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Waterways Management

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On Deck

Assistant Commandant's Perspective

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

In January of last year, the Coast Guard completed an important part of its focus on mission realignment by consolidating all waterways management functions under a single organizational element. Numerous studies have shown the benefits of consolidating these similar service delivery functions, which include ocean and transportation policy, aids to navigation, vessel traffic services, pilotage, navigation standards, bridge administration, and ice operations. We have achieved a pursuit attempted many times with varying degrees of success over the years.

Continued success of this effort, however, is dependent on a commitment to blend these activities into a cohesive national waterways strategy along with strong, persistent leadership. We must lead in establishing and enforcing a risk-based ports, waterways, and facilities management and control regime. This will require us to move away from serving in an advisory and monitoring capacity in waterways management to coordinating the establishment of effective operational rules, management, and controls in high-risk ports and around high-risk operations and critical infrastructure.

The Coast Guard has been given the broadest of authorities to protect the public and our nation from harm, be it intentional or accidental. The mission of the U.S. Coast Guard Assistant Commandant for Prevention is to provide for the maritime public's safety and national security and act as steward of our oceans, Great Lakes, and inland waterways. The Coast Guard has a unique role as regulator, facilitator, and user of the Marine Transportation System (MTS). We not only have a breadth of knowledge and capability resident within our organization, we have the long-established credibility and reputation that makes us a natural fit to help actively shape the MTS.

An incident of national significance or terrorist attack can disrupt or shut down part of the MTS, impacting the nation's intermodal transportation system and damaging our economic and national security. The National Strategy for Maritime Security identifies the Coast Guard as the executive agency within the Department of Homeland Security for coordinating measures to mitigate the impact of a significant incident in the maritime domain. The Coast Guard authorities, responsibilities, and capabilities for conducting maritime security, safety, and mobility operations situate us to best serve the national interest in restoring waterway usage, controlling maritime activities within the affected areas, and assuring continuity of commerce. Influencing and educating the public and public leaders, and engaging maritime stakeholders in the responsible ownership and operation of this maritime system, are critical to effective execution.

In the following pages you will see the breadth and depth of Coast Guard programs related to waterways management and the MTS, and why I am so excited about the creation of this new organizational entity, which brings all these functions together as one service delivery program under one directorate—the Waterways Management Directorate.

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Champion's Point of View

By CAPT Wayne Muilenburg
Acting Director, U.S. Coast Guard Waterways Management Directorate

To maintain economic prosperity and viability as a maritime nation, America relies heavily on an interconnected system of rivers, lakes, coastal waters, and ocean commons. When this marine transportation system is disrupted, whether unintentionally, maliciously, or naturally, rapid and effective waterway restoration is critical to the resumption of maritime commerce. The nation looks to its Coast Guard to minimize the cause and duration of such impediments, maximize resiliency, and ensure waterway availability and efficiency for all uses.

This is a daunting task. The marine transportation system consists of 25,000 miles of inland, intracoastal, and coastal waterways encompassing nearly 200 locks, 361 ports, 1,000 harbor channels, and 3,700 passenger and cargo terminals. More than 20,000 bridges span navigable waterways and must be properly lighted, permitted, and operated to ensure both land and maritime transportation needs are reasonably accommodated. Pilotage must be regulated throughout the multistate Great Lakes, a responsibility coordinated with our Canadian neighbors. Our fleet of domestic icebreakers ensures uninterrupted delivery of home heating oil and other vital supplies throughout the Great Lakes and the Northeast. Nearly 53,000 federal aids to navigation, an emerging suite of electronic navigation options, a dozen vessel traffic services, and Navigation Center information and services, coupled with Captain of the Port and other regulatory authorities, help guide mariners throughout this system and along America's 95,000 miles of coastline. And far from the coasts, our polar icebreakers support scientific research; monitor, enforce, and project U.S. sovereignty; and help ensure safe and reliable navigation in the rapidly changing and ecologically sensitive polar regions.

The waterways management program works in concert with other federal agencies, state and local governments, marine industries, maritime associations, and the international community to optimize the use and development of the nation's marine transportation system. Together, we assess waterway risk and develop risk mitigation measures; establish regulated navigation areas, ship routing measures, and safety zones; regulate special marine events; and work with harbor safety committees to develop practices and policies designed to promote safe and efficient waterway use.

By grouping into one directorate those capabilities that enable safe maritime navigation, the Coast Guard has made great strides toward ensuring coordinated service delivery in managing America's waterways. The symbiotic, interdependent relationship among previously disparate Coast Guard offices and responsibilities is transforming how we carry out the Coast Guard's waterways management responsibilities. Together, the articles in this edition of *Proceedings* serve to demonstrate exactly how the whole is much greater than the sum of its parts. My sincere thanks to the authors for their professional contributions. I hope you enjoy reading this edition as much as we enjoyed putting it together.

The Coast Guard's Waterways Management Program and the Nation's Marine Transportation System

by LT Abby Benson
U.S. Coast Guard Operations Directorate Administrative and Coordination Staff

Mr. Rajiv Khandpur
Chief, Office of Marine Transportation Systems
U.S. Coast Guard Waterways Management Directorate

My predecessor, James Loy, stated on many occasions that our maritime transportation system is both valuable and vulnerable."

—ADM Thad Allen at the United States Naval Institute Homeland Port Security Conference, New York, June 7, 2006.

The Nation's Marine Transportation Systems—Valuable and Vulnerable

The marine transportation system (MTS) contributes significantly to the American economy.[1] In 2004, the MTS transported 2.5 billion tons[2] of the estimated 15 billion tons[3] of freight cargo moving in, out, and within the United States. Ninety-nine percent of overseas trade volume (62% by value) enters or leaves the U.S. by ship. Waterborne cargo and associated activities currently contribute more than $742 billion annually to the nation's gross domestic product, and sustain more than 13 million jobs.[4]

Marine transportation system disruptions have been shown to severely affect local, regional, and national economies. In 1993, for example, two tank barges and a freighter collided in Tampa Bay, Fla., releasing approximately 330,000 gallons of #6 fuel oil and 32,000 gallons of jet fuel into the bay. As a result of this spill, the bay's main shipping channel was closed at various points for nine days.[5] Negative media coverage and long-term cleanup operations resulted in a 50% drop in tourist bookings and a two-year dip in tourism business to the Tampa Bay area. In addition, commercial fishing revenues dropped by 80%, and 5,000 sport fishers lost their boats.[6]

On a national level, the 2002 West Coast port lockout was estimated by some to cost the nation's economy approximately $1 billion a day.[7] This lockout resulted in 10 days of stopped work at West Coast ports that collectively handle over $300 billion in trade a year.[8] This lockout not only affected the more than half of the country's containerized imports and exports traveling through the West Coast, but also resulted in layoffs in a wide variety of industries across the country.

More recently, Hurricane Katrina severely disrupted a critical area of this country's MTS. Maritime activity within the Port of New Orleans alone is responsible for more than 107,000 jobs, $2 billion in earnings, $13 billion in spending, and $231 million in taxes statewide.[9] Although initial estimates claimed that Hurricane Katrina caused more economic damage than any other catastrophe in the U.S., its economic impacts were so far-reaching that they have not yet been accurately measured.

The "Systems Approach" Imperative

Waterways management functions are diverse, yet inherently interconnected because a systems approach is necessary to manage the complex marine transportation system. For example, vessel traffic services (VTS) would provide little benefit if buoys or other short-range aids were not available to assist mariners traveling in a channel, or if a bridge was blocking that channel due to inadequate navigational clearances, failure to maintain/operate a drawspan properly, or having been felled by terrorist activity.

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USCG's Waterways Management Program and the MTS

The traditional focus of the Coast Guard Waterways Management (WWM) Directorate was to ensure freedom of navigation on U.S. navigable waterways and foster maritime mobility and safety through programs such as aids to navigation (AtoN), icebreaking, vessel traffic services (VTS), and bridge administration. Since 9/11, however, waterways management functions have added a new dimension—that of protecting and preserving the physical and economic security of the nation, as demonstrated by a Department of Homeland Security strategic goal to "Safeguard our people and their freedoms, critical infrastructure, property, and the economy of our nation from acts of terrorism, natural disasters, or other emergencies." [1]

The directorate encompasses a wide variety of programs and partnerships, each with the common goal of managing the safety, security, efficiency, and environmental protection of our nation's marine transportation system. WWM includes three broad program areas; bridge administration, navigation systems, and the marine transportation system; and one headquarters unit, the Navigation Center.

Bridge Administration

The Bridge Administration Program (BAP) assures freedom of navigation on U.S. navigable waters, with a balanced intermodal approach to total surface transportation systems. The program approves the location and clearances of bridges crossing U.S. navigable waters through a permit application process. To meet its governing statutory purposes, the BAP ensures the bridges and causeways over or in the navigable waters of the United States do not impede the reasonably free, easy, and unobstructed passage of waterborne commerce and other marine traffic past bridge sites.

The program's core functional activities also include altering bridges that have become unreasonably obstructive to navigation and regulating the operation of drawbridges to balance the conflicting needs of land and waterborne transportation. Finally, risk assessment also plays a critical role. Inherent to the business management practices of the BAP is a risk assessment methodology to identify vulnerability of bridges to terrorist attacks and allisions by commercial and/or national defense marine traffic. The risk assessment process includes a full agency consideration of the bridge location, design, and the potential impact this will have on the security, safety, and mobility of both land and marine traffic.

Office of Navigation Systems

With due regard for the requirements of national defense, the Office of Navigation Systems aims to maximize the availability of safe, secure, and efficient waterways; to facilitate maritime commerce; and eliminate impediments to the movement of goods and people, while maximizing recreational enjoyment and environmentally sound use. It performs its mission through a combination of visual and electronic navigation services and navigation regulations. This program oversees placement, maintenance, and repair of short-range aids, such as buoys and lights, as well as radio navigation aids, such as differential GPS.

The office manages the nation's vessel traffic services, which provide active monitoring and navigational advice to vessels in particularly confined and busy waterways, through the use of the automatic identification system, radar, closed-circuit TV, and extensive communications networks. Regulatory efforts include maintaining, updating, and advising on navigation standards and the "rules of the road."

The program also conducts port and waterways safety assessments, which are a disciplined approach to identify major waterway safety hazards, estimate risk levels, evaluate potential mitigation measures, and set the stage for implementation of selected measures to reduce risk. The risk assessment process represents a significant part of joint public/private sector planning for mitigating risk in waterways. When applied consistently and uniformly in a number of waterways, the process is expected to provide a basis for making best-value decisions for risk mitigation investments, both on the local and national level.

Office of Marine Transportation Systems

The Office of Marine Transportation Systems encompasses mobility and ice operations, Great Lakes pilotage, and ocean and transportation policy. Specific missions include facilitating essential maritime commercial activities on domestic and polar ice-laden waters; preserving U.S. national interests in the polar regions; providing safe, efficient, and reliable pilotage service on the Great Lakes; and providing representation on several interdepartmental committees, such as the committee on ocean policy and the committee on the marine transportation system.

One primary focus of the office of MTS is partnerships. Partnerships are especially essential to management of the marine transportation system, since multiple agencies have responsibility for its components. The U.S Army Corps of Engineers, for example, dredges federal channels and manages the locks and dams in the inland waterway. The National Oceanic and Atmospheric Administration surveys the waterways and provides real-time hydrographic and weather information to MTS users.

Large portions of the marine transportation system are privately owned and operated by industry. The necessary partnerships between government agencies and MTS stakeholders are managed at the local and regional level by harbor safety committees, and at the national level by the cabinet-level committee on the marine transportation system and the marine transportation system national advisory council. In addition to these partnerships, WWM staff members represent the Coast Guard on 13 national and international partnerships.

NAVCEN

The Navigation Center (NAVCEN) is the Coast Guard's navigation center of excellence. NAVCEN operates the navigation information service, the nationwide differential global positioning system (NDGPS), and long-range navigation (LORAN).

In addition, the Navigation Center serves as the civilian interface for the global positioning system; disseminates navigation and maritime safety information to the public; staffs watches to control 84 NDGPS sites, 24 LORAN stations, and the inland river vessel movement center; and serves as the civilian interface to the Department of Defense on GPS operations and management. NAVCEN also manages the integrated aids to navigation information system project, as well as several other navigation-related projects.

Endnote:

1. DHS strategic plan, p. 22, www.dhs.gov.

Similarly, a pilot would be of little use in a waterway that was impassable due to ice.

Additionally, effective maritime domain awareness also relies on waterways being orderly, making anomalies and possible threats more obvious. Any part of the system not operating within expected parameters could be an early warning and a reason to explore further. Finally, without the partnerships fostered in the WWM directorate, it would be impossible to effectively manage the numerous multijurisdictional issues that exist within the marine transportation system.

The need for a robust waterways management system is best demonstrated by comparison with surface and air transportation management systems. In their infancy, both of these systems provided freedom for drivers or planes to travel essentially unimpeded in any desired direction. As the number of users increased, so did the risk of accidents. This increased risk resulted in increased management of each system. Roads today are subject to traffic signals, lane divisions, interchanges, and tolls. Airways today have restricted air space, height restrictions, and air traffic control systems.

The marine transportation system faces similar challenges, although in a much less visible manner. The amount of trade in our nation is expected to double by the year 2020, and statistics show that in order to keep up with current trade demand, the country will have to add port infrastructure equal to that of the Ports of Seattle and Tacoma each year.[10] Despite these predictions, the general public remains blissfully unaware of the marine transportation system's impact on the economy. Without a robust waterways management program to manage the increasingly congested MTS, maritime commerce would be severely affected, and the nation's economic security would face increasing risk.

Recovery From Hurricane Katrina—the Value of the Waterways Management Systems Approach

In the wake of Hurricane Katrina, the Coast Guard's WWM programs and partnerships were essential to restoring the marine transportation system and minimizing the potential ripple effect on the U.S. economy. After Katrina's landfall, the Coast Guard deemed the reopening of the waterways "critical" on two fronts. First, traditional Coast Guard missions such as search and rescue, port security, and environmental response require a functioning waterway for successful execution. Second, more than 6,000 ocean vessels representing, among others, the critical energy and agricultural sectors, move annually through New Orleans on the Mississippi River.[11]

With the waterway impeded, numerous ships carrying valuable cargo such as petroleum and natural gas had to wait offshore to enter Gulf ports, and exports, particularly perishable agricultural products, were left to rot in area warehouses.

Some of the primary issues affecting the Gulf waterways included silting, damage to infrastructure, obstructions to navigation, environmental hazards, and AtoN discrepancies. In order to address these discrepancies, the Coast Guard deployed 14 vessels equipped with NDGPS receivers as part of their electronic charting and navigation systems, allowing for efficient and precise positioning of buoys and fixed aids to navigation.

In addition to aids to navigation, the Coast Guard and Environmental Protection Agency worked together to address seven major oil spills, five medium oil spills, and over 4,800 minor spills that affected operations in area waterways. The Coast Guard, Army Corps of Engineers, and Navy Supervisor of Salvage worked together to identify and remove, within each agency's jurisdiction, the over 2,600 vessels in Sector New Orleans and Mobile, Ala.'s areas of responsibility that were wrecked as a result of the storm. In addition to these impediments, over 100 offshore drilling platforms in the Gulf of

Mexico were reported destroyed, and another 52 were damaged.[12]

Prior to the arrival of any hurricane in the Gulf Coast, the Coast Guard vessel traffic services in New Orleans, Port Arthur, or Houston/Galveston serve as communications centers to alert mariners of the storm's progress. Should hurricane landfall become imminent, these VTSs ensure an orderly evacuation of the port. Immediately after Hurricane Katrina, the sector commander reopened the VTS in New Orleans to provide up-to-the-minute marine information to waterways users and install good order and predictability on the waterway.

The Bridge Administration Program worked diligently to facilitate reconstruction of all damaged or destroyed bridges over navigable waterways and restore normalcy to the region. Temporary repair or replacement of severely deteriorated or damaged bridges to meet emergency land transportation requirements essential to the public health, interest, and safety were authorized. This was consistent with its established policy regarding bridge damage due to natural disaster.

