase "cost management" suggests that the chief financial officer and the budget office are hunting for resources, thereby suppressing the kind of organizational transparency that activity-based costing is designed to provide. Cost information must be integrated with, and considered as part of, an overall performance management system.

Three performance metrics—efficiency, effectiveness, and cost-effectiveness—usefully inform leaders and managers about the value of the work we're performing. More importantly, they facilitate Coast Guard planning, budgeting, and execution to create greater value for the American public.

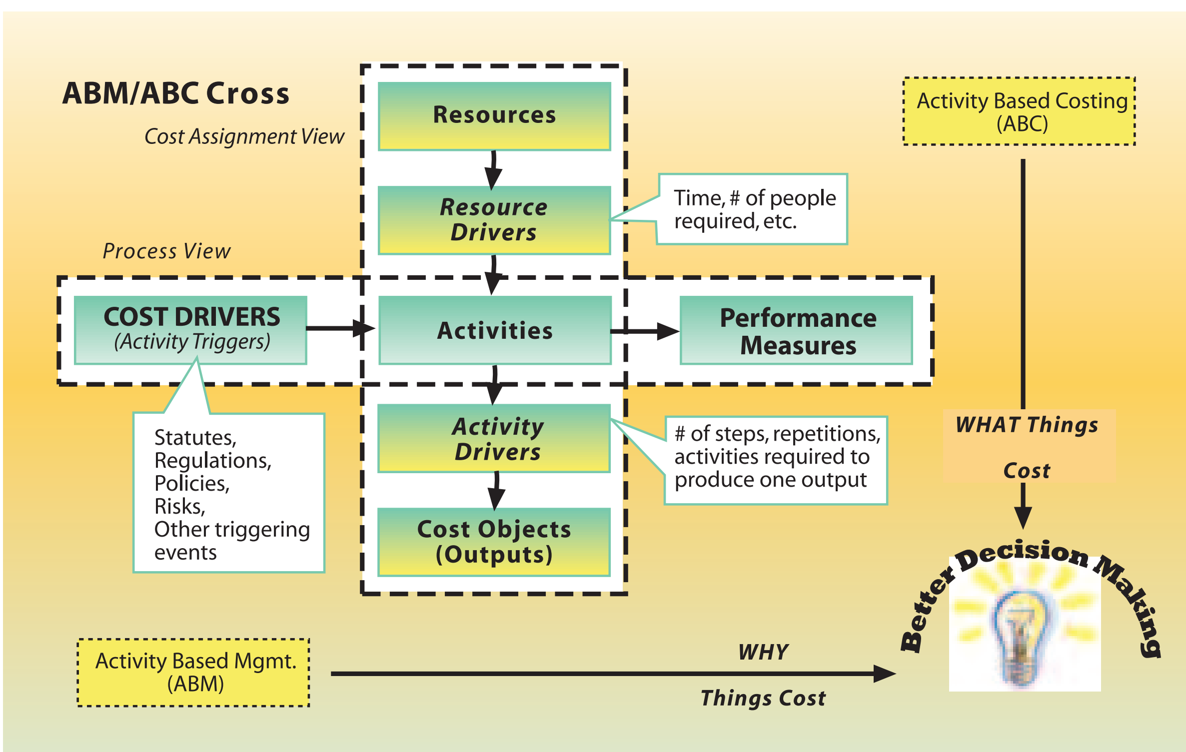


Figure 2: Courtesy of the Consortium for Advanced Manufacturing International.

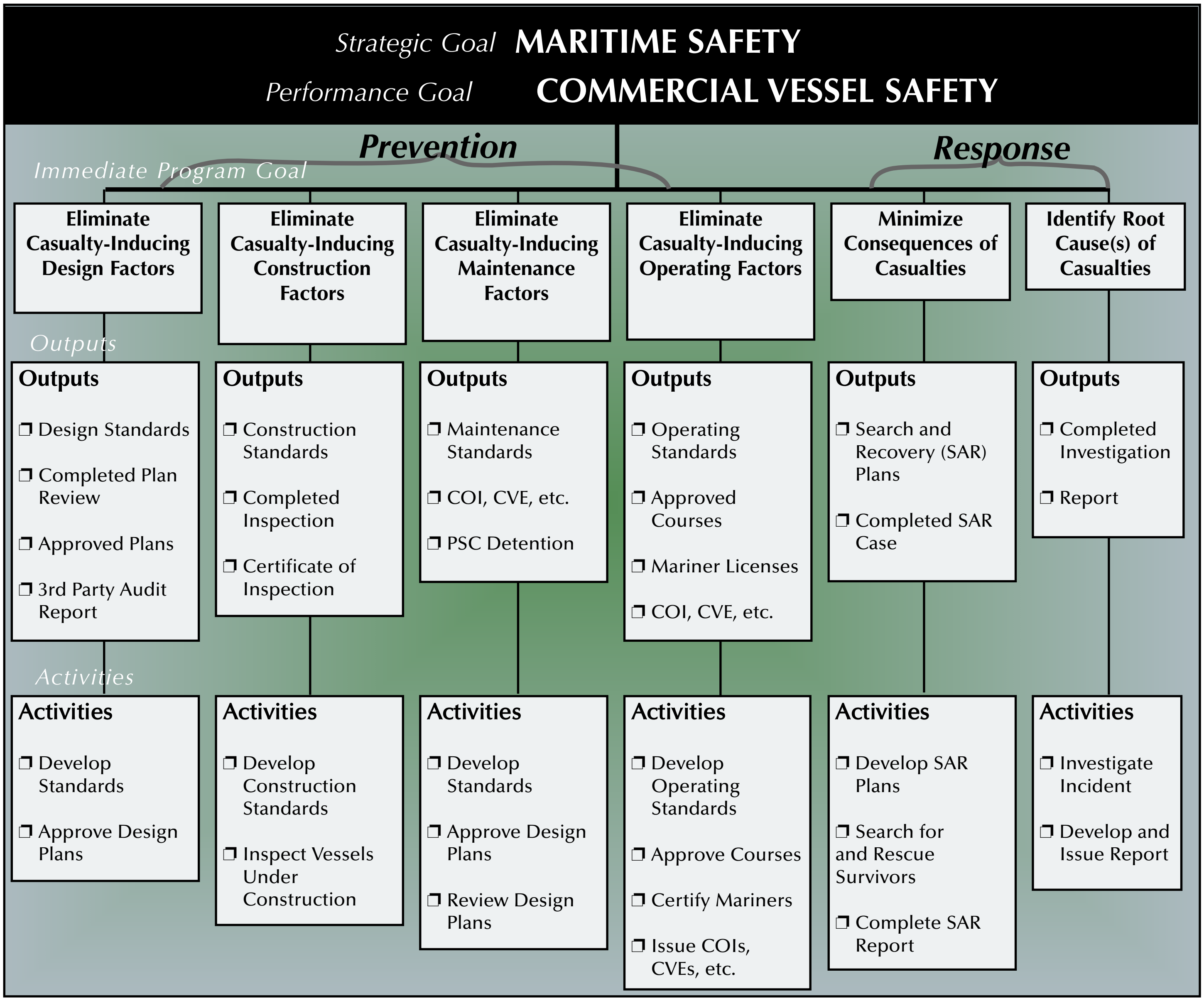


Figure 3: USCG Maritime Safety Performance Logic Model.