In order to rapidly restore maritime commerce, waterway prioritization was undertaken at the local level, with an eye on national impact. Government and industry worked together through existing partnerships to identify the most essential waterways and facilities. These partnerships were also necessary to ensure that waterways management efforts corresponded with on-land efforts. For example, a refinery that was brought back online would be of no use if its docks were unable to service crude oil tankers due to silting, obstructions, lack of AtoN, or proper operation of drawbridges damaged by Katrina.

As a result of these efforts, the Port of New Orleans opened for deep-draft traffic within one day of the storm. After 11 days, all draft restrictions were lifted for daylight transits. Within 32 days after the passing of Hurricane Rita, which made landfall on the Texas-Louisiana border on September 24, 2005, all restrictions for waterways in the New Orleans area had been lifted.[13] When these crucial waterways opened, the restoration of historical levels of MTS commerce resumed.

Looking Forward

The Coast Guard's Waterways Management Program, which includes several diverse yet interdependent functions, plays a vital role in supporting our nation's complex MTS. In particular, the program helps to protect the marine transportation system both physically and economically, and provides critical input to the nation's maritime domain awareness program.

As demonstrated in the wake of Hurricane Katrina, the Coast Guard's WWM program is critical to ensuring a fully functional marine transportation system before, during, and after a major disruption. A fully functional marine transportation system is critical to ensuring our nation's physical and economic security.

About the authors:

LT Abby Benson is currently a member of the administration and coordination staff for the Assistant Commandant for Operations at Coast Guard headquarters. In this role, LT Benson coordinates Congressional inquiries, hearings, and briefings related to the Coast Guard Prevention and Response missions. Prior to this assignment, she worked in the Office of Marine Transportation System at Coast Guard headquarters, and in the Port Operations Department at Marine Safety Office Boston. LT Benson holds a BS in geology and geophysics from Yale University, and a master of science in transportation and a master of engineering in logistics from the Massachusetts Institute of Technology.

Mr. Rajiv Khandpur is the chief of the Office of Marine Transportation Systems in the U.S. Coast Guard Waterways Management Directorate. He is the principal coordinator for all Coast Guard activities related to marine transportation system and ocean policy issues. He also oversees the administration of the Great Lakes pilotage program and the Coast Guard ice operations program. Mr. Khandpur has more than 30 years' experience in the marine industry. He has an unlimited motor chief engineers' license from the Department of Trade, United Kingdom and a BSc from the University of Michigan in naval architecture and marine engineering.

Endnotes:

1. "An Assessment of the U.S. Marine Transportation System," a September 1999 report to Congress, defines the U.S. MTS as a system of waterways, ports, and their intermodal connections, vessels, vehicles, and system users.
2. Institute for Water Resources, U.S. Army Corps of Engineers.
3. "Trade and Transportation: A Study of North American and Intermodal Systems," National Chamber Foundation, U.S. Chamber of Commerce, 2003, p. 5.
4. "An Assessment of the U.S. Marine Transportation System," September 1999.
5. Tampa Bay restoration plan, p. 4. A PDF of this form can be found at http://www.dep.state.fl.us/law/Documents/BER/PDFs/Tampa_Recreational_Restoration_Plan.PDF.
6. Http://www.floridadisaster.org/BusinessSurvey/introduction/tampa.asp.
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9. Http://www.portno.com/facts.htm.
10. "The Marine Transportation System and the Supply Chain," Marine Transportation System National Advisory Council Education Team presentation, August 1, 2006.
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12. USCG Hurricane Katrina Disaster Response Information Management Task Force.
13. USCG Hurricane Katrina Disaster Response Information Management Task Force.

U.S. Coast Guard Vessel Traffic Services

VTS past, present, and future: Beyond evolution to revolution.

by CDR Brian Tetreault
Chief, Vessel Traffic Services, U.S. Coast Guard Office of Navigation Systems

For more than 35 years, the U.S. Coast Guard has operated vessel traffic services (VTSs) in major ports throughout the United States. Over this period of time, VTS capabilities and roles have changed, and the relationship with other aspects of waterways management and maritime operations has matured. The role of VTS is in the midst of an operational revolution. This has become especially evident in the past 10 years with the expansion of advanced sensors and technology, greater recognition of the need for maritime domain awareness in support of all maritime missions, and larger and more numerous vessels plying America's waterways.

VTS Past—History and Authority

The United States has officially operated vessel traffic services since 1972, when VTS San Francisco was established. However, VTS-like operations had been in place in the U.S. and around the world for decades before. In the U.S., the earliest known VTS-like operation was on the St. Mary's River in Michigan, where manned reporting stations were established along the river to provide vessel information as they approached and departed the locks at Sault Ste. Marie.

In the late 1960s an experimental radar-based service called the Harbor Advisory Radar Project (HARP) was established in San Francisco. It was purely advisory, relied on the voluntary participation of vessels, and there were no established radio frequencies or communication protocols. As a result, HARP watchstanders observed helplessly on radar as the tankers *Arizona Standard* and *Oregon Standard* collided in dense fog near the Golden Gate Bridge in the dark hours of January 18, 1971. As a result of this accident and the resulting environmental damage, Congress passed the Ports and Waterways Safety Act (PWSA) of 1972, which gave the Coast Guard the authority to establish and operate vessel traffic services in U.S. ports. In addition to San Francisco, extensive VTSs were established in Puget Sound, New York, New Orleans, and Houston-Galveston in the early 1970s.[1]

In the United States, vessel traffic services get their authority from the PWSA, which authorizes the Coast Guard to "establish, operate, and maintain vessel traffic services in ports and waterways subject to congestion." It also authorizes the Coast Guard to require the carriage of electronic devices necessary for participation in the VTS system. The Oil Pollution Act of 1990 required commercial vessels to "utilize or comply with that service...," thereby making VTS participation mandatory.[2]

VTS Present—Operations, Equipment, and Personnel

Today, vessel traffic services exist in New York City, New Orleans, Morgan City, Port Arthur, Houston, Louisville, Valdez, San Francisco, Los Angeles, Seattle, and Sault St. Marie. To ensure consistency and some level of international standardization, U.S. VTSs are designed and operated in line with guidance from international bodies, in particular the International Maritime Organization (IMO) and International Association of Marine Aids to Navigation and Lighthouse Authorities (IALA). IALA has defined a VTS as "a service implemented by a competent authority, designed to improve the safety and efficiency of vessel traffic and to protect the environment. The service shall have the capability to interact with marine traffic and respond to traffic situations developing in the VTS area."[3] The required capability to "interact with traffic and respond to traffic situations developing in the area" separates a vessel traffic service from a simple

ship-reporting system. A vessel traffic service must be able to construct a traffic image of the waterway and communicate relevant portions of that image to the mariner. The vessel traffic service must also be able to intervene in the navigation decision-making process with appropriate advice or directions.

The tasks embodied by vessel traffic management can be categorized into three general areas:

- **Data collection** – Assembling a comprehensive picture of the maritime situation through sensors and information sources.
- **Data evaluation** – Interpreting the developing maritime situation.
- **Data dissemination** – Communicating pertinent elements of the maritime situation to vessels and shore-based organizations.

VTS advisory services should focus on assembling an accurate and complete traffic image. Such images allow the VTS to intervene in the navigation process with timely, relevant, and accurate advisories that achieve the desired traffic organization results while leaving shiphandling and navigation decisions to the mariner. This is how the vessel traffic service does its job.

In general, vessel traffic services should function primarily as information services. There are times, however, when the maintenance of good order and predictability on a waterway requires that a VTS offer recommendations or even directions in its dealings with a vessel. This oversight can be seen as a continuum of four basic levels of increasing involvement:

Monitoring – The vessel traffic service monitors activity in its area of responsibility to build a comprehensive traffic image. By its nature, this continuous monitoring influences vessel traffic toward order and predictability.

Informing – Based on the information collected and analyzed, the VTS may offer mariners information so they may navigate more safely or efficiently. This information may be provided as a general broadcast (most commonly done), sent to a specific vessel, or sent in response to a vessel's request.

Advising/recommending – In certain (usually infrequent) situations, the VTS may recommend a course of action to a vessel based on the vessel traffic service's overview of the vessel traffic situation.

Directing – In rare circumstances the VTS will direct a vessel's movement. This only occurs when it is obvious that the vessel is moving into imminent danger or is obviously in violation of regulations. Directions are normally given in the form of a desired outcome rather than specific conning orders. For example, a vessel may be directed not to proceed beyond a certain location, or told to remain at the dock until it is safe to transit.

There are exceptions to this theoretical smooth continuum. Some vessel traffic services have been established to exercise specific authority, such as enforcing one-way traffic or order of procession through a waterway. In these instances, the vessel traffic service will exercise direction more frequently. However, this direction is still normally given as an intended outcome or operating boundaries rather than direct maneuvering orders, such as ordering a vessel to adjust its speed or remain moored or at anchor so as to avoid entering a waterway until a specified time.

This is where vessel traffic service operations differ significantly from those of air traffic control, to which VTS is often compared. In general, air traffic control starts at a high level of control. Aircraft don't move without permission, and headings, speeds, and altitudes are frequently ordered. Vessel traffic service best serves as an active waterways management tool, not as a vessel control tool. In a VTS, the vast majority of "control" is exercised through information and recommendations to help the mariner make safe navigation decisions. Existing "passive" waterways management tools such as aids to navigation, non-VTS waterway regulations, and the collision regulations, in conjunction with timely, accurate, and relevant vessel traffic service information, combine to maximize safe maritime operations.

Day-to-day vessel traffic service operations can be considered "tactical," or short-term vessel traffic management. This is what you normally imagine as a vessel traffic service's role—actively communicating with mariners to ensure safe navigation. However, as technology and waterways management has matured, the role has also evolved to include "strategic," long-term vessel traffic management. Through continuous operations in the maritime arenas, VTSs amass large amounts of data, information, and knowledge about the local waterway environment. This information is valuable to other Coast Guard and maritime community waterway management activities. Vessel traffic service data is used for risk analysis, determining the effectiveness of aids to navigation (such as buoys, lights, etc.), icebreaking coordination, and other analyses. VTS data has been used to design, implement, and enforce restrictions on vessel operations in environmentally sensitive areas, such as national marine

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VTS Berwick Bay

Merging partnerships and technologies to meet unique challenges along America's Cajun coast.

by LT Kathryn A. Kulaga, *Chief, VTS Berwick Bay*

VTS Berwick Bay, an inland river vessel traffic service in the heart of Cajun country, was established in 1973 after Congress had enacted the Ports and Waterways Safety Act. The bridge of USCGC *Point Lookout*, moored in Morgan City, La., served as the traffic center's first location. From 1975 to 1985, the traffic center was located in the Morgan City railroad bridgetender's shack near the middle of the Atchafalaya River channel. From this small shack, with a small staff of petty officers, a radio, and a manual board, VTS Berwick Bay operated one of the busiest traffic centers in the country. The traffic center then moved to its present location at Marine Safety Unit Morgan City, where a staff of 15 petty officers, five civilians, and two officers now run the 24-hour operation.

Unlike most vessel traffic services, Berwick Bay directly controls vessel movements. On average, VTS Berwick Bay oversees 4,000 monthly transits. Of particular importance in the VTS area are the regulated navigation area and special area, where three bridges span the Atchafalaya River. The close proximity of these bridges, along with shifting currents, creates a risky navigation situation for southbound tows. Of these three bridges, one bridge serves rail traffic, whose movement must also be coordinated with vessel movement along the Atchafalaya River. In this unique situation, vessel traffic holds while the bridge tender lowers the bridge for rail passage. Over the course of a month, the bridge may be held in the "down" position for up to 150 hours, or the equivalent of approximately six days!

Shifting currents along the coastal waters of Louisiana also create huge sediment deposition along banks and bends, increasing the likelihood of vessel groundings. To aid in navigation safety, twice a year the U.S. Army Corps of Engineers (USACE) conducts dredging operations of these channels to their charted depth. Dredging often requires waterway closures or restrictions, so VTS Berwick Bay and USACE must directly work together to coordinate safe vessel passage.

With the comparatively shallow waters of the Atchafalaya River, the Port of Morgan City does not receive deep draft vessels. Rather, most of the vessel traffic consists of towing vessels pushing barges carrying anything from chemicals to scrap metal. The Atchafalaya River serves as a gateway to the key commercial transportation corridor of the Gulf Intracoastal Waterway. Whether anticipated or unexpected, any waterway closure has the serious potential to disrupt maritime commerce worth millions of dollars. Representing the inland barge industry, VTS Berwick Bay works closely with the Gulf Intracoastal Canal Association and USACE to inform mariners of such a situation.

The relationship proved especially fruitful during the 2005 hurricane season. Through effective partnering, mariners safely evacuated prior to Hurricane Katrina's landfall. Following the hurricane's passage, the partnership worked to bring about an unprecedented restoration of inland maritime commerce on the Gulf Intracoastal Waterway. As a result of these efforts, the Gulf Coast inland waterways joint hurricane team was established. The team created a response protocol, which captures best practices from past storms and is reviewed annually. The team also is qualified to respond to other disruptive waterway events, such as vessel groundings resulting in one-way traffic schemes.

Controlling vessel traffic throughout Berwick Bay requires a plethora of resources, from the most simple to the most advanced. In its early days, the traffic center only had a small communications console and a manual board to hold colored cards that represented vessels in the traffic system. Over the years, the traffic center acquired five closed-circuit television monitors and cameras, radar, a tower to support the center's electronics suite, and an automatic identification system. VTS Berwick Bay's newest project is the $1 million construction of a 100-foot tall antenna tower and shelter at mile marker 99 of the Gulf Intracoastal Waterway. Undertaken specifically to improve vessel traffic management, security, safety, and marine commerce, the project will be accomplished through a no-cost, 20-year land lease (with an option to renew for another 20 years) negotiated with the local parish school board. The concrete structure will house two additional Pelco pan-tilt cameras with microwave link, secondary automatic identification system and Terma radar, and a backup generator.

About the author: *LT Kulaga received her commission through the direct commission officer environmental management program in March 2000. Prior to her present position, LT Kulaga served as investigating officer at MSU Morgan City. She holds a B.S. in biology and English, an M.S. in conservation biology, and currently is a Ph.D. candidate in environmental science and public policy.*

sanctuaries and activities by other government agencies, including the U.S. Army Corps of Engineers, the National Oceanic and Atmospheric Administration, and the Canadian Coast Guard.

In order to carry out effective operations, vessel traffic services have a variety of equipment available to them. To collect information and build an effective vessel traffic picture, they have sensors such as VHF radio, radar, an automatic identification system (AIS), and cameras. Vessel traffic service information processing and display systems help VTS watchstanders evaluate and disseminate collected information.

Of course, more important than equipment are vessel traffic service personnel. Their experience, judgment, and daily interactions with mariners make them the most vital part of VTS operations. A substantial part of VTS watchstander training involves interaction with the maritime community. As part of the initial and continuing training, vessel traffic service personnel conduct shiprides and local facility visits to stay up to date with local conditions and operations. This outreach and involvement with the maritime community works both ways. Local maritime stakeholders are intimately involved with the VTS through visits to the traffic center, participation in waterway workgroups through the harbor safety committee, and the development of local operating procedures and improvements to VTS operational procedures.

VTS Future

Primarily due to advances in technology, but also due to an increasing awareness of the value to other maritime operations, including security, we are in the midst of a revolution in vessel traffic service operations. Improvements in sensor technology have vastly increased the amount of information vessel traffic services have available to them, how they display and analyze it, and how they make it available to VTS participants and other maritime stakeholders. The introduction of the automatic identification system has been the biggest advancement thus far.

AIS has allowed more extensive surveillance of vessels throughout and beyond the VTS area of responsibility. It also allows vessels to receive information not only from each other, but also information previously unavailable or cumbersome to deliver (i.e., via VHF voice transmissions).

In the early days, VTS "displays" consisted of cards on a table, moved in reference to visual and radar observations and radio reports from vessels. Basic computer-assisted radar displays came into use in the 1980s and advanced data processing systems have been in use since the late 1990s, integrating multiple sensors and automating many VTS tasks. These evolutions and revolutions in VTS technology are forcing a revolution in operations. Ultimately, we may shift to "near-voiceless VTS" with information from the vessel traffic service, other vessels, aids to navigation, and other sources presented to the mariner on advanced shipboard displays.