Measurement. We can't manage what we don't measure. Decision making is the fundamental role of a manager. Managers make decisions with the best information they have available. Effective, objective, and systematically derived measures are basic necessities for managing to optimal performance.

The Coast Guard continues to collect a great deal of data, but it is not always sufficient to measure and manage the work we do for the American public. While we work to minimize the data burden and maximize its value, too often information is not shared across program boundaries. In addressing this phenomenon in the federal government, the 9/11 Commission stated in its 2004 report that our separate "agencies are like a set of specialists in a hospital, each ordering tests, looking for symptoms, and prescribing medications. What is missing is the attending physician who makes sure they work as a team" to cure the patient.[3]

The Coast Guard understands these problems and has begun substantive change to ensure that the business of management is the business of all Coast Guard personnel. To help us select the right information, the performance logic model provides a "skeleton" (Figure 3) for selecting appropriate measures of:

- efficiency,

- effectiveness,
- cost-effectiveness.

Each step in the PLM is causally related to the steps above and below it. The types of measures for each are separate but related.

- Activity and output measures are primarily efficiency measures, including cycle time, cost/unit, etc. While performance effectiveness is the primary measure of how well we achieve our public purposes, the stewardship of public resources is also important. There's no reason to consume more resources (financial, labor, material) than necessary to do our job.
- Outcome measures look at results to determine effectiveness and cost-effectiveness. If the immediate goal of an output is to change a behavior, influence a decision, or prevent something from happening, our measures should help us determine whether we changed, influenced, or prevented something.

Managing the 3Rs RRR

Coast Guard leadership supports various initiatives that are aligned with the 3R (risk, readiness, resources) concept. While the logic of these various initiatives is easy to understand, there are many challenges to implementation that lie ahead.

These challenges include:

- adapting various Coast Guard taxonomies into one composite library, so that words mean the same across the entire Coast Guard,
- establishing a Coast Guard enterprise architecture that fully meets Coast Guard needs and aligns with federal enterprise architecture,
- developing and using web-enabled risk management and activity-based costing systems fully aligned with the Coast Guard enterprise architecture and other major decision-support systems that use the same activity-based metrics and nomenclature, and that are supported and valued by the users.

- Lagging (also called "trailing") indicators are used to report on results (past effectiveness). Using them alone to plan ahead, however, is like driving a car by looking through the rearview mirror.
- Leading indicators are environmental trends, trends in triggering events, anticipated costs, etc.

The primary measures are those that help us manage and optimize performance. They are based upon data that is systematically selected, captured, and analyzed to help us learn and decide how best to manage.

ADM Allen's message on the Coast Guard's 216th birthday summed up the Coast Guard's history of assuming new responsibilities and adapting to new requirements:

"The world has changed dramatically since 1790 and continues to change with every day. The global war on terrorism, the Maritime Transportation Security Act, The Homeland Security Act, the National Strategy for Homeland Security, and the National Strategy for Maritime Security have given the Coast Guard additional areas of mission emphasis. Meeting those new maritime security demands, while sustaining the trust and confidence of the public we serve in preserving our maritime safety and exercising our maritime stewardship duties, requires us to continually challenge ourselves and improve the way we do business." [4]

About the author:
Mr. Wood is the deputy office chief of the U.S. Coast Guard Office of Performance Management and Decision Support. He is a primary facilitator for Coast Guard business transformation to a systematic, transparent, integrated, enterprise-wide, and goal-focused management system. Mr. Wood attended the Federal Executive Institute in Charlottesville, Va. He has a Bachelor's degree in Liberal Arts from the University of Illinois and a Master's degree in Business Administration from Texas A&M University. He retired from the U.S. Navy Reserve as a special operations officer.

Endnotes:

1. Available at http://www.whitehouse.gov/omb/mgmt-gpra/gplaw2m.html.
2. "Source to Strategy" – Commandant Memo 7110, November 8, 2006.
3. Page 353 of the 9/11 Commission Report, available at http://www.9-11commission.gov/report/911report.pdf.
4. ADM Allen's All hands e-mail of August 4, 2006 is available at http://www.uscg.mil/comdt/all_hands/message4.asp.

Survey available online:
www.uscg.mil/proceedings

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PROCEEDINGS Magazine, Spring 2007

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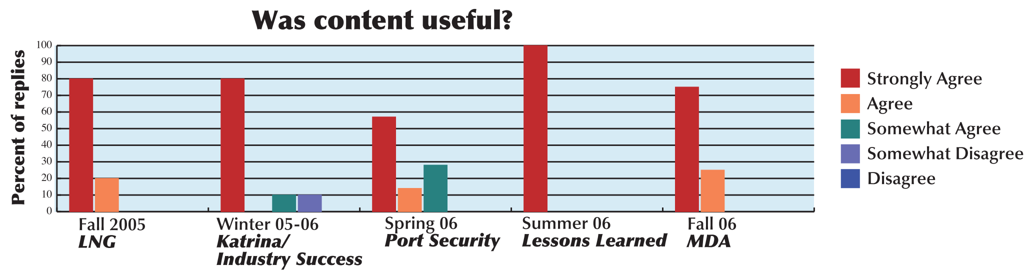

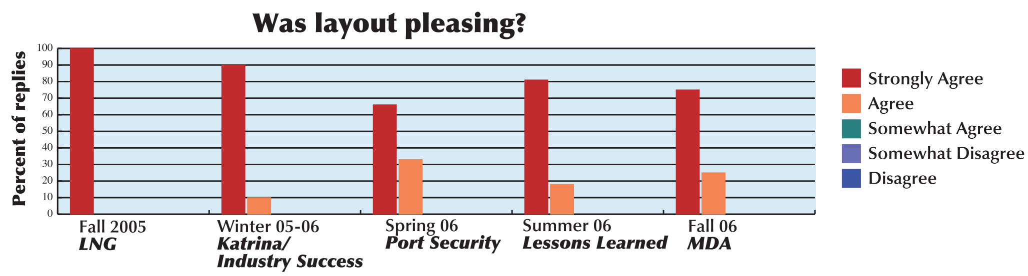

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Keep up the good work. More on ports & harbor security. Spring 2006