Vessel traffic service operations have become intimately integrated with other Coast Guard and other government agency operations as the ease of sharing VTS information electronically has developed. Now, port security watchstanders, marine sanctuary managers, and fishery enforcement officers have need for and access to the same data as the vessel traffic service, but are using it in new ways. VTS data is being analyzed in ways only dreamed of in the past, with historical vessel movement data, vessel density, and predicted changes to waterway use now being displayed and modeled to improve safety and efficiency.

As we move forward in this revolution, some issues will need to be considered and addressed. Expansion of surveillance technology will allow "VTS-like" operations where they are currently not cost-effective or justified based on the level of vessel traffic or risk assessment. We will need to develop clear guidance for any such operations that may be established by the Coast Guard or other entities. To this end, partnerships with others who have waterways management interests will be important. We have already begun, and are increasing our outreach and partnership with other government agencies such as the St. Lawrence Seaway, the U.S. Army Corps of Engineers, the National Oceanic and Atmospheric Administration marine resources, and have entered into or explored cooperative VTS arrangements with port authorities, pilot organizations, marine exchanges, and others. Coast Guard vessel traffic services have played a key role over the past 35 years to ensure the orderly and predictable movement of vessel traffic on U.S. waters. With the current revolution in VTS operations, this history of service will not only continue, but flourish.

About the author:

In his 20-year career, CDR Tetreault has served aboard icebreakers in the North Atlantic and Great Lakes, a fisheries patrol cutter in Alaska, at two vessel traffic services, and on the U.S. Coast Guard headquarters and Pacific Area staffs. He graduated from the U.S. Coast Guard Academy in 1987. He holds an unlimited 2nd mate license as well as a 1600-ton master license.

Endnotes:

1. LCDR Robert McFarland, "Vessel Traffic Service: A Status Report," MTS Oceans 1977 conference.
2. 33 USC 1223.
3. http://www.iala-aism.org/.

VTS Personnel and Training

VTS watchstanders—the people behind the scenes.

by Mr. Bruce Riley
Vessel Traffic Specialist, Vessel Traffic Services Division
U.S. Coast Guard Office of Navigation Systems

For more than 30 years, two influential organizations, the International Maritime Organization (IMO) and the International Association of Marine Aids to Navigation and Lighthouse Authorities (IALA) have been deeply involved in developing effective training and operational guidelines aimed at increasing the efficiency and effectiveness of vessel traffic service operations.

IMO's activities in the VTS community have been directed toward the development and drafting of documents such as the Guidelines for Vessel Traffic Services, Resolution A.857 (20), and a resolution calling for internationally agreed-upon provisions for the training and certification of VTS personnel.

The mission of the International Association of Marine Aids to Navigation and Lighthouse Authorities is to promote the safe, economic, and efficient movement of vessels. IALA has drafted numerous documents concerning VTS operations, personnel, and training. While IALA does not have authority to require member countries to adhere to specific procedures, the organization is well respected. Its manuals, recommendations, and guidelines are accepted worldwide by mariners and administrators in the maritime industry.

Operations
A vessel traffic service conforming to IMO guidelines is designed to improve vessel safety and efficiency and protect the environment. To accomplish this, the VTS provides services that will minimize the risk of collision and damage to property or the environment while promoting compliance with navigation regulations. Worldwide, vessel traffic services normally provide one or all of the following:

- information service,
- navigational assistance service,
- traffic organization service.

In the U.S., vessel traffic services support all listed above and normally assume secondary responsibility for maritime security, search and rescue, marine environmental protection, and aids to navigation assistance, among other tasks.

The internal operating procedures of a VTS serve as the basis for development and conduct of qualification training.

Personnel
The services mentioned above are of no benefit unless supported by highly skilled, highly knowledgeable people. One of the goals of the U.S. VTS program is to provide all vessel traffic services with certified, motivated, professional watchstanders at the proper staffing level.

In the U.S., both active-duty Coast Guard and civilian personnel are employed as VTS watchstanders. Most large vessel traffic services are staffed by a 50/50 split of civilian and military watchstanders. Many civilian watchstanders are former active duty members who have prior experience. VTS New Orleans, Port Arthur, and the new VTS in Tampa were intended as all-civilian operations. Many former mariners were recruited and hired.

Current VTS staffing levels stand at 155 civilian and 130 active-duty personnel. Using these numbers, one could expect that one-third (approximately 43 active-duty watchstanders) will transfer in and out of VTS annually. The assignment of new active-duty person-

nel drives the bulk of the training program, although refreshing skills is also an important aspect.

Training

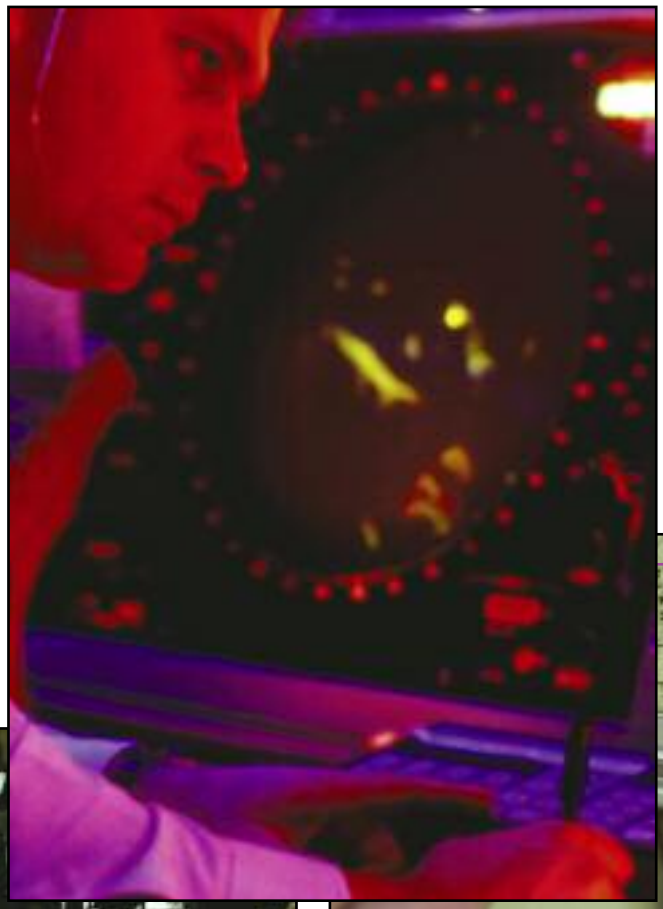
Most civilians hired into VTS watchstander positions were previously qualified, active-duty watchstanders and therefore needed little in the way of basic VTS operator training. However, many of the active duty personnel ordered to VTS have no prior vessel traffic service experience and need to be trained and qualified before assuming watch. VTS training typically averages four to six months from orientation to qualification.

Within the last two years, the training curriculum for new employees has been expanded to include generic "certification" or entry-level training. The internationally designed and accepted curriculum, based on IALA's recommendation V-103 and related model courses, is conducted at a professional maritime training facility utilizing simulation. The two-week certification course includes instruction in communication coordination, language, VHF radio, equipment, nautical knowledge, traffic management, emergency situations, personal attributes, security, and maritime domain awareness. The VTS certification course will soon be accredited by the competent authority to IALA V-103 standards.

The vessel traffic services program manager has also instituted a professional maritime training program that allows VTS watchstanders to attend commercial marine training courses related to VTS and the professional mariner. Ship handling, bridge resource management, electronic chart display, and other courses are available for up to 80 watchstanders per year.

About the author:

Mr. Bruce Riley retired from the Coast Guard as a senior chief quartermaster. In his 21-year career, Mr. Riley has served as a search and rescue controller, a vessel traffic service operator, a supervisor and training coordinator, and served in the cutter training division at Coast Guard headquarters. He also served as the force manager for the quartermaster rating. Mr. Riley was hired into his present job following retirement from active duty and has served in the capacity of training and personnel administrator for the VTS program for 18 years.



Leveraging Technology to Improve VTS Operations

by LCDR Ulysses Mullins
Deputy Chief, Vessel Traffic Services, U.S. Coast Guard Office of Navigation Systems

The earliest vessel traffic service (VTS) systems employed manual tracking, radar, and voice communications systems that used single-function standalone components with minimal multimission functionality. Today the VTS employs a system that integrates radar, communications, and advanced vessel identification systems to present vessel traffic service watchstanders with a graphic display of all vessels within their purview.

Vessel Data Cards

The initial VTS system was comprised of vessel data cards upon which pertinent vessel information was manually entered. The cards were then positioned on a plotting table. Via radio communications, the cards were then maneuvered to simulate a position within the vessel traffic service area. Later, radar was integrated into this process, which served to enhance operator accuracy in positioning vessels.

Coast Guard Vessel Traffic System

In the early 1990s, in conjunction with Northrop Grumman, the Coast Guard developed and deployed the Coast Guard vessel traffic system, otherwise known as CGVTS. CGVTS is an operating system that integrates data obtained from multiple sensors, radar, VHF-FM voice, and camera video into leased communication lines to transmit all of the information to the vessel traffic center (VTC). The integrated data is displayed on a graphic display, which incorporates electronic charts, to provide a real-time display to the VTC watchstander. This data feed was a tremendous improvement in data collection, enhancing situational awareness and allowing watchstanders to improve their evaluation of the traffic picture. CGVTS was originally deployed in four ports: New York, Houston/Galveston, San Francisco, and Puget Sound.

The Ports and Waterways Safety System and the Automatic Identification System

The mid-1990s saw the advent of the ports and waterways safety system (PAWSS). This commercial, off-the-shelf product was based on the MTM-200 software architecture developed by Lockheed Martin and consists of communications and decision support equip-

Table 1 – AIS Vessel Data

• Name - name of ship. Twenty characters are provided.	• True heading - 0 to 359 degrees, derived from gyro input.
• MMSI number - unique referenceable identification.	• Time stamp - the universal time (to the nearest second) that this information was generated.
• IMO number - unique referenceable identification.	• Type of ship/cargo - there is a table of possibilities that are available.
• Radio call sign - international call sign assigned to vessel, often used on voice radio.	• Dimensions of ship - to nearest meter.
• Navigation status (e.g. "at anchor," "underway using engine," "not under command").	• Location on ship where reference point for position reports is located.
• Rate of turn - right or left, 0 to 720 degrees per minute.	• Type of position-fixing device - various options, from differential GPS to undefined.
• Speed over ground - 1/10 knot resolution from 0 to 102 knots.	• Draught of ship - 1/10 meter to 25.5 meters.
• Position accuracy - differential GPS or other and an indication if receiver autonomous integrity monitoring processing is being used.	• Destination - 20 characters are provided.
• Longitude and latitude.	• Estimated time of arrival at destination - month, day, hour, and minute in Coordinated Universal Time.
• Course over ground.	

Photo courtesy of USCG historian.

ment as well as sensors. The system, which was acquired through a Congressional mandate to modernize VTS, compresses radar, VHF-FM voice, the automatic identification system (AIS), and video from closed-circuit television into commercial-leased T-1 land lines or microwaves and sends the information to a central vessel traffic center. The PAWSS system represented another major evolution in the leveraging of technology within the VTS realm. PAWSS is deployed in nine ports: New York, Houston/Galveston, New Orleans, Sault Ste. Marie, Morgan City, Prince William Sound, San Francisco, Seattle,[1] and Port Arthur.

The introduction of the automatic identification system to the vessel traffic service program has further revolutionized VTS operations. Data that was previously acquired via radio communications between the VTS watchstander and the vessel can now be provided instantaneously through AIS feed. The data feed can also be broadcast to any AIS-equipped vessel within frequency range. Table 1 contains a list of the data that can be transmitted via AIS.

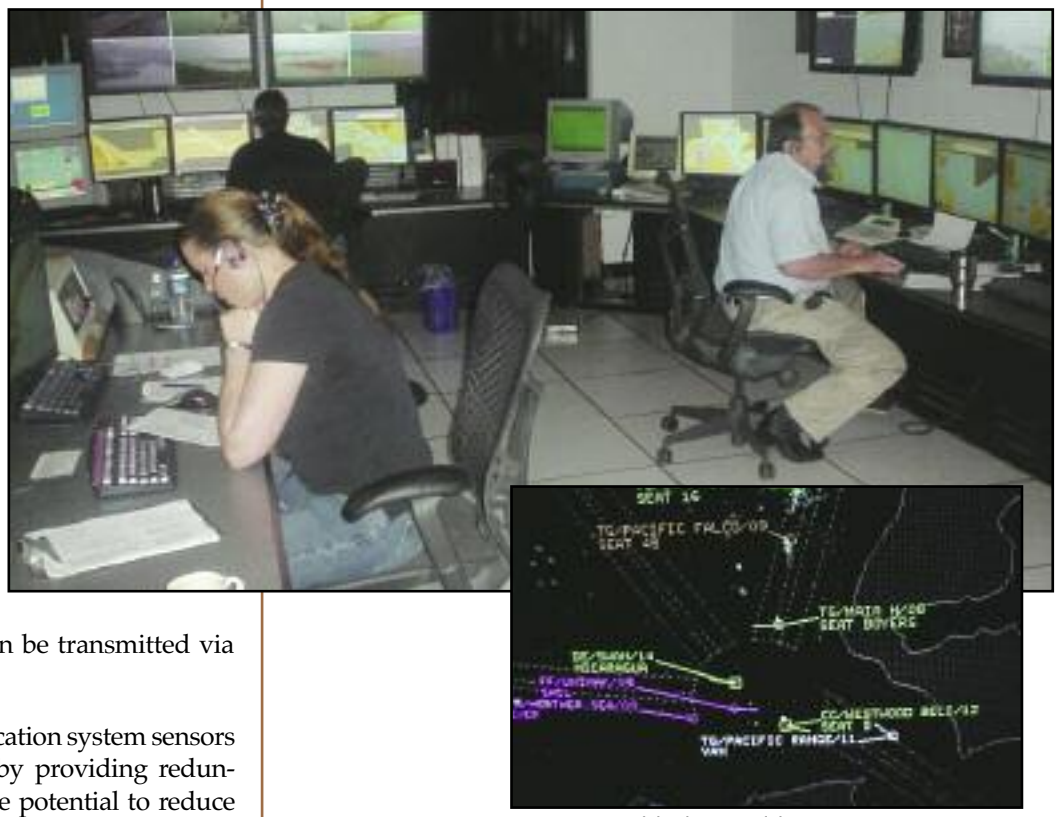
The addition of automatic identification system sensors has augmented VTS operations by providing redundancy for vessel positions and the potential to reduce radio communications through which data is gathered.

Technology's increased speed has benefited the vessel traffic service program by automating the collection and recording of data while increasing the watchstanders' domain awareness, thereby reducing collisions, reducing groundings, and facilitating the safe and efficient transit of vessel traffic. The data collected by the operating system also permits the reconstruction of collisions, spills, and other incidents. In addition, the data can be analyzed to identify potential hazards, trends, traffic density, and tonnage. The track data gathered in PAWSS has facilitated the Coast Guard's homeland security missions as well by sharing its track data with the common operational picture. The technology in the vessel traffic service program has grown by leaps and bounds over the past few decades, and as we move further into the 21st century, the program hopes to continue to capitalize on emerging technology to improve its operations.

About the author: *LCDR Ulysses Mullins is the deputy chief of vessel traffic services assigned to the U.S. Coast Guard Office of Navigation Systems. He has served the Coast Guard for more than 15 years in the marine safety field with previous assignments in Norfolk, Chicago, Jacksonville, Pittsburgh, and New Orleans.*

Endnote:

1. The ports of San Francisco and Puget Sound are operating with a hybrid system, which consists of an interface with both CGVTS and PAWSS.



USCG graphic by David McKnew.

That was then, this is now. Above: A watchstander at VTS Puget Sound in the 1970s uses vessel track data cards. Center: Present day VTS operations. Bottom: Screen shot of operator's workstation.