I would like to read about real-life action or incidents regarding security, criminal activities, violations of rules & regulations, etc. and the investigations, disposition, or end results of these kinds of matters. In any case, the magazine is still of great interest to me. Spring 2006

The ICS/NIMS issue is excellent. I trust the subject will be kept up to date and in the eye of the reader going forward. Winter 2006-07

Your format is both stimulating and well thought-out. The content is informative and balanced. In a society where the mainstream media seems to crave sensationalism and negativism, Proceedings *exemplifies the humble efforts of the hard-working men and women of the U.S. Coast Guard. Keep up the good work. P.S. Cool cover.* Spring 2006

Enjoyed this issue as casualty investigations provide hard-to-learn real-world situations concerning seamen, ships, equipment & rules. Would like more (many more) casualty reports, causes and conclusions and more interesting reading to your non-Coast Guard (and retired USCG) readers. Summer 2006

How about a regular column on casualty investigations and prevention? Single-topic issues are really boring! Winter 2006-07

Would like to see a little more on seamanship and seaworthiness, and maybe a little less on homeland security and law enforcement. I'd also like to see you bring back the "Chemical of the Month" articles. They were most informative, and most were real eye-openers. Fall 2006

There is a fine balance of many topics of interest. Continue with vessel casualty articles. Summer 2006

Gentlemen: wanted to pass on a "Well Done" for the Summer 2006 edition of the Coast Guard Proceedings*. You have many fine articles in your publication, but Summer 2006 was a very special "cover to cover read" for me. The items pertaining to "Lessons Learned" were outstanding and in greater depth than most marine casualty accounts from commercial publishing sources. Keep up the great work.* Summer 2006

Keep hammering away on intel and fusion. A little case study on a positive operational result from actionable intel would be great. (Fall 2006) was way too much data all at once. Every article should be required reading for every commanding officer and those who aspire to command, but it took me two days of concerted on-and-off reading to get through it. Help us get through it in bite-sized chunks or perhaps disseminate the Cliff Notes version via CG Central or Homeport. This sheer volume of reading at the field level is overwhelming and will most likely go unread at the field level. Fall 2006

I'm involved with smaller vessels (T-boats and uninspected.) However I found every article in the summer issue has a lesson on safety or training I could relate to. The glossy cover is attractive, however I find glossy pages difficult to read. They reflect light so I'm constantly tilting the pages to reduce glare. Non-reflective pages would be easier on the eye (and perhaps less expensive.) Summer 2006

"

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Comparing Apples to Apples

A risk-informed approach to agency-level budget planning.

by LCDR Michael Glander
Performance Analyst, U.S. Coast Guard Office of Mission Analysis, Planning and Policy Directorate

In 1940, political scientist V.O. Key asked the seminal question, "On what basis shall it be decided to allocate 'X' dollars to activity 'A' instead of activity 'B'?" [1] The question is relevant today, with respect to the discretionary budget authority of multimissioned government agencies—agencies like the Coast Guard that have many customers and partners.

Does the nation need more search and rescue or more security patrols? More buoys or more inspections? Predictably, the answers to these questions vary widely among stakeholders. In the language of performance management, the questions become more sophisticated but no less easy to answer. For example: Given the costs of things, should we invest to increase our rescue rates by 'A' % next year, or aim to remove 'B' % more cocaine from smuggling zones?

These are difficult questions to answer at the agency level—little wonder, then, that the Coast Guard has instead focused its effort on creating win-win approaches to performance, such as investing in multimissioned assets, creating a well-rounded workforce, and stressing flexibility in the field.

Recently, the Coast Guard, like the Department of Homeland Security (DHS), has attempted to pick up Key's gauntlet, by suggesting that public risk reduction is a sound basis for informing agency budget development. The Coast Guard's Office of Mission Analysis, in partnership with ABS Consulting, and under the guidance of the office chief for performance management and decision support at Coast Guard Headquarters, has developed an approach that measures the value of different Coast Guard outcomes using the same yardstick: public risk reduction. Instead of considering investment options across the breadth of different outcome types, the Coast Guard is beginning to compare apples to apples.

Assessment

Step 1: Name the undesirable incidents and scenarios within purview that cause public loss.

This was not a difficult task for the Coast Guard, but it did require a review of statutory mandates, roles, and missions. Not surprisingly, planners rediscovered that not all of the organization's outcomes strictly involve mitigating public loss. Polar icebreaking, for example is more about enhancing a public good, vis-à-vis scientific understanding, than it is about countering negative incidents. Outcomes like these, which are exceptions for the Coast Guard, were considered separately, rather than forced into the risk paradigm.

In creating the list of undesirable incidents, the goal was to name a manageable number of different events responsible for the majority of expected public loss. Figure 1 lists the incidents the Coast Guard strives to

This article explains how the Coast Guard created profiles of residual public risk, over which it has influence (the assessment), and describes how these profiles were applied to the budget planning process (the application). It is presented in a manner that leaders or managers contemplating the same approach might find useful. The terms "risk" and "expected public loss" are used interchangeably throughout.

- Groundings
- Collisions / allisions
- Flooding / sinking
- Maritime mishaps: injury, illness, or death
- Fire / explosion
- Direct terrorism attacks on maritime infrastructure of transportation system
- Transfer into the nation of terrorists
- Transfer into the nation of weapons of mass destruction
- Drug smuggling
- Entry of illegal migrants
- Invasive species introduction
- Attack on the U.S. by a nation state
- Oil spills
- Discharge of sewage or debris
- Accidental release of hazardous materials
- Domestic illegal fishing
- Encroachment into the U.S. exclusive economic zone (foreign illegal fishing)
- Damage to marine species caused by marine operations
- Seasonal conditions that affect traffic flow
- Interruption of military operations
- Periodic or expected natural disaster
- Maritime incidents that affect waterway mobility
- Other incidents that affect waterway mobility

Figure 1: The list of undesirable incidents that are responsible for the majority of public loss.

prevent outright, protect the public from, or mitigate the consequences of, should they occur. Each received its own risk profile.

Step 2: Decide the scope of the risk assessment.
In its National Maritime Strategic Risk Assessment (NMSRA), Coast Guard planners wanted profiles that described the risk outlook for the next five years, to correspond with its five-year Department of Homeland Security budget. The profiles were to describe the residual risk in the maritime domain—that loss which was still expected to occur, despite the existence of the Coast Guard and other government and private sector programs that manage maritime risk. Lastly, planners wanted profiles that described only the types of risk that the Coast Guard was responsible for mitigating (in other words, the risk over which the Coast Guard has influence).