Planning and Preparation Ensures Success

Aids to navigation restoration after Hurricane Katrina.

by CDR John Arenstam
Chief, Visual Aids to Navigation Division, U.S. Coast Guard Office of Navigation Systems

Even before the birth of our nation, the safe and efficient movement of waterborne commerce was the lifeblood of our economic system. The ability to move goods on the water was essential to the country's development and remains critical to our economic and military supremacy. While oceans are the primary means of moving freight internationally, U.S. river, coastal, and Great Lakes waterways serve as the receiving and distribution points essential to the movement of ocean-borne freight to and within the United States.

Waterways management, restoration capacity, and expertise are essential to maritime preparedness, port resilience, rapidly restoring commerce and economic stability, and ensuring long-term recovery following massive damage. The Coast Guard's aids to navigation units and the waterways management team were put to the test as a result of the massive devastation left in the wake of Hurricane Katrina.


Figure 1: USCG assists evacuation post-Katrina. USCG photo.

Successful aids to navigation (AtoN) restoration begins well before landfall. The Coast Guard, along with partners in the maritime community, develops plans to prepare for natural disasters to mitigate their effects long before a particular storm bears down on coastal areas. These plans include generating a prioritized list of waterways and aids to navigation. These prioritized lists provide commercial merchant shippers a sense of predictability regarding restoration efforts. The lists also assist AtoN personnel in the rapid restoration of critical waterways in a time of limited communications.

Ensuring readiness was another vital component of the planning. Not a single USCG AtoN afloat asset was damaged as a direct result of Hurricane Katrina. The units were predeployed to areas outside of the immediate impact zone, yet remained in a position to respond immediately.

USCG incorporated lessons learned from previous natural disasters, especially from the 2004 hurricane season, when four hurricanes made landfall in Florida. To prepare for Katrina, deployable aids to navigation teams were established with boats, crews, and AtoN spare equipment from around Florida. These teams were in place and on the road, heading west as Katrina made landfall. Other vital preparations included the clear identification and updated inventory of hurricane AtoN equipment stores and aids to navigation positioning equipment. Even with these preparations, a herculean effort was still needed to actually restore the waterways.

Katrina Mission Priorities

When reacting to any major disaster, the Coast Guard first focuses on saving lives (Figure 1) and property, flood relief, restoring mission capabilities at damaged USCG units, and restoring navigable waterways. In Katrina's aftermath, in addition to providing search and rescue operations, the Coast Guard flowed forces to the regions that suffered the impact of the storm to restore ports and waterways, respond to pollution, and provide security and additional law enforcement.

USCGC *Pamlico*, USCGC *Cypress*, and a mini flotilla of smaller USCG assets (Figures 2 and 3) were immediately sent downriver to "provide assistance." That generic guidance was all they needed. USCG personnel successfully evacuated more than 3,000 people, provided force protection and a federal presence in the area and on the water, and performed medical evaluations and triage.

In many regards, the most important role *Pamlico* and *Cypress* played was providing a sense of hope. During the Hurricane Katrina response, Coast Guard AtoN vessels responded from neighboring areas within the Gulf Coast region and inland rivers and played a major role in the recovery effort. In fact, these vessels ensured a safe navigable waterway for the first major Coast Guard cutters and the designated command and control platform, USS *Iwo Jima*. USCGC *Spencer* arrived in downtown New Orleans within two days after the storm hit, due to the efforts of the AtoN crews.

Figure 3: USCGC *Pamlico* and part of her mini flotilla. USCG photo by CWO4 Lewald.

Restoring the Waterways

In addition to the vast devastation, the hurricane hit at the height of the Midwest grain harvest, which created additional urgency to open up the waterways. Coast Guard AtoN assets rapidly surged in order to reopen waterways and restore access for vital commercial shipping. Even during search and rescue operations, AtoN units began to assess the damage and make plans for restoration. They received information about the extent of damage from numerous avenues, overflights, USCG units, local pilots, and other floating units.

Given the enormous size of the storm, it was easiest to assume that all the aids from Morgan City, La., to Mobile, Ala., were severely damaged or destroyed. This turned out to be fairly accurate. Out of more than 1,800 aids to navigation in the area, all but 137 suffered damage. The storm completely destroyed 73 fixed navigational range structures. As a result of the massive damage, more equipment than that stored locally and in the hurricane stores was needed. These vital supplies came from across the nation.


Figure 2: USCGC *Pamlico* begins repairs to Cubits Gap Rear Range. USCG photo by CWO4 Lewald.

AtoN personnel partially staffed various incident management teams. This became crucial, as every available space on aircraft heading to the area was filled with available aids to navigation equipment. This equipment included dayboards, steel and foam buoys, self-contained light-emitting diodes, and pilings. More than $19 million of equipment and materials were needed to restore the aids to navigation system.[1]

Aid restoration was initially based on the predetermined prioritized lists. These were continually adjusted based on waterway criticality; port infrastructure availability; commercial ship arrival; damage; and availability of the assets, people, and equipment needed to restore the waterway.

Twelve Coast Guard cutters and 17 aids to navigation teams worked diligently to restore the waterways (Figure 4). Thankfully, Coast Guard AtoN resources were not alone. They were aided by a number of invaluable federal partners, including the National Oceanic and Atmospheric Administration, U.S. Navy, U.S. Army Corps of Engineers, U.S. Maritime Administration, and the local pilots associations.

Success in Stages

Waterways were opened as channels were cleared of obstruction, aids were restored, and port infrastructure was available. When a waterway could not be completely opened, it was opened in stages, beginning with daylight hours only and one-way traffic; daylight hours only

Figure 4: USCGC *Wedge* works long into the night to rebuild range structure in Mobile Bay, Ala. USCG photo by BMCM Unkrich.

with two-way traffic; 24 hours with one-way traffic only; and, finally, 24-hour, two-way traffic.

This systematic approach to the waterways management efforts resulted in the consistent and continual growth of commercial traffic, ensuring that vital products were delivered and economic impact was minimal. All waterways were restored and open to two-way commercial traffic by September 20, 2005, less than four weeks after one of the worst hurricanes in U.S. history made landfall.

A Continuing Mission

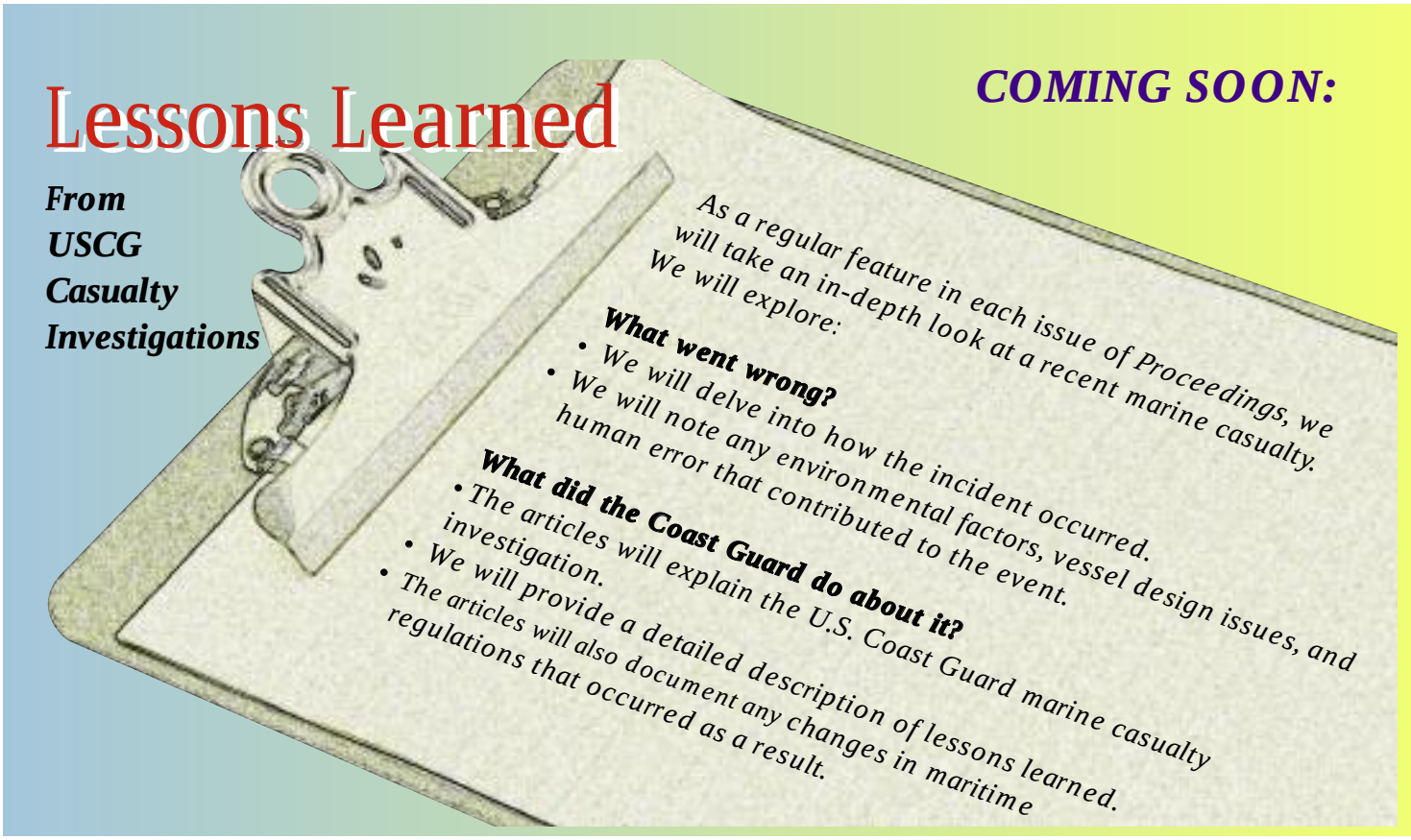
As a maritime nation, it is imperative that the United States retain its capability and expertise in managing its complex system of waterways, under the best and worst of conditions and situations. The Constitution calls for the federal government to regulate interstate commerce, a very large portion of which is generated from waterborne commerce. The proper maintenance and immediate restoration of our nation's aids to navigation system is critical to maintaining the safety and economic, military, and homeland security of America's ports and waterways.

As Katrina highlighted for the nation, there is a fundamental connection between the Coast Guard's aids to navigation system and maritime infrastructure recovery. Our rescue and recovery successes demonstrated the critical importance of rapidly deploying AtoN assets under the most challenging conditions to reopen waterways and restore vital commercial shipping capabilities.

About the author:
CDR John Arenstam has served in the U.S. Coast Guard for over 20 years. He has served in many capacities, most notably as commanding officer of USCGC Firebush*, and commanding officer of USCGC* Penobscot Bay.

Endnote:

[1] USCG hurricane supplemental funding request spend plan.



Important Partnerships

Harbor safety committees' growing impact on the marine transportation system.

Waterways Management Overview

by LCDR Lloyd Banks
U.S. Coast Guard Office of the Marine Transportation System
Oceans and Transportation Division

Within our ports, the harbor safety committee (HSC) has developed into a productive model for dealing with the many complex facets of the marine transportation system. The term "harbor safety committee" can be defined as a local port-coordinating body whose responsibilities include recommending actions to improve the safety and efficiency of a port or waterway. HSCs are comprised of representatives of government agencies, maritime labor, industry organizations, environmental groups, recreational boaters, and other public interest groups. Although these port-coordinating groups may be referred to in various ports under different names, such as "port safety forum," "marine advisory association," or "port advisory group," they all serve the same function—providing a means to ensure communication among all stakeholders within the port.

The volunteer nature of the committee, the mutual cooperation of industry and government, and the variety of stakeholders represented helps ensure that our waterways operate smoothly and that regulatory agencies remain sensitive to the interests of our various port users. HSCs fulfill the Coast Guard's need to establish partnerships that ensure our ports are effectively, safely, and securely managed, and various members of the port community are communicating with the USCG and with one another.

Such end-user input has provided federal, state, and local agencies with a fresh perspective on balancing their regulatory roles with the safe and efficient flow of vessels and commerce. This allows agencies to better plan and respond to emerging events and heightened post-9/11 security.

Harbor Safety Committee Membership and Mission
U.S. port complexes and their associated waterways and terminals are extremely diverse in infrastructure, management, function, and markets served. Local HSCs are often the only forums available to operators and other stakeholders to organize in a comprehensive way to address and resolve issues that affect port operations.

Participants within the HSCs are fairly consistent across all port areas and include most of the following entities:

- port authorities;
- vessel owners and operators (tankers, dry cargo, barges, ferries);
- harbor pilots and pilot associations;
- marine exchanges;
- docking pilots/tug and tow operators;
- shipping agents;
- terminal operators;
- industry associations (national, state, and local);
- organized labor;
- commercial fishing industry associations;
- state and local government agencies, including:
  - environmental agencies;
  - maritime administrations;
  - regional development agencies;

Online Community

The Coast Guard's interactive web-based site, Homeport, located at http://homeport.uscg.mil, is a useful tool for HSC communications. Homeport makes a host of information related to safety, security, and environmental stewardship available to the maritime community.

Within the ports and waterways "community," access is provided to HSC members to post meeting minutes, share best practices, and exchange thoughts and ideas. The Coast Guard oversees the user-friendly registration process and provides secure access to harbor safety committee members from around the nation.

- emergency management agencies;
- federal government representatives, including;
  - U.S. Coast Guard;
  - National Oceanographic and Atmospheric Administration hydrographic group;
  - U.S. Army Corps of Engineers.

Primary Industry Needs and Requirements

Industry organizations within port areas have long used a marine exchange or similar forum as a means of coming together to solve particular operational problems and/or to serve a common good. For example, the Maritime Association of the Port of Charleston was founded in 1926 and now has 450 members. It influences decisions on port use, training, marketing, navigation, and industrial development. However, such mechanisms were not universal and did not include all stakeholders.

Industry has consistently expressed the need to provide input on regulatory decisions affecting their industry and livelihood. These end users have an extensive knowledge of the waterway and their experiences allow them to recommend measures to reduce risks and offer valuable advice on related issues.

Industry strongly believes that it is important for the Captain of the Port to maintain a nonregulatory role within the HSC. For this reason, within the scope of the local harbor safety committee, USCG works with industry as a partner rather than as a regulator.

The informal organizational structure and mutual cooperation of its members have allowed harbor safety committees to become the ideal model for balancing the needs of various interests in the marine transportation system whether they are economic, environmental, recreational, regulatory, or for national defense.

About the author:
LCDR Lloyd Banks is currently assigned to the U.S. Coast Guard Oceans and Transportation Division. He has been involved in the Coast Guard's marine safety program for the past 15 years. He has a bachelor's degree in management information systems from Norfolk State University and a master's degree in business administration from Old Dominion University.

The National Harbor Safety Committee conference is held in one of our major ports in the spring of each year. The conference is hosted by the United States Coast Guard, the Transportation Research Board, and a local harbor safety committee.

The conference agenda is organized around various panel sessions that address general issues such navigation, environmental protection, best practices, and disaster preparedness. Frequently these panel sessions are geared towards the conference theme, which in recent years has included, "Safety: Our First Mission Along the Rivers, Lakes, and Coastal Ports," "Forging Partnerships to Improve Safety in the Marine Transportation System," and "Balancing and Optimizing the Missions: Safety, Security, Mobility, and Environment."

For more information, go to http://www.trb.org/calendar or search for the conference at http://homeport.uscg.mil.

HSCS: THE MODEL FOR SUCCESS

Successful harbor safety committees are uniquely created to fit the specific needs of each port. For example, some are large, some small; some chaired by the USCG COTP, and others by industry or state or local government. However, they all share certain elements:

- HSCs must work to promote a consensus-based approach to addressing port issues that facilitates acceptance of decisions.
- HSCs must provide a forum where all stakeholders come together on an equal footing.
- Successful HSCs focus on common stakeholder goals.
- HSCs work because the USCG and other government agencies are partners in the process, not controllers of it.
- HSCs enable the public to interact with the maritime industry.
- HSCs must address port issues and challenges with a system's perspective, taking into consideration that safety, security, environmental protection, and port efficiency issues all interact and affect each other.
- HSCs must be organizationally flexible enough to adapt to the changing needs of the port.

The Marine Board

Providing independent scientific and technical advice to support Coast Guard missions.

by Dr. Martha Grabowski
Chair, Marine Board, Transportation Research Board, the National Academies

Mr. Richard Vortmann
Vice Chair, Marine Board, Transportation Research Board, the National Academies

Ms. Joedy Cambridge
Staff Director, Marine Board, Transportation Research Board, the National Academies

Mr. Peter Johnson
Senior Project Officer, Marine Board, Transportation Research Board, the National Academies

The Marine Board of the National Academies is an internationally recognized source of expertise on maritime transportation, marine technology, and offshore development. It serves national interest by providing analyses and advice concerning the ability of the nation's marine and maritime industries to operate safely and efficiently and in an environmentally responsible manner. When performing its role as an independent advisor to the Coast Guard, the board identifies research and engineering needs and provides a forum for the exchange of information relating to new technologies, laws/regulations, economics, the environment, and other issues affecting marine transportation, ports and waterways, offshore energy, coastal development, and maritime policy.

The board is part of the Transportation Research Board division of the National Research Council. Members are appointed by the National Research Council and serve without compensation. Because of its affiliation with the Transportation Research Board and its standing committees, the board can develop activities that encourage discussion and examination of maritime transportation, marine research, policy issues, and technology developments in a broad context.

The Coast Guard and other federal agency sponsors engage the board when they need outside independent analyses and advice regarding critical national issues in such areas as:

- water transportation on oceans and inland waterways;
- waterways, harbor, and channel infrastructure;
- ports and terminal operations;
- marine security and safety;
- marine environmental protection;
- shipbuilding, naval architecture, and marine engineering;
- coastal engineering;
- maritime policy and economics;
- offshore operations and development;
- ship operations, technology, and human factors;
- global shipping and logistics.

Recently, Marine Board committees have conducted several policy studies of particular interest and value to Coast Guard waterways management missions. Each of these studies was sponsored and supported either in whole or in part by the Coast Guard and directed toward unique problem-solving approaches. Four studies have ended recently, providing key conclusions and recommendations.

***Study 1:* The Marine Transportation System and the Federal Role—Measuring Performance, Targeting Improvement**

This project focused on developing an analytical framework for federal agencies to identify needs and coordinate investments on marine transportation system infrastructure. The federal role in the marine transportation system (MTS) includes activities in support of safe navigation, waterway maintenance, environmental protection, security, customs services, setting national goals and funding mechanisms, and evaluating performance.

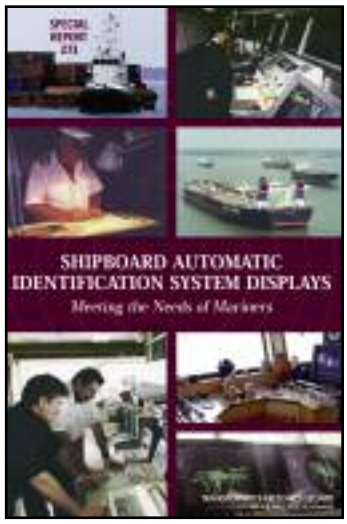
The report reviewed current and projected investments, assessed industry trends, and identified options for future investments. While many federal agencies have responsibility for MTS investments, the Coast Guard's missions are critical to effective and efficient marine transportation system performance, public safety, security, and protection of the environment.

The 2004 study report concluded that the federal role in the marine transportation system is large, influential, and justified by the nation's strong interest in facilitating commerce and furthering related public interests. This role is widely dispersed among many agencies, and there is a need for one agency to take the lead. The report recommended that the Department of Transportation (DOT) consult with other agencies and users and establish performance goals for the MTS as well as a regular analysis of system use, condition, and performance.

The lack of performance data inhibits the Coast Guard and others in their efforts to justify needed investments. It is only practical to set goals and measure performance government-wide, so that each agency's contribution can be considered within the total. The interagency committee on the marine transportation system within DOT can provide the necessary leadership, and this study report can inform and support the process.

***Study 2:* Shipboard Automatic Identification System Displays—Meeting the Needs of Mariners**

As the Coast Guard prepared for the implementation of mandatory carriage requirements for automatic identification systems (AIS) aboard vessels in U.S. waters, it was concerned about the lack of standards and requirements for shipboard display of AIS information. It asked the Marine Board to examine the technology and operational factors affecting automated identification system displays and how they could be the most effective onboard navigation tools.



A board committee investigated evolving AIS systems technology and its use aboard vessels for collision avoidance and waterways traffic management. It concluded that the automated identification system had the potential for significant improvements in shipboard navigation practices and safety, but also could introduce unnecessary additional problems with poor designs and applications.

In its 2003 report, the committee recommended a systematic implementation plan to ensure underlying research demonstrating needs-based results. It also recommended that standards and requirements for AIS displays should be carefully developed and integrated with all other shipboard navigation tools so that mariners could benefit from the total complement.

The committee also made recommendations regarding the need for display designs to include human factors as a focus in the process. It cautioned about the limitations of automated identification systems, and recommended that the Coast Guard work closely with all stakeholders to develop all requirements and include appropriate training and certification guidelines for AIS users.

***Study 3:* Polar Icebreakers in a Changing World—An Assessment of U.S. Needs**

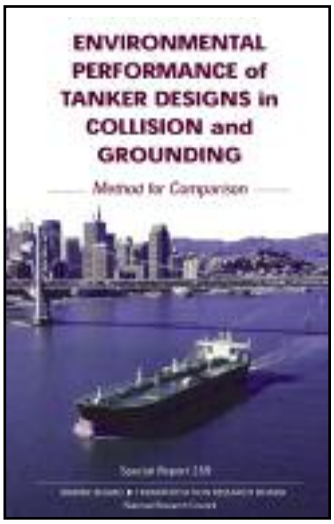
The United States has enduring national and strategic interests in the Arctic and the Antarctic, which have been growing more active in recent years. These interests have been supported by a fleet of Coast Guard icebreakers that provide icebreaking and platforms for scientific, security, commercial, and related activities. The two most capable polar icebreakers are at the end of their service life, and the U.S. risks being unable to support national interests in these areas. In the north, the nation has territory and citizens in the Arctic. In the south, we maintain three scientific stations to assert U.S. presence and leadership among the nations that are signatories to the Antarctic Treaty.

In 2005, Congress directed the Coast Guard to request that the Marine Board assess its polar icebreaker roles and future needs. A board committee evaluated the current and future roles expected for U.S. polar icebreakers to support all national priorities. The committee's 2006 report covered icebreaking needs in the Arctic and Antarctic and concluded that the U.S. should continue to project an active and influential presence in both polar regions. The committee also concluded that the U.S. should maintain world leadership in polar research requiring icebreakers to access the deep Arctic and ice-covered waters in the Antarctic.

Since the nation's polar icebreaking fleet is in dire need of renewal, and demand for future icebreaking capability will undoubtedly increase, the committee recommended that the United States immediately program, budget, design, and construct two new polar icebreakers to be operated by the Coast Guard. It is expected that these new vessels would not enter into service for another eight to 10 years and would require substantial resources. This report will serve as scientific and technical justification for major national policy debates in the years to come.

Study 4: **Environmental Performance of Tanker Designs in Collision and Grounding—Method for Comparison**

Since the early 1990s, the Coast Guard has implemented the double-hull standard for tankers carrying oil in U.S. waters, as mandated by Congress in the Oil Pollution Act of 1990. This standard has generally been adopted by the industry and the world tanker fleet changed to double-hull construction. While both the U.S. Coast Guard and the International Maritime Organization have issued regulations to that effect, the regulations did not provide for alternative tanker designs that might achieve the same end as the double hull.



In 1998, Congress called for the Coast Guard to commission the board to investigate the issue of alternative tanker designs and recommend a process to evaluate new designs as equivalent to double hulls in their ability to prevent oil spills after a collision or grounding accident. Several designs had been proposed; however, even if none were actually superior to double hulls now, Congress thought there should be a method to allow for innovations and improvements in the future.

Coast Guard Cutter *Polar Star.* USCG photo.

The committee published its report in 2001 and proposed a rational approach for assessing the performance of alternative tanker designs based on their relative ability to prevent environmental damage from oil spills following collision and grounding accidents. The methodology can be used by regulatory authorities as a tool to determine whether to approve a proposed alternative design. The committee's approach makes use of available data on structural damage, oil outflow modeling with existing computational tools, and existing techniques for measuring environmental damage from oil spills. The report provides examples of the use of the methodology and suggests steps for its implementation.

Future Challenges

The Marine Board has supported Coast Guard needs for independent scientific, technical, and policy advice for many years. The board frequently consults with the Coast Guard about maritime technology developments, new policy initiatives, industry trends, and national needs and priorities. The recent work described here is but a small sample of the wide range of topics the board has addressed.

Future initiatives will support the Coast Guard's continuing need to upgrade its technological capabilities, improve mission performance, and enhance efficiency of operations. Key topics for future board attention include:

- evaluating risk assessment methods and techniques as a Coast Guard decision-making aid, with goals of improving maritime mobility and safety, reducing major risks to life and property from all waterway users, and selecting mitigation strategies;
- using risk assessment techniques to improve the safety of ship operations and reduce accidents among the growing commercial traffic along the North Pacific Great Circle route in close proximity to the Aleutian Islands;
- examining the future of all USCG-supported aids to navigation including electronic, physical, and shipboard systems, with attention to evolving technology, future user needs, and justification for future funding options;
- investigating data collection systems and analyses of leading indicators for improving safety management and early warning of problems.

The board will continue to serve the national interest by examining these and other developments in marine technology, maritime transportation, and related subjects to advise the Coast Guard and help maintain a safe, secure, productive, and efficient national maritime community.

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Truman-Hobbs

Quantifying navigational benefit.

by Mr. William F. Knutson
Bridge Management Specialist, U.S. Coast Guard Eighth District

The Truman-Hobbs Act of 1940[1] provides a process through which the U.S. Coast Guard decisively participates in waterways management. This process is used to identify, analyze, and recommend alterations to bridges that are unreasonable obstructions to navigation. These bridges often predate the modern waterway and impede or prevent realization of its full potential. When waterway improvement projects (such as channel widening, dredging, straightening, and replacing outdated locks and dams) have been completed, but antiquated, obstructive bridges remain, the waterway's promise of improved efficiency is unfulfilled.

The Process

The Coast Guard has administered bridge alterations under the Truman-Hobbs Act since 1967, when the program was transferred from the U.S. Army Corps of Engineers.[2] The process starts by identifying bridges as "worthy of study" because of a high number of bridge allisions and numerous complaints from waterway users. These bridges typically share many characteristics, including being constructed prior to the creation of a modern waterway, being located in river bends, and having navigation openings that are too narrow or placed poorly in the bridge structure (Figures 1 and 2).

When a bridge is selected for a formal Truman-Hobbs study, the first matter of business is to accurately identify problematic attributes. This is done by reviewing Marine Information for Safety and Law Enforcement (MISLE) data together with other information on file with the Coast Guard unit responsible for investigating allisions for a particular bridge. Another source of information comes from the mariners that transit the problem bridges on a regular basis. They provide first-hand information regarding problems associated with the bridge, including the extra effort made to avoid hitting the bridge, such as "double-tripping" (Figure 3) or using assist boats. Double-tripping is a lengthy process that involves breaking down the tow on one side of the bridge, taking only part of the tow through the bridge at a time, and then rebuilding the tow on the other side. The navigation industry assists in this process by providing information about how much extra time is required to transit a subject bridge.

The Tools

A primary tool used to quantify the obstructive character of a bridge is a questionnaire that identifies zone of influence, speeds that are possible, and the percentage of times that the bridge is double-tripped or an assist boat is used. When the data is entered into a spreadsheet, the sampling is applied to the total number of commercial tows that transit the bridge.

Once all data is accumulated, a preliminary report is prepared and submitted to the commandant. The preliminary report breaks the costs associated with an obstructive bridge into three main categories:

- transit time savings,
- water accident reduction savings,
- certain other savings.

continued on page 29

Figure 1: A southbound 15-barge tow transits the Burlington railroad drawbridge, mile 403.1 upper Mississippi River, which provides a horizontal clearance of 153 feet. An assist boat, shown in the foreground, is often used at this bridge. USCG photo by W. F. Knutson.

THE BRIDGES

A typical "Truman-Hobbs" bridge is a railroad drawbridge built from 1890 to 1920, when navigation consisted of sternwheel steam boats that pushed rafts or small barges weighing a few hundred tons. The timber protection fences were adequate at that time to protect the bridge structure by shearing the vessels away from vulnerable bridge components. The waterways have since been steadily improved with larger locks and dams, larger tows, and more powerful towing vessels.

Figure 1: A southbound tow, 105 feet wide, approaches the Elgin, Joliet, and Eastern railroad drawbridge, located at mile 270.6 Illinois Waterway. The bridge features a mere 120.5-foot horizontal opening. USCG photo by W. F. Knutson.

A typical modern tow on rivers with locks and dams consists of 15 barges, configured five long and three wide. The resulting tow is 1,100 feet by 105 feet, with a total weight of about 27,000 short[1] tons. A small tow of nine barges will typically have a gross weight of more than 16,000 short tons. A protection system designed to shear a few-hundred-ton vessel away from sensitive bridge parts offers little protection from a modern tow that fails to precisely transit an antiquated bridge. The timber protection fences are vulnerable to repeated events that accumulate to significant bridge damage.[2]

Perhaps the bridge has been the subject of a port and waterway safety assessment (PAWSA) report, as in the case of the Louisville and Indiana railroad drawbridge, located at mile 604.4 on the Ohio River.[3] This bridge provides a very narrow opening—approximately half of what the waterway would allow—and is located in a river bend.

A bridge may be hit repeatedly, much more often than other movable bridges, as in the case of the Elgin, Joliet, and Eastern railroad drawbridge at mile 270.6 on the Illinois Waterway (Figure 1), which holds the dubious distinction of being the "most hit" bridge on the inland waterway system.[4] Often bridges worthy of a Truman-Hobbs study absorb a significant amount of Coast Guard assets to investigate bridge hits and even fatalities, as in the case of the Galveston Causeway railroad bridge, mile 357.2 on the Gulf Intracoastal Waterway. This bridge sustains possibly the highest number of "hits" in the Gulf Coast area.[5]

Added efforts may include avoiding the bridge altogether, as in the case of the Simmesport railroad bridge located at mile 4.4 on the Atchafalaya River near Simmesport, La. The location of the movable navigation span in a river bend with chaotic currents is a detriment to the entire waterway (Figure 2). Mariners prefer to transit the Simmesport railroad bridge under a fixed span. When the fixed span is not available due to high water, they will add a day or about 130 miles to their trip by using the Port Allen route.[6]

Figure 2: A tow transits a fixed span on the Simmesport railroad drawbridge, mile 4.4 Atchafalaya River. The movable span to the left of the tow is avoided and many mariners opt for a longer route when they cannot transit the fixed span. USCG photo by W. F. Knutson.

Endnotes:

1. In shipping, a "short" ton is 2,000 lbs., a "long" ton is 2,240 lbs.
2. Wiebusch, R. K. "The Design, Maintenance, and Repair of Bridge Navigation Fender Systems," American Railway Bridge and Building Association 101st Annual Conference, September 22-25, 1966.
3. Results of PAWSA for the port of Louisville, Ky. Letter from commanding officer, Coast Guard Marine Safety Office Louisville to commander, Eighth Coast Guard District, May 20, 2002.
4. Coast Guard Second District, "Detailed Report on the Obstructive Character of the Elgin, Joliet, and Eastern Railroad Bridge," 1994.
5. Coast Guard Eighth District, "Detailed Report on the Obstructive Character of the Galveston Causeway Railroad Bridge," 2000.
6. Coast Guard Eighth District, "Detailed Report on the Obstructive Character of the Simmesport Railroad Bridge," 2005.

Figure 2: An eastbound tow approaches the Galveston Causeway railroad bridge, mile 357.2 Gulf Intracoastal Waterway. A narrow bridge opening of less than 108 feet, located in an open bay area, results in significant delays due to wind and tide conditions. The highway bridge in the foreground will be replaced with a bridge that will provide about 300 feet of horizontal clearance. USCG photo by W. F. Knutson.