This notion of "risk ownership" was considered for each incident. In general, if the Coast Guard had significant regulatory or response authority in a given area, it claimed ownership of all of the risk for associated incidents (such as groundings and collisions). Where risk mitigation was clearly and substantially shared with other agencies, yet methods for discreetly separating responsibility were lacking, planners discounted Coast Guard risk ownership by some reasonable percentage—as in the case of drug smuggling risk, which is shared with U. S. Customs and others. This is one feature of the assessment that will benefit greatly from stakeholder and partner review.

Step 3: Create a consequence scoring mechanism that equates different types of public loss.
Building on work from previous, smaller-scale assessment efforts, planners fused existing versions of maritime consequence scoring charts and expanded this for use across all agency outcomes. It was then reconciled with the Coast Guard's MSRAM and reviewed by leadership. Shown is a portion of this scoring chart (Figure 2).

Each category column describes types of public loss assumed to be the same rough order of magnitude. The values in the top row represent the proxy values of loss where "1" equates to $1 million in monetary loss. Incidents thought to cause multiple types of loss (such as death and economic loss) would be represented by the sum of those loss types.

Organizational leadership must be comfortable with the inherent value judgments contained in the scoring mechanism—and yet comfort should not come overnight. The Coast Guard has recognized the importance of very carefully describing, quantifying, and equating the different maritime manifestations of public loss, and has committed itself to continuous improvement of its scoring tool, which is so vital to the assessment process.

Step 4: Decide, for each incident, the best way to estimate and represent the risk.
Previous Coast Guard risk assessments had focused mainly on safety-related incidents: sinking and flooding incidents, personnel mishaps, etc. These relatively discrete occurrences lend themselves to fairly straightforward risk estimation, by which their expected annual frequency (e.g. 52 for weekly) is multiplied by the magnitude of their consequence.

This method was a poor fit, however, for other Coast Guard missions in which the occurrences causing public loss are far more vague and defy the ability of planners to enumerate. Drug smuggling, for example, ultimately causes public loss that unfolds contin-

Consequence Scoring Table			
Impact Types	Category 1 0.155	Category 2 1.65	Category 3 16.5
Death and injury	No deaths; 1 life-threatening injury	No deaths; >1 life-threatening injury	One to 9 deaths and others with life-threatening injuries
Direct economic loss (including property damage)	$10,000 to $299,999 in damage/loss	$300,000 to $2.9 million in damage/loss	$3 million to $29 million in damage/loss
Environmental (Oil)	< 15 barrels spilled	15 barrels < 150 barrels spilled	150 < 1500 barrels spilled

Figure 2: A portion of the consequence scoring table from the National Maritime Strategic Risk Assessment.

uously in manifold ways: broken or strained families, productivity loss, crime, etc. In these cases, the Coast Guard worked from the top down, by examining scholarly and official studies that estimated total societal impact of drug abuse—and then assuming a societal loss value for each 1 kg of cocaine smuggled through the maritime transit zone. Another example is terrorism-related risk, the estimation of which also included vulnerability factors, in keeping with what have become standard DHS methods for assessing terrorism risk.

Step 5: Assess the risk.

For many traditional risks, the incident frequencies indicated by historical data were a good place to start, as in the example of oil spills. Here, experts and program managers needed only to judge whether the expected future frequency would be different, and why. To calculate the terrorism risk to maritime critical infrastructure, planners used the Maritime Security Risk Assessment Model vulnerability information provided by field commanders. For the catastrophic "transfer scenarios"— in which the maritime domain is the entry point for weapons of mass destruction and terrorists— planners took advantage of all available studies and research. In all cases, assumptions about threat frequency were made using the best available intelligence.

Results were communicated to managers at all levels of the organization, assumptions were carefully reviewed, and iterative changes were made. The following profiles resulted (Figure 3). Note that the colors of the profiles denote the consequence severity of the incidents that comprise the risk. The risk can also be displayed in more detail, in ways meaningful to Coast Guard managers: by vessel or facility type, or in some cases, by initiating cause.

Application

Step 1: Perform a secondary analysis. Determine what the results should mean for the agency.

The Coast Guard had the goal of creating a risk-informed budget submission. This first required coming to terms with the limitations of its risk assessment:

1) The risk profiles by themselves could not tell managers where to invest. To maximize risk reduction return-on-investment, an agency must understand the sensitivity of different types of risk to its interventions. Though it might be tempting to simply shovel resources to the highest risk, this could quickly become wasteful.
2) Likewise, the risk profiles did not immediately indicate where it would be safe to scale back. Because the risk profiles only showed residual risk, they provided no information about how much a particular risk profile might suddenly increase if interventions were decreased.
3) Lastly, the profiles did not come with labels that indicated whether the different risk levels were acceptable or unacceptable in the public's mind. Various factors apply here, not least of which are public expectations about the government's role. For example, would America have the Coast Guard focus equally on ferry commuters, who expect to be protected from terrorist attacks; as on recreational boaters, who voluntarily engage in activities in a riskier environment?

Coast Guard managers focused on these weighty issues during a dedicated planning phase, while analysts assisted by studying the estimated sensitivity of risks to Coast Guard activities.

Step 2: Determine where public risk reduction fits among other budget proposal criteria.