Transit time savings is the extra time vessels need to transit the bridge because of the slowing and extra maneuvering needed to get through a narrow opening, then having to regain speed once through the bridge. Water accident reduction savings involves costs associated with bridge allisions resulting in bridge damage and hull damage, including lost cargos when barges are breached or sink. Certain other savings include any special costs, such as use of an assist boat, vessel delay while waiting for another tow to clear the bridge zone, or loss of human life.[3] The total savings is the navigational benefit—the monetary amount the subject bridge costs the inland marine industry and the transportation infrastructure on an annual basis.

The next step, providing the navigational benefit is found to be sufficient, is to conduct a public hearing, typically held as near as practical to the bridge site. All interested parties are invited to make a statement or submit a written statement that will become part of the public record. The public hearings are usually attended by a wide array of interested persons representing the bridge owner; transportation industry; federal, state, and local agencies; and political staff personnel.

A copy of the transcript becomes part of a detailed report that also includes letters of complaint and other information submitted. The preliminary report is amplified to reflect new information submitted for the public record. The detailed report is submitted to the commandant and if the cost/benefit ratio is sufficient, the commandant orders the bridge altered.

When the bridge "order to alter" is issued, the project is set to be completed only after congressional funding is allocated. Coast Guard bridge engineers work with the bridge owner to design the bridge structure alteration and complete the environmental requirements of the National Environmental Policy Act.

The Results

The statistics show that altered bridges immediately improve the efficiency of waterways.[4] Allisions are greatly reduced, the navigation industry realizes a tangible navigation benefit, and the threat of environmental harm is reduced. Coast Guard assets that had been used to investigate bridge hits can undertake other missions, and the need to monitor conditions at a specific bridge is diminished.

About the author:

Mr. William F. Knutson is a bridge management specialist at Coast Guard Eighth District, where he performs Truman-Hobbs studies. Previously he was a marine surveyor for more than 25 years. He served during the Vietnam conflict and retired from USCGR as a lieutenant commander. Mr. Knutson is a graduate of the University of Minnesota and is currently working on a master's degree in geographic information systems at Southern Illinois University, Edwardsville.

Endnotes:

1. 33 U.S.C. 511-524.
2. Commandant Instruction M16590.5C, Bridge Administration Manual. March 26, 2004.
3. Coast Guard Eighth District, "Detailed Report on the Obstructive Character of the Galveston Causeway Railroad Bridge," 2000.
4. Wiebusch, R.K., bridge administrator, Coast Guard Eighth District, personal correspondence.

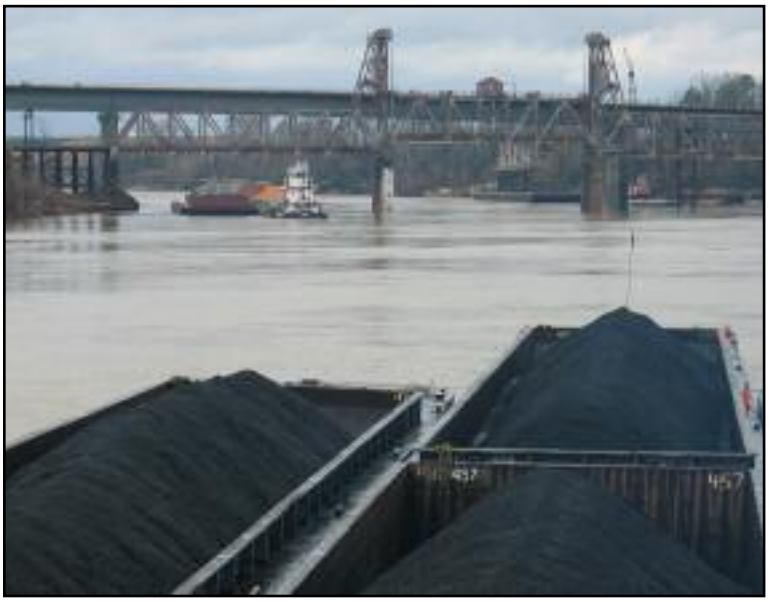


Figure 3: A tow transits a fixed span on the Naheola railroad bridge, mile 173.5 Black Warrior Tombigbee Waterway. Mariners often "double-trip" this bridge during periods of high water. USCG photo by W. F. Knutson.

Navigation

The E-Navigation Revolution

by Mr. William R. Cairns
Principal Engineer for E-Navigation
U.S. Coast Guard Waterways Management Directorate

The Office of Navigation Systems in the U.S. Coast Guard Waterways Management Directorate is helping to define and shape the future of e-navigation through its efforts on the International Association of Marine Aids to Navigation and Lighthouse Authorities (IALA) e-Navigation Committee and the International Maritime Organization Subcommittee on Safety of Navigation correspondence group.

What is E-Navigation?

E-navigation involves the collection, integration, and display of maritime information onboard and ashore by electronic means. This includes navigation-related sensors and equipment connected via communications networks and interfaced for presentation.

The e-navigation concept has been creeping into maritime discussions since around 2005. The United Kingdom Department for Transport may have coined the term in 2005 as it was considering its aids to navigation infrastructure and a perceived lack of coordination in the marine navigation realm. Another early appearance occurred as e-navigation was addressed at the November 2005 IALA seminar on "Global Tracking of Vessels" in Kuala Lumpur.

At the 81st session of the International Maritime Organization (IMO) Maritime Safety Committee (MSC) in May 2006, Japan, Marshall Islands, the Netherlands, Norway, Singapore, the United Kingdom, and the United States jointly proposed and the committee approved a new work item on e-navigation.[1] It has since become the subject of the International Maritime Organization Subcommittee on Safety of Navigation correspondence group. Because information transfer relies on radiocommunications, e-navigation is also being considered at the IMO Subcommittee on Radiocommunications and Search and Rescue (COMSAR).[2]

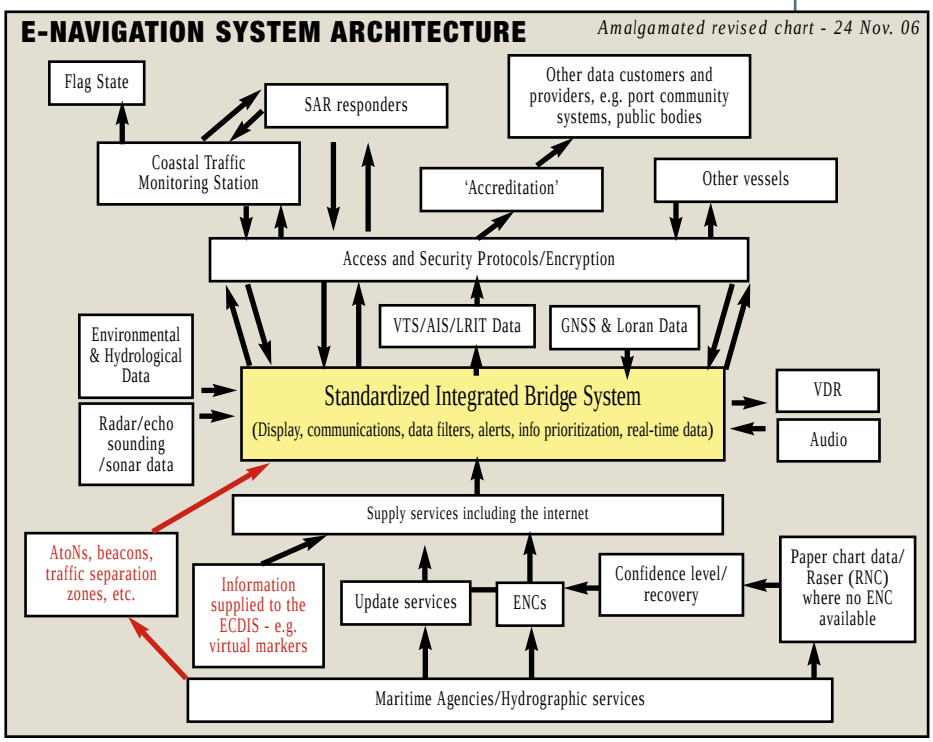


Figure 1: E-navigation systems architecture.

E-NAV at IMO

The tasks of the IMO correspondence group in progress include:

- Define the scope of e-navigation in terms of its purpose, components, and limitations, in order to produce a system architecture (Figure 1).
- Identify key issues and priorities in a strategic vision and policy framework.
- Identify benefits and obstacles.
- Identify the roles of IMO, its member states, other bodies, and industry.

- Formulate a work program for further development of e-navigation, including the roles of the NAV and COMSAR subcommittees.

In parallel with the IMO shipboard perspective, the International Association of Marine Aids to Navigation and Lighthouse Authorities is leading the shoreside development of e-navigation.

E-NAV at IALA

The inaugural session of the IALA e-Navigation Committee (E-NAV) was held from September 18–22, 2006. This committee was formed from its committees on automatic identification systems (AIS) and radionavigation. IALA brings expertise in aids to navigation, vessel traffic services, radionavigation, and automatic identification systems to the e-navigation discussion.

Expectations of E-Navigation

The overriding objectives are safety and efficiency. To this end, IALA is contributing to the IMO effort on e-navigation, providing input to the IMO Subcommittee on Safety of Navigation correspondence group.

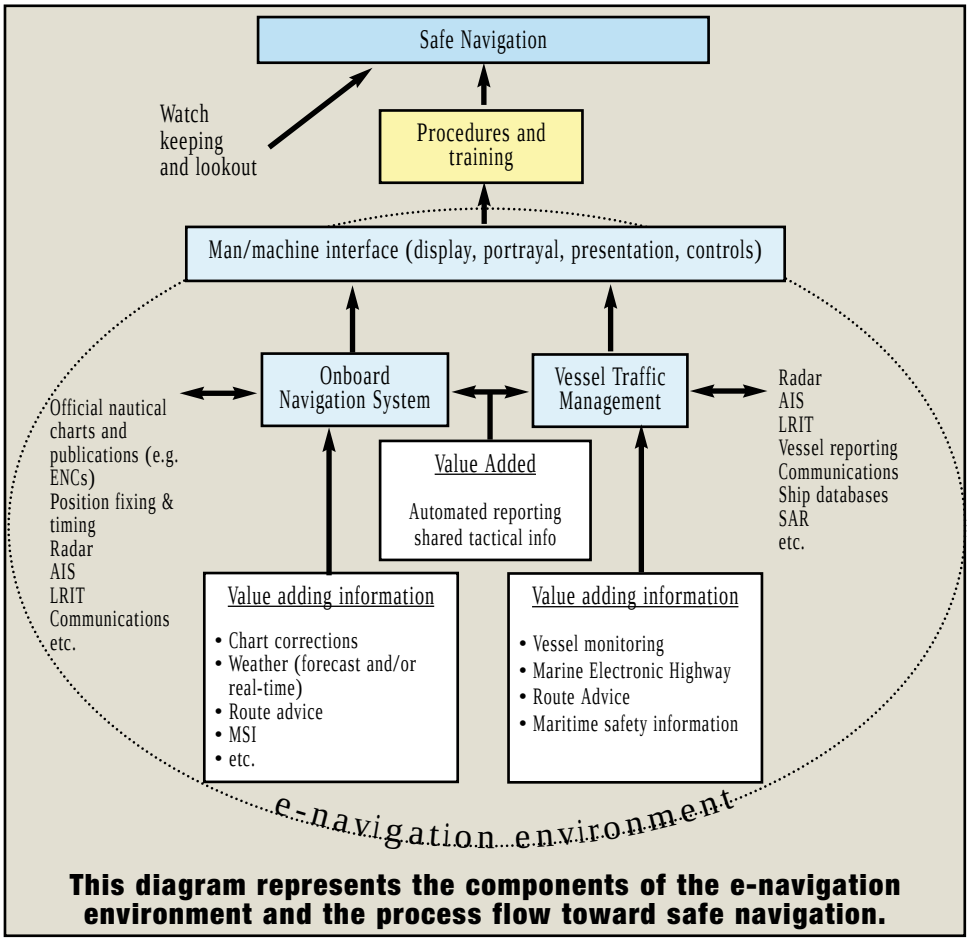


Figure 2: E-navigation environment.

E-navigation data standards must be defined (ship to ship, ship to shore, shore to ship, and shore to shore). Shipboard and shoreside displays/presentations must focus on providing appropriate and relevant information to the officer on watch in a timely manner. The E-NAV committee intends to produce an open, telematic architecture for e-navigation to include conceptual, logical, and physical layers. As technologies advance, this e-navigation architecture should be scalable and flexible to grow and adapt to those advances.

Why the Maritime Community Needs E-Navigation

Shipboard bridges are filled with independent electronic systems. Rather than "just another box," e-navigation should provide a holistic or systems approach to shipboard and shoreside navigation activity. This includes improving the human/machine interface and providing clear information to mariners so that they may correctly interpret the situational display, make informed decisions, and safely navigate (Figure 2).

E-navigation should harmonize and standardize transfer of information, equipment interfaces, and functionality while maintaining transparency and adaptability to advances in technology. The e-navigation presentation should prioritize information for the mariner and adapt to changing situations. It should facilitate simple, efficient communications, creating an effective ship-shore navigation team. This will improve traffic efficiency and port risk management, contribute to an optimum mix of aids to navigation, and improve situational awareness to both the ship and shore. E-navigation may eventually expand traditional vessel traffic service capabilities to include coastal and oceanic areas.

Limitations of E-Navigation

The existing legal framework (for example, the United Nations Convention on the Law of the Sea) and the ultimate responsibility for a ship resting with the master can be viewed as inherent boundaries for all maritime discussions. Radio spectrum (including AIS frequencies and international bandwidth limitations) is constrained by International Telecommunication Union Radiocommunication regulations and national spectrum authorities. There are also technological limitations with existing processing power and human/machine interfaces.

One pervasive theme in early E-NAV discussions has been that mandatory carriage requirements would expedite the implementation of e-navigation technologies. Along those lines, widely available, affordable electronic nautical charts appear necessary for any successful strategy. Also, mariner and vessel traffic service operator skill levels, procedures, and training must accompany any technological advances.

Market and other commercial constraints as well as political constraints, including national security issues, may also place limitations on e-navigation. Standards-making bodies will need to quickly achieve consensus and approvals so that they will be able to keep up with the market.

Office of Navigation Systems

The ultimate development of e-navigation will likely touch on all aspects of shipboard and shoreside navigation and communications equipment. In its roles on the IALA E-NAV committee and the IMO subcommittees on Safety of Navigation and Radiocommunications and Search and Rescue, the U.S. Coast Guard Office of Navigation Systems is helping to define and shape the international e-navigation revolution.

About the author:

Mr. William R. Cairns is the principal engineer for e-navigation in the Waterways Management Directorate at U.S. Coast Guard Headquarters. He has served on U.S. delegations to the IMO Maritime Safety Committee and NAV and COMSAR subcommittees. He was coordinator of the COMSAR correspondence group on long-range identification and tracking and is a U.S. member of the ad hoc working group on engineering aspects of long-range identification and tracking. He is chairman of the IALA e-Navigation Committee and a Fellow with the Royal Institute of Navigation.