Other criteria besides public risk reduction must be

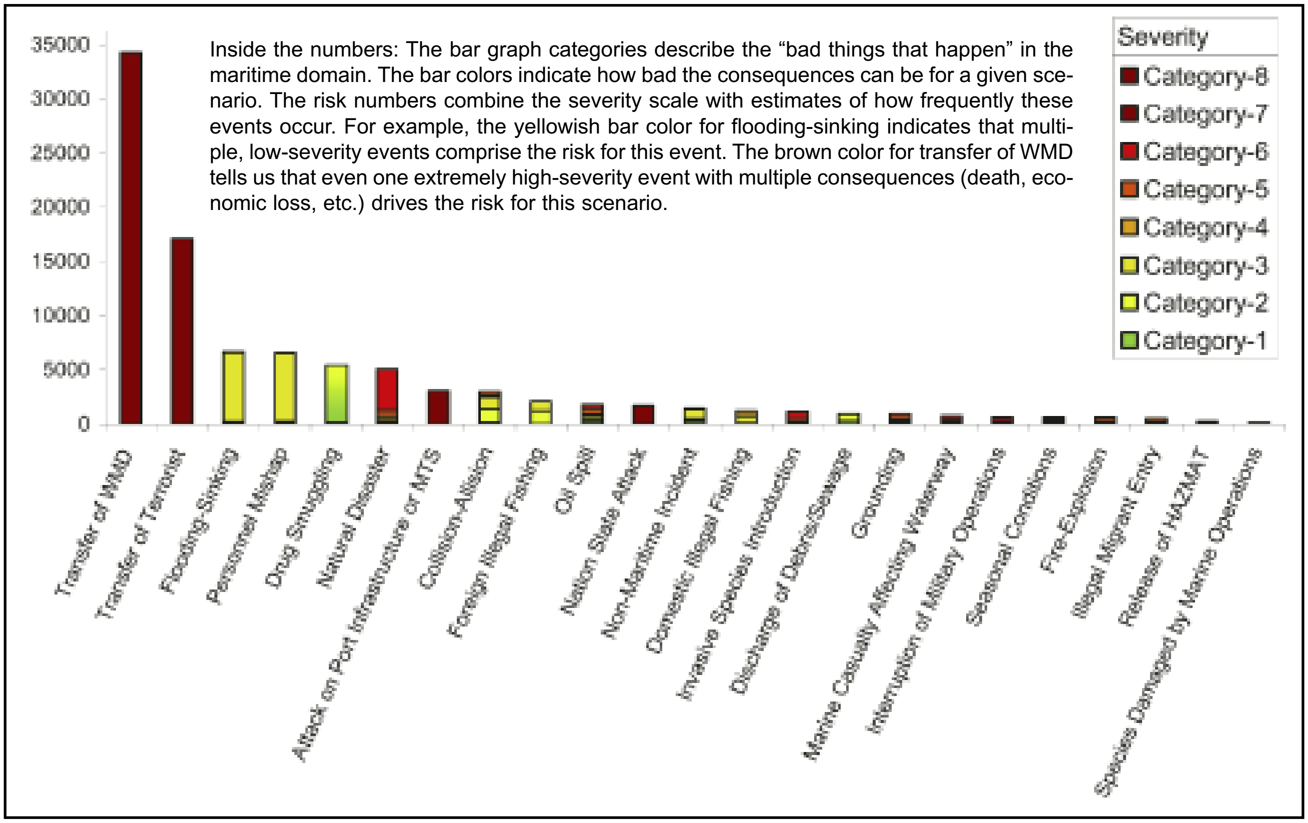

Figure 3: Expected residual loss (risk) that the Coast Guard has the ability to influence.

used to formulate agency budget submissions. This might include perceptions of agency performance; executive and legislative priorities; and other strategies, both short- and long-term.

At the time of this writing, the Coast Guard is considering how these and other factors translate to written guidance for budget builders. It is envisioned that proposals will likely be scored on multiple criteria. Risk reduction will likely be scored using a method that compares groups of budget proposals to each other, with respect to their potential for impacting public risk. Ultimately, planners hope to be able to calculate the estimated change in risk (whether up or down) for different budget proposals, in order to arrive at return-on-investment figures useful to decision makers.

Challenges and Next Steps

Coast Guard planners continue to improve their ability to understand the investment value of support functions that create readiness: maintenance, training, and other vital but behind-the-scene aspects of agency performance. However, the detailed relationships between readiness spending and ultimate public risk reduction have yet to be fully demonstrated to the high standards expected by Coast Guard leadership. The work continues.

The Coast Guard can also do a better job of describing its risk reduction value publicly. Currently, only one Coast Guard program uses risk-reduction as the means to express annual outcome performance in the published federal budget. Listed directly next to the program's cost to the taxpayer, it makes a powerful case for return on investment value. Sometime in the not-too-distant future, it is expected that all Coast Guard programs will demonstrate their performance this way, allowing the public to truly consider the fruit of its investment in the Coast Guard.

About the author:
LCDR Michael Glander is a graduate of the U. S. Coast Guard Academy and is a Coast Guard cutterman. He has served on the teaching staff of the academy, and earned an M.P.A. from George Washington University in 2004. He works as a performance analyst in the Coast Guard's Office of Mission Analysis, Planning and Policy Directorate.

Endnote:

[1] V. O. Key, Jr., *American Political Science Review* (December 1940), "The Lack of a Budgetary Theory."

A Pound of Cure

Oil spills: risk management and the human element.

by Captain William J. Abernathy
PTP coordinator, U.S. Coast Guard Human Element and Ship Design Division

and Mr. Steven Spearman
SAGE Systems Technologies, LLC, Technical Writer, U.S. Coast Guard Human Element and Ship Design Division

When the aging Maltese oil tanker *Erika* sank in rough seas off the west coast of France in 1999, breaking in two and dumping thousands of gallons of oil into the pristine waters of the Bay of Biscay, the resulting ecological disaster galvanized the European Commission to propose new regulatory initiatives to increase maritime safety.

Known as the *Erika* I and II packages, this legislation sought to reduce the likelihood of such casualties by strengthening existing vessel inspection and classification directives, and by setting an international timetable by which single-hull oil tankers like the *Erika* would be phased out of service, in favor of double-hull designs.

Regulations such as the *Erika* packages in Europe, the 1990 Oil Pollution Act, and similar U.S. legislation arising from the *Exxon Valdez* grounding are important tools in managing the risk of oil spills at sea. Expanding inspection and classification measures can reduce or eliminate casualties, and there is plenty of evidence to suggest that double-hull vessels fair better in groundings where oil leakage may occur. Recent improvements to stability systems and new navigational equipment requirements are other examples where legislation has paid off in increased vessel safety.

So the case for more stringent regulations and better naval architecture as a means of managing risk seems obvious. But are these measures enough?

Regulating Against Risk: Compliance is Not a Cure-all

Without question, regulation is an important tool in any maritime risk management program. Developing inspection guidelines, setting safety standards, mandating ship design improvements, and monitoring operations all act to serve the bottom line—improving the safety of the crew and protecting the ship and marine environment. Effective regulation fosters a "culture of compliance" that increases awareness, encourages teamwork, and strengthens commitment and involvement at all levels of an organization. But regulatory oversight and compliance are only part of the risk management picture.

Every casualty has a timeline or chronological sequence of events that unfolds in procession. Every step in this sequence represents an opportunity to avert disaster. Too often, the benefits realized with new regulations come only from the technology side of the equation—the products, designs, and systems that reduce the impact of a casualty—but do little to disrupt the sequence of events, or causal chain, leading up to the casualty itself. The double-hull design mandated in the *Erika* I package perfectly illustrates this limitation. Double hulls may prevent or reduce the impact of oil spills at sea, but they cannot take the place of skill, experience, training, and good judgment to prevent a tanker from running aground in the first place, or to recognize when an aging vessel should retire to the scrap yard, before it founders.