Endnotes:

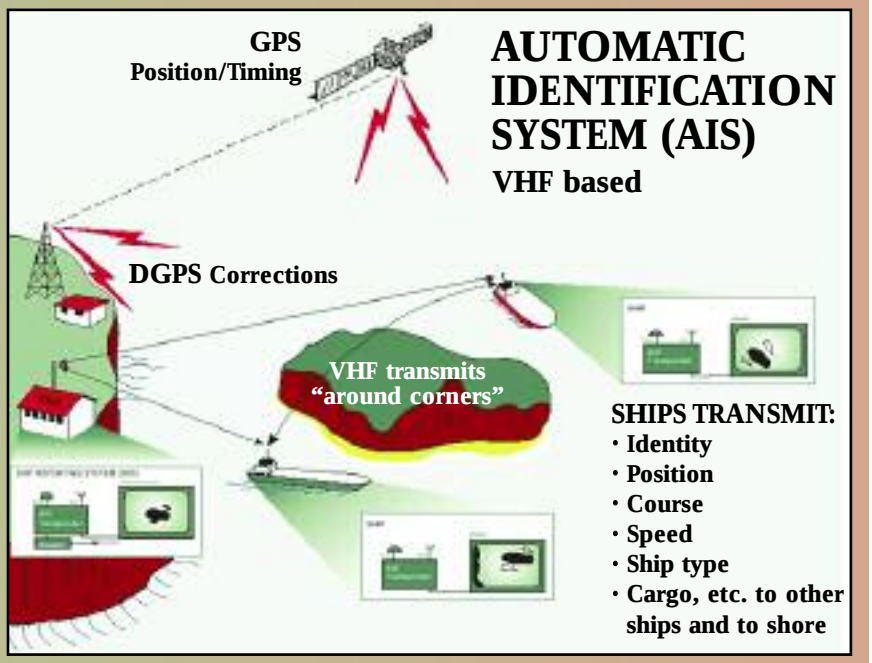
[1] MSC 81/25 para. 23.32 and annex 39.

[2] MSC 81/25 para. 23.32.

COMPONENTS OF E-NAVIGATION

There is an extensive list of equipment that's available today and expected in the future. The list includes:

- AIS;
- radar;
- VHF/HF/MF radios;
- the Global Maritime Distress and Safety System;
- terrestrial radionavigation systems;
- marine safety information;
- Navtex, Inmarsat, and other satellite communications;
- electronic charts;
- integrated navigation/integrated bridge systems;
- meteorological/hydrological sensors;
- long-range identification and tracking systems.



Other less conventional contributors to the E-NAV solution could include visual sensors, voice recognition, closed-circuit television, portable pilot units, assisted docking systems, virtual AtoNs, and automatic three-dimensional ship control systems. The challenge is to incorporate these systems into a single architecture.

Tell Me What You Think

The Navigation Safety Advisory Council.

by Mr. John Bobb
Chief, Oceans and Transportation Policy Division
U.S. Coast Guard Waterways Management Directorate

The Navigation Safety Advisory Council (NAVSAC) is a Department of Homeland Security federal advisory committee sponsored by the U.S. Coast Guard. It operates under the requirements of the Federal Advisory Committee Act (FACA). To understand NAVSAC, one must first understand a bit about the act itself. It was enacted by Congress in 1972 to ensure that advice provided to the executive branch by individuals, groups, organizations, or special interests does not have undue influence on government actions.

Congress wanted to enhance public accountability and reduce wasteful spending. It also wanted to offset the undue influence of special interest groups by balancing committee membership and ensuring public access to committee deliberations.

FACA established management controls to minimize costs and identify and eliminate unproductive or unnecessary committees. Under the Federal Advisory Committee Act, advisory committees must provide an annual report to Congress. There are three types of advisory committees: presidential, statutory, and agency-established. FACA makes clear that advisory committees advise—they don't decide.

Federal advisory committee members come from nearly every occupation, relevant industry group, and geographical part of the U.S. and its territories. Members of specific committees have the expertise and professional skills that the president, Congress, and agencies need to help meet their respective goals. Agencies select members to ensure that majority and minority views are represented.

The Coast Guard currently sponsors nine advisory committees, including the Navigation Safety Advisory Council.

A Brief History

NAVSAC began four decades ago as an agency panel to seek maritime industry input on the international and inland rules of the road. The Coast Guard initiated several efforts to address the hodgepodge of navigation rules—including inland, Great Lakes, western rivers, and pilot rules—that had developed over the years. In 1965, the Coast Guard established a "rules of the road" coordinating panel to create one comprehensive set of rules for U.S. waters. Mr. Nicolas Healy, a prominent admiralty lawyer and the president of the Maritime Law Association, chaired the panel. The panel developed a draft set of inland rules that were widely distributed, but despite the work of the experts and the Coast Guard, no

The Federal Advisory Committee Act requires that:

- Meetings are announced in advance and open to the public.
- The public has the right to speak at meetings and submit written statements.
- Memberships are fairly balanced in terms of points of view and the functions of the committee.
- Committee documents are kept, and available for public inspection.

consensus was reached. The hodgepodge remained.

The secretary of the Department of Transportation established the original Rules of the Road Advisory Committee in 1977 to provide advice to the Marine Safety Council of the U.S. Coast Guard on matters affecting the rules of the road. It began meeting in another attempt to draft a unified set of inland rules, consistent with the International Regulations for the Prevention of Collisions at Sea, 1972.

In 1980 the president signed the Inland Navigation Rules Act. This act also created the Rules of the Road Advisory Council (RORAC), replacing the advisory committee. RORAC provided advice to the secretary of the Department of Transportation on matters relating to the international and inland navigation rules. In 1989 Congress expanded the scope of RORAC and renamed the council the Navigation Safety Advisory Council (NAVSAC).

Advisory committees existed long before Congress decided to codify them. The nation's first "advisory committee" was created by George Washington to get advice on how to best deal with an important problem in 1794—the Whiskey Rebellion.

Purpose

The purpose of the council is to advise, consult with, and make recommendations to the secretary of the Department of Homeland Security on matters relating to the prevention of collisions, rammings, and groundings, including the Inland Rules of the Road, the International Rules of the Road, navigation regulations and equipment, routing measures, marine information, diving safety, and aids to navigation systems. The statute requires that any advice or recommendation made by the council to the secretary reflect the independent judgment of the council on the matter concerned.[1]

Accomplishments

In the long history of the council and its predecessors, the contributions made have consistently brought value to the Coast Guard (and ultimately, the public) by making it aware of the public point of view on navigation issues. NAVSAC's top five accomplishments are, of course, subject to debate, but here are five that have had much positive impact:

Number 5: NAVSAC made recommendations and provided input supporting Coast Guard efforts at the International Maritime Organization to develop electronic chart display information systems (ECDIS) standards and approved training and certification requirements for ECDIS operators.

Number 4: The committee and its previous versions provided valuable advice to the Coast Guard during the negotiations that led to the international adoption of the International Regulations for the Prevention of Collisions at Sea, 1972. These regulations formed the basis of the Inland Navigation Rules Act of 1980.

Number 3: The council recommended that the Coast Guard complete the development and deployment of the differential global positioning system (DGPS) for application on the inland river system. Today DGPS applications track everything from watches to supertankers all over the United States and its maritime domain. New companies and information technologies

NAVSAC Membership

Twenty-one members (from the following groups) are chosen to sit on NAVSAC :

- recognized experts and leaders in organizations having an active interest in the rules of the road and vessel and port safety;
- representatives of owners and operators of vessels, professional mariners, recreational boaters, and the recreational boating industry;
- individuals with an interest in maritime law;
- federal and state officials with responsibility for vessel and port safety.

Each year, seven members are either appointed for the first time or reappointed for a second three-year term. After two terms, a member other than the chair cannot be reappointed. The chair may serve one additional term.

Distinguished Members

In addition to Mr. Nicholas Healy, many distinguished experts in their fields have served on the Navigation Safety Advisory Council. Mr. Gordon Paulsen, the first Rules of the Road Advisory Committee chair, was a distinguished member of the admiralty bar as a partner in the firm of Healy & Baillie. He was a member of the permanent advisory board of the Admiralty Law Institute (Tulane University), the Maritime Law Association of the United States, and the Comité Maritime International. He has served as chairman of the Rules of the Road Advisory Council and its successor, the Navigation Safety Advisory Council. The Coast Guard recognized his contribution by awarding him the Meritorious Public Service Award and the Distinguished Public Service Award.

Mr. Antonio J. Rodriguez, a current member, has extensive experience in all aspects of maritime law, with particular emphasis on collision and other significant shipping and pollution casualties. He is an internationally recognized expert on the Oil Pollution Act of 1990 and CERCLA, subjects upon which he has written and lectured extensively. He is a distinguished professor at the Tulane University School of Law. He has served as chairman (1990-1994) and a member (1987-1990; and 2000 to the present) and is the recipient of the Distinguished Public Service Award.

Dr. Martha Grabowski, a mariner and a distinguished professor at Le Moyne College and Rensselaer Polytechnic Institute, is currently the Chair of the Marine Board of the Transportation Research Board. She served on the council from 1994–1998.

sprang from the availability of accurate timing and positioning signals.

Number 2: In 1998, NAVSAC urged the Coast Guard to continue to expedite implementation of automatic identification systems (AIS) and encouraged the maritime industry to participate in the expedient development and implementation of AIS. The Coast Guard agreed and promulgated AIS implementing regulations (carriage requirements) in 2003. In addition to providing invaluable information for collision avoidance, AIS information also contributes significantly to maritime domain awareness.

Number 1: Reaching a consensus on integration of the inland navigation rules was a monumental task with far-reaching consequences. The effort resulted in the passage of the Inland Navigation Rules Act of 1980. On signing the bill into law on December 24, 1980, President Jimmy Carter stated that the unified [inland] navigation rules would reduce the potential for confusion and lessen the danger of collision. He went on to acknowledge the work of the committee with these words:

"Credit for this achievement is deservedly shared by many. Members of the Coast Guard's Rules of the Road Advisory Committee, who represent a cross section of maritime interests, have worked selflessly for several years on a totally voluntary basis to reach this result."[2]

The same can be said of all NAVSAC members, past and present. It would be difficult to overstate the important contributions and critical role NAVSAC plays in the United States and internationally by helping to advance navigation safety. The Coast Guard looks forward to a continued productive relationship with these experienced, knowledgeable maritime professionals.

About the author:
Mr. Bobb is the chief of the Oceans and Transportation Policy Division of the U.S. Coast Guard Waterway Management Directorate. Since 1997, he has worked for the Coast Guard after retiring as a deck officer on container ships in international and domestic trades. He holds both an undergraduate and a law degree from the University of Miami in Coral Gables, Fla. He has written previously for Proceedings *on the International Convention on Standards of Training, Certification and Watchkeeping for Seafarers, 1978, as amended.*

Endnotes:
[1] Public Law 101-225 (December 12, 1989).
[2] Speech at the signing of H.R. 6671, the Inland Navigational Rules Act of 1980.

Navigation

U.S. Coast Guard Navigation Center's New Mission

The Inland River Vessel Movement Center.

by LT Geraldine Danielly
Chief, Navigation Information Service Branch, U.S. Coast Guard Navigation Center

LT William Brent
Chief, Differential Global Positioning System Branch, U.S. Coast Guard Navigation Center

Mr. Burt Lahn
U.S. Coast Guard Waterways Management Directorate

Following the September 11, 2001 attacks on the United States, the Coast Guard rapidly established the National Vessel Movement Center (NVMC) as a central clearinghouse for all Department of Homeland Security (DHS) agencies with a need for information on vessels and cargo entering U.S. ports. This clearinghouse used data submitted from federally mandated 96- hour notice-of-arrival reports.

Soon after NVMC's standup, the Eighth Coast Guard District identified a lack of maritime domain awareness information on the transit of certain dangerous cargo (CDC) over the 10,000 miles of navigable inland rivers. Improvements in maritime domain awareness, particularly information involving the transit of certain dangerous cargo along the nation's arteries of inland rivers, were needed to meet elevated maritime security levels.

In March 2003, the Eighth Coast Guard District closed this gap by establishing a regulated navigation area, requiring vessels transporting certain dangerous cargo to report their positions to the Coast Guard when passing approximately 100 reporting points along the western rivers. The Inland River Vessel Movement Center (IRVMC) was established in St. Louis to collect and process position and movement reports as barges carrying CDC transited past regulated navigation area reporting points. This includes all navigable waters of the western rivers, beginning at mile 235 on the lower Mississippi River at Baton Rouge, La., and extending to the Illinois River at Chicago, Ill., encompassing 23 rivers located across the Eighth and Ninth Coast Guard Districts.

The Transition

IRVMC in St. Louis, Mo. operated from 2003 until 2006 and was staffed by 23 Coast Guard reservists. The staff manually entered more than 2,000 CDC barge reports on a monthly basis into a database. Information on CDC transits was then accessed by sector and marine safety unit (MSU) personnel via a web interface which allowed marine safety personnel to schedule inspections or security escorts. The Inland River Vessel Movement Center outgrew facilities in St. Louis and needed a permanent and cost-effective solution. In April 2004, U.S. Coast Guard personnel developed a bridging strategy that outlined the future vision of IRVMC while ensuring proper support to sustain this critical maritime domain awareness information source for Coast Guard and other DHS partners.

In March 2006, the new home for the Inland River Vessel Movement Center was identified as USCG NAVCEN in Alexandria, Va. This decision set in motion a highly motivated transition team made up of personnel from IRVMC St. Louis, Coast Guard NAVCEN, Coast Guard Operations Systems Command, Eighth Coast Guard District, USCG Command and Control Engineering Center, USCG Maintenance and Logistics Command Atlantic, and USCG headquarters.

This team immediately developed and implemented a comprehensive transition plan. Over a period of six months the following milestones were completed:

- IRVMC St. Louis demobilized, deactivating or reassigning reserve personnel with no impact to IRVMC operations.
- NAVCEN, CG Office of Navigation Systems, and USCG Maintenance and Logistics Command Atlantic developed a detailed statement of work outlining current and future IRVMC watchstanding requirements.
- USCG Maintenance and Logistics Command Atlantic awarded a commercial contract to General Dynamics IT to provide contract personnel for IRVMC watchstanding functions.
- NAVCEN and IRVMC St. Louis developed and implemented a detailed training and orientation plan for new contractors.
- Operations Systems Command Martinsburg engineered and developed a new IRVMC applet to the Coast Guard Marine Information for Safety and Law Enforcement (MISLE) software application, linking and archiving CDC information to existing MISLE vessel and barge data. OSC Martinsburg also created a wide variety of CDC transit reports customized for each sector and Captain of the Port.
- OSC Martinsburg automatically integrated electronic report information from barges in transit into the IRVMC applet of MISLE, using a standard format and in near real-time, significantly improving accuracy and timeliness of reporting. Currently 25 percent of all CDC barges automatically report their position and movement, and more are added as industry upgrades their IT systems and barges.
- USCG Command and Control Engineering Center programmers integrated exported CDC position reports from MISLE to the Coast Guard common operating picture, providing information on CDC transits along the western rivers to all users.

In August and September 2006, the NAVCEN transition team traveled to ISC St. Louis and trained as IRVMC managers and watchstanders in preparation for the upcoming transition. Team members augmented IRVMC operations while reservists from St. Louis traveled back to NAVCEN and trained new contractors and other NAVCEN personnel who would eventually stand up the IRVMC in Alexandria, Va.

In late September 2006, NAVCEN assumed administrative control and operational control responsibilities for the existing IRVMC operation while maintaining a close working relation with the Eighth and Ninth Coast Guard Districts, local sectors, marine safety units, and Coast Guard Captains of the Port, as each used data from IRVMC for a wide variety of activities within the fields of mission planning, homeland security, and marine safety.

Technology

During the transition to NAVCEN, IRVMC took advantage of the latest technology and transitioned from an aging, failure-prone, and maintenance-intensive database used to organize CDC reports, to an efficient IRVMC applet residing in an already robust MISLE software application. This effort eased data access and significantly improved the reporting and retrieval of information on CDC barge locations and movement into one application on the Coast Guard Standard Workstation.

Users at all levels did not have to learn and use multiple applications to view CDC transits within their area of responsibility. Additionally, by partnering with industry IT managers, the Coast Guard developed an avenue for barge operators and companies to automatically submit reports directly into the MISLE database electronically, reducing labor, time, and cost for all stakeholders while exceeding CDC reporting requirements. The automatic feeds to MISLE provide near real-time position reports of CDC locations, allowing port security assets to effectively manage and position scarce resources.

Future Vision

The vision for IRVMC is to further automate the reporting process, reducing the burden on towboat operators while improving the timeliness and accuracy of CDC barge positions and movements, and improving services and reports for MSUs, COTPs, and districts.