Clearly, regulatory compliance with vessel design criteria plays a critical role in an effective maritime risk management program. In addition, mariner certification and training standards and safety management systems address human and organizational factors. But, as former IMO Secretary-General O'Neil warned in a speech on risk management and the shipping industry, compliance is only "a prerequisite—a starting point." [1] What is also needed is a proactive approach, one that prevents or intervenes in the sequence of events leading up to a marine casualty. This is where Prevention Through People (PTP) comes in.

To Err Is Human: The Role of the Human Element

A strictly compliance-based approach to risk management cannot adequately address the unique nature of the human element. What do we mean by "the human element"? Simply put, the human element refers to those individual and organizational errors that may cause or aggravate marine casualties. Such errors can have a direct or an indirect influence, and may be skill- or knowledge-based, depending on the particular circumstances. For example, an individual error might involve inexperience, fatigue, or improper use of equipment; an organizational error might include a lack of a procedure or policy, insufficient personnel, or inadequate oversight.

The United States Coast Guard's risk-based decision making guidelines divide errors involving the human element into four types:

1) intentional errors – those made because of a misunderstanding or based on incomplete or incorrect information,
2) unintentional errors – those made accidentally,
3) errors of omission – those resulting from failure to perform a critical task or step,
4) errors of commission – those occurring when a critical task or step is performed incorrectly.

All four types are characterized by an absence of deliberate intent to do harm. This categorization is useful in understanding and preventing human errors. However, marine casualties often involve a combination of error types.

While circumstances like those aboard the *Selendang Ayu* casualty (see sidebar) may be somewhat unique, the role that human error played in the casualty is not. The captain's decision to cut the engines to perform repairs rather than to continue on in search of refuge is arguably above reproach, given the information available at the time. At worst, it might be classified as an intentional error. However, his delay in calling for help is a classic example of an error of omission—the captain clearly failed to perform a critical task until it was too late. Had he radioed for assistance earlier, the tragedy might have been prevented altogether.

Human errors such as those committed in the *Selendang Ayu* casualty represent a big link in most causal chains. How big? According to the U. S. Coast Guard, human error is implicated in a staggering 80 percent of marine casualties.[2] And while this figure is reason enough for concern, it becomes more alarming when we consider that the nature of human errors often makes them unquantifiable. The role a cracked hull plays in a casualty is assessable; the role of fatigue or inattention is much more elusive.

Unanticipated events present risks that we cannot expect regulations to protect against. An approach that recognizes the role of human action in preventing, mitigating, or shaping the outcome of a casualty, and one that emphasizes individual and organizational inputs to these ends, gives us a focal point from which we can develop an effective risk management program. Prevention Through People (PTP) is such an approach.

An overflight photo, taken weeks after the rescues, shows the bow and stern section of the *Selendang Ayu* near Skan Bay. Photo courtesy United Command.

PTP takes a comprehensive view of safety and risk by focusing on the interplay among four areas where the human element holds sway:

- management,
- work environment,
- human behavior,
- technology.

PTP promotes the idea that effective risk management is realized only when an organization considers the often complex relationships among these four factors, as when a change in technology requires a new training program, when production pressures lead to risky behavior, or when new job responsibilities warrant changes in work and rest schedules. By concentrating on errors involving the human element—individuals, groups, and organizations—PTP overcomes the criticism most often leveled at rules and regulations; namely, that they cannot hope to foresee all possible consequences.

About the authors:

Captain William J. Abernathy has served for more than seven years as the PTP coordinator for the Human Element and Ship Design Division at U.S. Coast Guard headquarters. He amassed over 25 years of maritime "human element" experience from sailing in the U.S. Merchant Marine.

Mr. Steven Spearman of SAGE Systems Technologies, LLC, is a technical writer and editor for the Human Element and Ship Design Division.

Endnotes:

1. Available at http://www.imo.org.
2. The U. S. Coast Guard Marine Safety and Environmental Protection Business Plan (2001-2005), available at http://www.uscg.mil/hq/g-m/nmc/gendoc/fy2001pp.pdf, pp. 1-4.

Before the crash. Coast Guard rescue helicopter 6020 is pictured transporting motor vessel *Selendang Ayu* crewmembers to the Coast Guard cutter *Alex Haley*. During these rescue efforts, Helo 6020 itself crashed. USCG photo.

A tragic example of an incident that involved a combination of error types was the grounding of the Selendang Ayu in December of 2004.[1]

The vessel was a commercial freighter that suffered engine trouble in the midst of a powerful winter storm off the coast of Alaska. A cylinder liner ruptured, threatening to disable the engine and strand the crew at sea. The captain decided to shut down the engine to repair it amid rough seas, with the hope of finding safe harbor once the repairs were made.

The crew hurried to repair the faulty engine as the huge swells and gale-force winds pummeled the powerless freighter. Fearing a grounding on the rocky shores of nearby Unalaska Island, the captain radioed for help—some 15 hours after the onset of engine trouble.

Dramatic attempts by the Coast Guard Cutter Alex Haley and several tugboats to tow the foundering vessel to safety proved futile. As the storm pushed the freighter into shallow waters, the crew dropped anchor in an attempt to buy more time to repair the engine. Less than two hours later, the vessel began to drag anchor and was soon adrift. The decision was made to abandon ship.

In harrowing conditions of high winds and snow squalls, two Coast Guard helicopters rescued eight crewmembers as the captain and several shipmates secured another anchor and tried again to start the engine. As the storm continued unabated, the second anchor gave way. The freighter began to drift helplessly. Without warning, it struck a submerged rock, rupturing the hull and placing the lives of those on board in grave danger.

In the ensuing rescue attempt of those still onboard, tragedy struck anew. One helicopter, swamped by water from a huge wave that battered the freighter's bow as it hovered above the deck, stalled and plummeted into the ocean. The crew of the second helicopter managed to rescue the helicopter crew, the ship's captain and a shipmate, but not before the freighter succumbed to the raging seas. It broke in half, spilling more than 300,000 gallons of fuel oil into the surrounding water. In the end, six people lost their lives and the marine waters, bays, and coastal habitats of Unalaska Island suffered untold environmental damage.

[1] NTSB Marine Accident Brief DCA-MM-008.

Nautical ENGINEERING Queries

1. The amount of fuel injected in a particular time, or degree, of crankshaft rotation is termed ________.

Note: The primary function of the fuel- injection system is to deliver fuel to the engine cylinders at the proper time, and in the proper quantity, under various engine loads and speeds. The fuel injection system must also accurately atomize, distribute, and control the rate of injection of the fuel.

A. metering

Incorrect Answer: Metering, or measuring, is the term that refers to the amount of fuel delivered to each engine cylinder just prior to each power stroke. Accurate metering is essential for an even distribution of load between cylinders, and smooth engine operation. For each setting of the engine fuel control lever, the same quantity of fuel must be admitted to each cylinder each time it fires. The amount of fuel delivered to each cylinder is dictated by load demand, and is achieved by varying the effective stroke of the cylinder injector pump via the engine fuel control lever.

B. timing

Incorrect Answer: Timing refers to the moment when fuel injection begins. It is essential that injection begin at the proper moment to obtain the maximum power from the fuel. If the fuel is injected too early, ignition may be delayed because the final compresson temperature is not high enough. Early fuel injection results in detonation and low exhaust temperatures. If fuel injection occurs too late, the fuel will be burning in the cylinder well past top dead center resulting in high exhaust temperatures. In both cases, fuel consumption will be high, and power output will be low.

C. rate of injection

Correct Answer: Rate of fuel injection of the metered quantity of fuel injected into the combustion chamber in a unit time, or a degree of crank travel, will be reflected in the rotational speed of the crankshaft. The rate of injection determines the degree of combustion, and should proceed at a rate such that the rise in combustion pressure is not excessive. An incorrect rate of injection affects engine performance in the same way as improper timing. If the rate of injection is too high, a given amount of fuel will be injected during a short time, or during a narrow degree of crank travel, and the result is similar to early injection. Conversely, if the rate of injection is too low, the result will be similar to that of late injection. To lower the injection rate, an injector nozzle tip with smaller holes is utilized to increase the duration of fuel injection. To raise the injection rate, a nozzle tip with larger holes is utilized to decrease the duration of injection.

D. rate of distribution

Incorrect Answer: Distribution is the term that refers to the atomized fuel's ability to penetrate into the combustion chamber. Injection pressure, combustion space design, and compression pressure are the primary factors in determining a fuel's ability to penetrate to all parts of the combustion chamber where oxygen is available. If the fuel is not properly distributed, all of the available oxygen will not be utilized, and incomplete combustion may occur.

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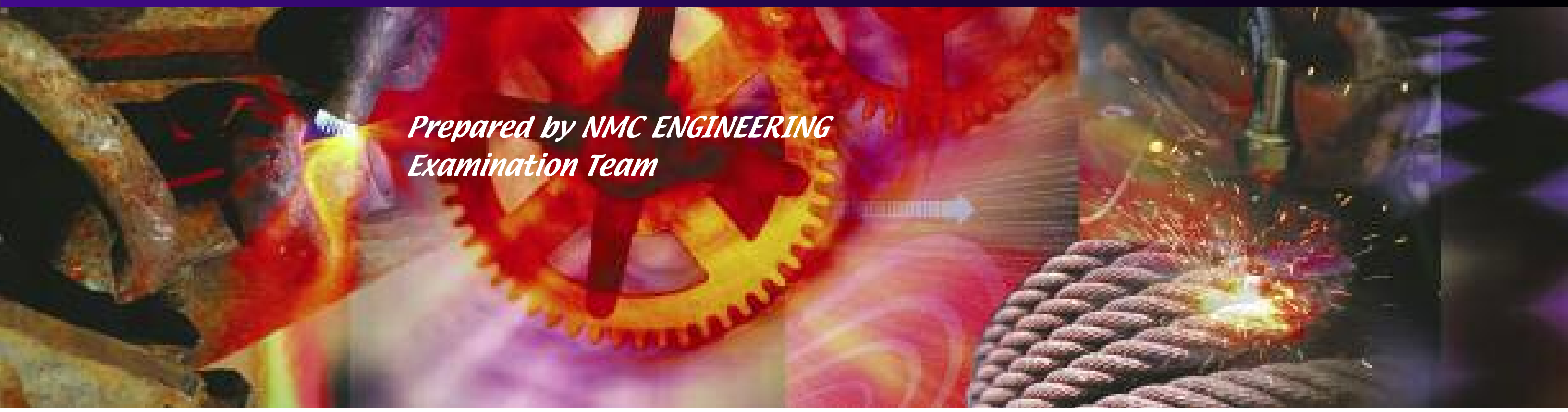
2. Which ring dam arrangement should be used for centrifugal purification?

Note: If the oil discharged from a purifier is to be free of water, dirt, and sludge, and if the water discharged from the bowl is not to be mixed with oil, the proper size discharge ring (ring dam) must be used. The position of the oil and water layer (interface) in the purifier bowl is a function of the specific gravity of the oil, and ring dam size. As a rule, the higher the specific gravity of the oil, the smaller the inside diameter of the ring dam. Hence, an oil with a specific gravity closer to water, will need to have a relatively small inside diameter ring than a lighter oil. While the outside diameter of the discharge ring is fixed, only the inside diameter will vary. The inside diameter, in millimeters, is stamped on each ring. Nomograms, provided in manufacturers' manuals, specify the proper ring dam size to use with an oil of a given specific gravity at a specified temperature.

A. The largest inside diameter ring without loss of oil.

Correct Answer: The use of the largest inside diameter discharge ring results in the positioning of the oil-water inter-



face towards the outer edge of the purifier bowl. The closer the interface is to the outer edge of the purifier bowl, the smaller the seal water layer depth and the larger the oil layer depth. These factors result in the oil being subjected to centrifugal force for a longer period of time, due to the larger radius of the oil layer. As the increased radius allows for a higher centrifugal force to be applied, this results in a more complete separation.

B. The largest outside diameter ring without loss of oil.
Incorrect Answer: The outside diameter of the ring dam is fixed, and does not change for the specific centrifuge model.

C. The smallest inside diameter ring without loss of oil.
Incorrect Answer: The use of the smallest inside diameter discharge ring results in the positioning of the oil-water interface towards the center of the purifier bowl. The closer the interface is to the center of the purifier bowl, the greater the water layer depth, and the smaller the oil layer depth. This results in the oil being subjected to a lower value of centrifugal force for a shorter period of time, and as the time of separation of water from the oil is reduced, more water entrained with the oil would tend to carry over.

D. The smallest outside diameter ring without loss of oil.
Incorrect Answer: The outside diameter of the ring dam is fixed, and does not change for the specific centrifuge model.

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3. The Total Base Number (TBN) value of diesel engine lube oil refers to its ability to ________.

Note: The TBN of diesel engine lube oil is the measure of the alkaline reserve, or the ability of the oil to neutralize acids from combustion. Depletion of the TBN can lead to acidic corrosion and fouling within the engine.

A. resists changes in viscosity with changes in temperature
Incorrect Answer: The ability of lube oil to resist changes in viscosity with changes in temperature is referred to as Viscosity Index (VI). Oils which are determined as having a narrow or small change in viscosity with a wide change in temperature are assigned a high VI, and oils which undergo a wide or large viscosity change with a narrow change in temperature are assigned a low VI.

B. resists emulsification
Incorrect Answer: An emulsification is a water in oil mixture. The presence of water in lube oil will result in the formation of acid and sludge, which can result in serious damage to engine components if left uncorrected. Additives blended into the lube oil and proper purifier operation both help in resisting emulsification.

C. neutralize acids
Correct Answer: The TBN of a diesel engine lube oil is the measure of the alkaline reserve, or the ability of the oil to neutralize acids formed by the byproducts of combustion.

D. resists oxidation at high temperatures
Incorrect Answer: The ability of lube oil to resist oxidation at high temperatures is defined as Oxidation Stability.

Nautical DECK Queries

1. Which entry on a dangerous cargo manifest concerning the classification of cargo is NOT correct?
   Note: Any carrier who will transport hazardous material is required to prepare a Dangerous Cargo Manifest. The manifest must list hazardous material in accordance with either the Hazardous Materials Table, 46 CFR 172.101 or by the International Maritime Dangerous Goods Code (IMDG).

   A. Class 8
   Incorrect Answer: A Class 8 Hazardous Material Classification corresponds to Corrosives.

   B. Division 3.1
   Correct Answer: There is no hazardous material that corresponds to Hazardous Material Classification Division 3.1. Numeric decimal numbers identify further subdivision of a classification and a Class 3 Hazardous Material Classification corresponds only to a broad Flammable Liquid classification.

   C. Division 2.3
   Incorrect Answer: Division 2.3 Hazardous Material Classification corresponds to Poison Gas.

   D. All of the above are incorrect.
   Incorrect Answer: This is false since answers A and C are proper Hazardous Material Classifications.

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2. You are loading in the winter in Albany, N.Y., for a voyage to a port governed by the tropical load line mark. Which of the following statements is TRUE? (Hydrometer reading in Albany is 1.000)
   Note: A hydrometer measures the density of the water in which the ship is floating. This is required to calculate your Fresh Water Allowance (FWA), the amount in inches of draft the ship will rise/fall when transiting between fresh and salt water. A reading of 1.000 corresponds to fresh water, a reading of 1.025 corresponds to salt water, and anything in between is considered brackish (combination fresh and salt water). Since the vessel is loading in fresh water and on the Hudson River, the vessel can submerge its Winter mark by its FWA and the amount of fuel to be burned off to reach the sea.

   A. You may not exceed the winter load line mark when you finish loading except for the burnout to sea.
   Incorrect Answer: Title 46 CFR 42.07-10 (c), Submergence of load line marks, the vessel in addition to the burnout to sea, exceed the winter mark by the fresh water allowance.

   B. The freshwater allowance and burnout to sea may be subtracted from the required freeboard in Albany.
   Correct Answer: Title 46 CFR 42.07-10 (c) and (d), Submergence of load line marks, you may exceed the winter mark by the fresh water allowance and burn out to sea.

   C. You may calculate the burnout necessary to reach the tropical zone and load extra cargo to compensate.
   Incorrect Answer: Title 46 CFR 42.07-10, (d), only allows for burn out to sea, and not the burn out to the tropical zone.

   D. You may load to the winter mark less the freshwater allowance if you will be at the tropical mark upon arrival in the tropical zone.
   Incorrect Answer: Title 46 CFR 42.07-10, (c), states the vessel load to the appropriate load line mark plus the freshwater allowance. Since the vessel is limited by the winter load line and loaded in fresh water, it would be impossible to arrive at the next port at or near the higher tropical mark as an allowance was not computed for the fresh water allowance and the draft would continue to decrease by the fuel burn off and other materials consumed during the transit.

3. The operator of each vessel subject to the pollution regulations is NOT required to keep written records of __________?

Note: 33 CFR Part 155 – OIL OR HAZARDOUS MATERIAL POLLUTION PREVENTION REGULATIONS FOR VESSELS. These regulations apply to all vessels with exception of warships, naval auxiliary (or other vessels owned or operated by a country when engaged in non-commercial service), or vessels specifically excluded by MARPOL 73/78. There are four required written records: 1) the name of each person designated as a person in charge, 2) the date and results of the most recent equipment inspection, 3) hose information not marked on the hose, and 4) Declaration of Inspection.

A. the name of each person designated as a person in charge
Incorrect Answer: This information is required to be made available during an inspection by the Captain of the Port (COTP) or Officer In Charge, Marine Inspection (OCMI) under Subpart C – Transfer Personnel, Procedures Equipment, and Records, 155.820, Records.

B. the date and results of the most recent equipment inspection
Incorrect Answer: This information is required to be made available during an inspection by the COTP or OCMI under Subpart C – Transfer Personnel, Procedures Equipment, and Records, 155.820, Records.

C. cargoes carried and dates delivered, including destinations
Correct Answer: This information is not required to be recorded.

D. hose information not marked on the hose
Incorrect Answer: This information is required to be made available during an inspection by the COTP or OCMI under Subpart C – Transfer Personnel, Procedures Equipment, and Records, 155.820, Records.

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4. The color of the signal flare sent up by a submarine indicating that a torpedo has been fired in a training exercise is __________.

Note: U.S. submarines are equipped with signal ejectors which may be used to launch identification signals, including emergency signals. Two types of signals used are smoke floats and flares or stars. Submarine emergency identification signals can be found in the Coast Pilot.

A. white
` Incorrect Answer: Two white flares/smoke in succession indicates that the submarine is about to surface.

B. green
Correct Answer: Used under training exercise conditions only, green or black is used to indicate that a torpedo has been fired, or that the firing of a torpedo has been simulated.

C. yellow
Incorrect Answer: Yellow indicates that the submarine is about to rise to periscope depth

D. red
Incorrect Answer: Red indicates an emergency condition within the submarine and that it will surface immediately, if possible.

Correction: *In the Fall 2006 issue of Proceedings, Question 4 had an improperly keyed answer. This question has subsequently been removed from circulation and a revised question can be found at http://www.uscg.mil/STCW/mmic-deckexquest.htm in the "modified questions" section of "What You Needed to Know, but Were Afraid to Ask About Deck Questions."*

U.S. Department of Homeland Security

United States Coast Guard

A Risk Management Success Story

In January 2004, USCG Sector St. Petersburg hosted a parasail vessel safety workshop. Interest in this issue was so strong that more than 120 parasailing stakeholders from around the nation and the Caribbean participated.

That spring, Sector St. Petersburg launched a first-of-its-kind voluntary commercial parasail vessel safety exam program. In the three years the program has been in existence, there have been no reported marine casualties involving parasail vessels within Sector St. Petersburg's area of responsibility. See article on page 25.

Photos courtesy of Mr. Arrit McPherson, president of the Professional Association of Parasail Operators.