Automation will enable more detailed historical archives that federal, state, and local agencies can use to fine-tune preparedness and response plans. This will allow for the creation of effective risk mitigation strategies for potential terrorist targets along the western rivers that are aligned with other maritime domain awareness initiatives. Collaborative partnerships, sharing information, and leveraging resources across the Coast Guard, with academia, and among our interagency partners (U.S. Customs and Border

The official rededication ceremony of the Inland River Vessel Movement Center in Alexandria, Va. took place at the United States Coast Guard Navigation Center on Nov. 20, 2006. RDML Craig E. Bone, assistant commandant for Prevention, was the featured speaker.

The admiral presented personal awards to transition team members along with a CG team commendation to more than 70 Coast Guard enlisted, officers, civilians, and contractors from a wide variety of units that actively participated in the IRVMC transition effort.

IRVMC's original crewmembers from St. Louis, Mo. present the plank owner's certificate to NAVCEN. Pictured are, from left, Assistant Commandant for Prevention, RDML Craig E. Bone; CDR Ken Hines, the last supervisor of IRVMC St. Louis; CAPT Mike Brown, USCG (retired), the first supervisor of IRVMC St Louis; and CAPT M. Blizard, current commanding officer of NAVCEN Alexandria. USCG photo.

IRVMC watchstanders Mr. Lee Perry and Ms. Cynthia Russell in their new home at NAVCEN in Alexandria, Va. USCG photo.

Protection; the Bureau of Alcohol, Tobacco, and Firearms; and Immigration and Customs Enforcement) is the way ahead for IRVMC.

In addition to increasing the number of CDC barges that report automatically, IRVMC will take advantage of the commercial visibility and access of the Homeport application. This navigation information portal provides industry the capability of submitting position reports, notice of arrivals, and a variety of mandatory preparedness plans electronically through one central access point to a variety of government agencies. It allows a wide variety of local, state, and federal government agencies access to homeland security data for development of response plans and interagency coordination. Automation has the potential to eliminate manual reporting from towboat operators and barge companies, which reduces overhead costs while increasing the security posture of our nation.

Future enhancements in MISLE include automated e-mail notification to sectors and MSUs, informing them of CDC transits in their areas of responsibility when automatically submitted position reports pass key checkpoints.

About the authors:

LT Danielly has served in the U.S. Coast Guard for more than 24 years. LT Danielly is currently stationed at Coast Guard NAVCEN Alexandria, Va., serving as chief of the Navigation Information Service Branch, which includes oversight of the Inland River Vessel Movement Center. Notable assignments include project officer for the Office of Integrated Systems, Radio Systems Branch; project officer for the CG Telecommunications and Information Center Command; and recruiter-in-charge, Glen Burnie, Md. LT Danielly has also served aboard CGC Forward*, at C2CEN, and at LORAN stations in Lampedusa, Italy, and Dana, Ind.*

LT William Brent has served in the U.S. Coast Guard for more than 14 years. LT Brent is currently assigned as the branch chief of the Nationwide Differential Global Positioning System Branch at NAVCEN. Previous assignments include assistant operations officer for Group New Orleans; the Office of Electronic System Support at Coast Guard headquarters; Command and Control Engineering Center, Portsmouth, Va.; and Electronics Engineering Center, Wildwood, N.J.

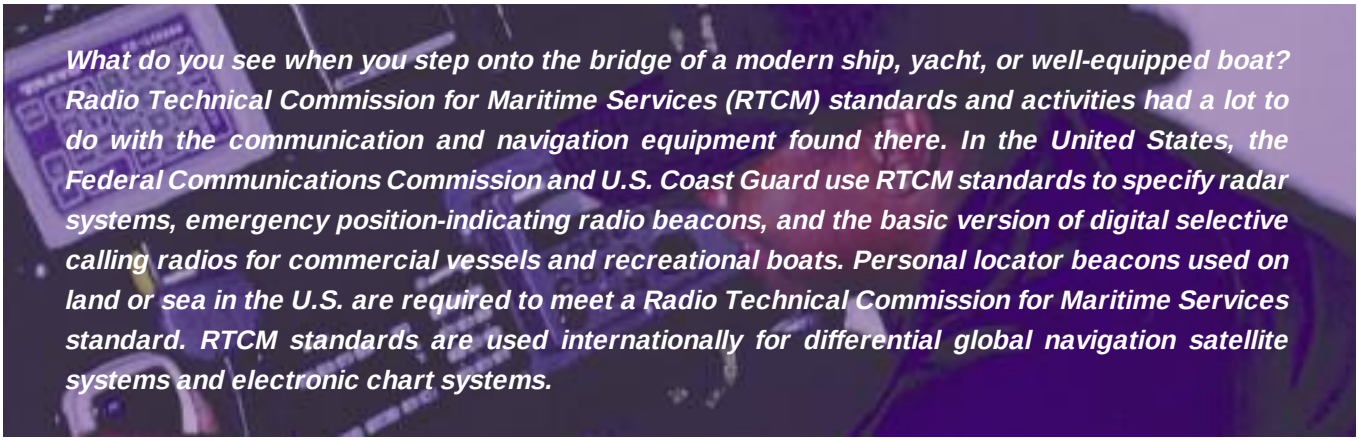
Mr. Burt Lahn is a civil service marine transportation specialist assigned to the U.S. Coast Guard Waterways Management Directorate. He is a retired LCDR with 24 years of USCG active duty service. Mr. Lahn has more than 18 years of experience in the marine safety field, conducting vessel inspections, performing marine casualty investigations, and enforcing hazardous material transportation regulations. Mr. Lahn holds a merchant marine license as a master 200 gross ton, and mate 1,600 gross ton.

Shipboard Communications and Navigation Equipment

Navigation

The role of the Radio Technical Commission for Maritime Services.

by Mr. Robert L. Markle
President, Radio Technical Commission for Maritime Services



What do you see when you step onto the bridge of a modern ship, yacht, or well-equipped boat? Radio Technical Commission for Maritime Services (RTCM) standards and activities had a lot to do with the communication and navigation equipment found there. In the United States, the Federal Communications Commission and U.S. Coast Guard use RTCM standards to specify radar systems, emergency position-indicating radio beacons, and the basic version of digital selective calling radios for commercial vessels and recreational boats. Personal locator beacons used on land or sea in the U.S. are required to meet a Radio Technical Commission for Maritime Services standard. RTCM standards are used internationally for differential global navigation satellite systems and electronic chart systems.

The Early Years

The Radio Technical Commission for Maritime Services is the younger of two related organizations. The Radio Technical Commission for Aeronautics (RTCA) was established in 1935, when the U.S. Department of Commerce invited all organizations inside and outside of the government to form a commission concerned with the development, application, and use of radio in aeronautical operations.[1] RTCA developed a number of recommendations and reports that became the basis for advances in aeronautical radio communication and navigation.

In recognition that similar benefits could be realized for maritime radio communication and navigation, the Radio Technical Commission for Maritime Services was formed in 1947, and modeled on the RTCA organization. For many years, RTCM operated as a government advisory committee, first under the State Department, then under the Federal Communications Commission, and always with the support of the U.S. Coast Guard.

One of RTCM's first projects in 1947 was to complete a study of modulation systems for very-high-frequency marine radiotelephony, which recommended that FM be adopted for the maritime mobile service within the frequency range of 30 to 300 megacycles. In 1953, RTCM special committee 18 was formed for the purpose of recommending a system of channel designators for the maritime mobile channels. Its function was to provide a simple and standardized method of identifying the various radiotelephone channels, thereby eliminating the need to refer to channels by the frequency or frequencies used. The report was completed in 1955.[2] This work eventually led to the present channel structure of the maritime VHF-FM communication system.

The antennas on this cruise ship show that it is equipped for modern communication and electronic navigation. RTCM photo courtesy of R. L. Markle.

In 1980, as a result of restrictions on advisory committees in the 1972 Federal Advisory Committee Act, the Radio Technical Commission for Maritime Services reorganized as an incorporated, nonprofit membership organization. RTCM retained its principal objective to foster the expansion and dissemination of knowledge about maritime telecommunications, thereby improving both the technical quality and the practical applications of maritime telecommunications for the benefit of all concerned in the private and public sectors.

RTCM Today

The Radio Technical Commission for Maritime Services is now an international nonprofit scientific, professional, and educational organization. RTCM members are organizations (not individuals) from government, industry, and academia. The Radio Technical Commission for Maritime Services keeps its members informed about regional and international maritime radionavigation and radiocommunication policy issues, regulatory changes, and technical standards development. RTCM special committees provide a forum in which members work together to develop technical standards and consensus recommendations on issues of particular concern.

RTCM continues to participate in the development of U.S. regulations and standards governing maritime communications and electronic navigation. But over the years, international regulations and standards have become more important. It is not possible to develop maritime communication and navigation regulations and standards without taking into account the requirements and standards of the International Maritime Organization, the International Telecommunication Union, the International Electrotechnical Commission, and others. Consequently, the Radio Technical Commission for Maritime Services has become more involved in the work of these organizations. As a result, RTCM now has an international membership and takes an interest in developments in maritime communication and electronic navigation beyond the United States.

The Radio Technical Commission for Maritime Services members include organizations from 14 countries, including government agencies from six countries. RTCM has more than 120 member organizations, including:

- manufacturers of radionavigation and radio communication systems,
- government agencies concerned with standards for maritime radionavigation and radiocommunication systems,
- government agencies and commercial entities involved in operation of maritime radionavigation and radiocommunication systems,
- associations with an interest in maritime radionavigation and radiocommunication systems and related public policy,
- ship owners and operators,
- educational institutions,
- sales and service providers,
- independent designers and consultants.

Special Committees

RTCM special committees are chartered to address in-depth radiocommunication and radionavigation areas of concern to its membership. The documents and reports prepared by these committees are usually published as RTCM standards. Special committees are chaired by a subject expert appointed from a member organization.

All RTCM member organizations are eligible to participate in any special committee activity. Special committee output documents in the form of RTCM recommendations and standards have been widely accepted for both voluntary and mandatory use, and the special committees routinely update the recommendations to reflect ongoing changes in technology.

RTCM and the Future

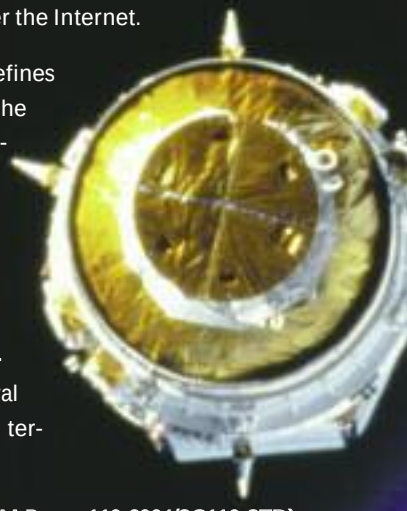
E-navigation is the term that is being used to refer to the convergence of electronic navigation systems

continued on page 42

RTCM Standards

The current technical standards developed by RTCM special committees include:

- **RTCM Recommended Minimum Standards for Digital Selective Calling (DSC) Equipment Providing Minimum Distress and Safety Capability, Version 1.0 (RTCM Paper 56-95/SC101-STD).** This standard is referenced in the regulations of the U.S. Federal Communications Commission and defines minimum functions for DSC transceivers used in the U.S. It brought the first generation of affordable DSC radios to mariners in the U.S., and is now being phased out in FCC regulations in favor of a newer IEC standard.
- **RTCM Standard 10403.1 for Differential GNSS (Global Navigation Satellite Systems) Service, Version 3.** This is the newest version of the differential GNSS standard, intended to be more efficient, easy to use, and more easily adaptable to new situations as compared to the version 2 series (see following paragraph). This standard consists primarily of messages designed to support real-time kinematic (RTK) operations, including network RTK.
- **RTCM 10402.3, Recommended Standards for Differential GNSS (Global Navigation Satellite Systems) Service, Version 2.3.** This is the latest version of the standard widely used around the world for differential satellite navigation systems, both maritime and terrestrial. Although originally developed for high-accuracy navigation in harbors, DGNSS techniques have become especially important in surveying. Although not a maritime application, RTCM continues to support DGNSS in surveying and all of its other applications.
- **RTCM 10401.2, Standard for Differential Navstar GPS Reference Stations and Integrity Monitors (RSIM).** A companion to the preceding DGNSS standards, this standard addresses the performance requirements for the reference stations located at known locations, which broadcast data used by mobile receivers to calculate precise positions.
- **RTCM 10410.0, Standard for Networked Transport of RTCM via Internet Protocol (Ntrip).** Networked transport of RTCM via Internet protocol is an application-level protocol that supports streaming global navigation satellite system (GNSS) data over the Internet.
- **RTCM 10900.3, Standard for Electronic Chart Systems (ECS).** Another standard used around the world, it defines requirements for electronic chart systems that are not intended to meet the international requirements of the Safety of Life at Sea Convention. This standard is the basis for a new IEC standard on ECS currently in development. When the IEC standard is published, RTCM will probably retire its standard.



- **RTCM 11000.2, Standard for 406 MHz Satellite Emergency Position-Indicating Radiobeacons (EPIRBs) (RTCM Paper 77-2002/SC110-STD).** This standard is referenced in the regulations of the U.S. Federal Communications Commission and defines performance requirements for EPIRBs used on U.S.-registered vessels.
- **RTCM 11010.1, Standard for 406 MHz Satellite Personal Locator Beacons (PLBs), (RTCM Paper 76-2002/SC110-STD).** Closely related to the previous standard, it too is referenced in the regulations of the U.S. Federal Communications Commission and defines performance requirements for PLBs used in the U.S., primarily in terrestrial applications.
- **RTCM 11020.0, Standard for Ship Security Alert Systems (SSAS) using the Cospas-Sarsat Satellite System (RTCM Paper 110-2004/SC110-STD).** This standard contains minimum requirements for the functional and technical performance of maritime satellite ship security alert systems operating in the 406.0 to 406.1 MHz band through the Cospas-Sarsat satellite system.
- **RTCM 11701.0, Standard for Installed Maritime VHF Radiotelephone Equipment Operating in High-Level Electromagnetic Environments.** This standard defines a test program to demonstrate satisfactory operation of VHF radios in areas where they might be susceptible to interference from other radio frequency devices, such as pagers.
- **RTCM 11702.0, Standard for Portable Maritime VHF Radiotelephone Equipment Operating in High-Level Electromagnetic Environments.** This standard defines a test program to demonstrate satisfactory operation of portable VHF radios in areas where they might be susceptible to interference from other radio frequency devices, such as pagers.
- **RTCM 11901.0, Standard for Maritime Survivor Locating Devices.** This standard specifies the minimum functional and technical requirements for maritime survivor locating devices (MSLD). MSLD alerting units are intended to be carried by individuals engaged in on-deck activities on vessels, or in activities on shore where falls into the water are a risk, or in other marine activities where location of persons may be required. The alerting unit activates a base unit on the vessel, and the system provides for locating the person in the water.

Satellite emergency position-indicating radio beacons and personal locator beacons are available in many forms. Photo courtesy National Oceanic and Atmospheric Administration.

onboard ships, ashore, and on the waterways. For instance, a ship might have an electronic chart system, two radar installations, a global positioning system (or global navigation satellite systems) satellite receiver, as well as an automatic identification system (AIS) transceiver. Increasingly, these systems are being made to work together as an integrated whole.

Using a satellite-determined position, one screen can show the electronic chart of the area where the ship is operating, merged with radar data and AIS data to show where other ships are, their speed and heading, and even an outline of those ships at appropriate screen scales. This information can be used to predict dangerous navigation situations. The aids to navigation in the area might also be AIS-equipped, enabling them to be clearly displayed. If an aid to navigation is missing, a shore station could replace it virtually in an AIS message. These technologies will enable an evolution in bridge displays and ship control in the coming years. RTCM will be involved in the development of standards in this complex and exciting area.

Since its development in the 1950s, the maritime VHF-FM radio system has become an indispensable tool for communicating with ships and maritime shore stations within a range of 20 miles or so. We tend to think of this system as "busy," but in fact there is a lot of time when there are no transmissions on some of these channels.

This unused "white space" can possibly be used for short messaging services without interfering with the existing uses of the channels. This short messaging service would be similar to text messaging used by cellular telephones, and could be used to send e-mail or other data messages. The system would work by listening to a frequency to see if it is being used. If not, a short burst of data would be sent. After listening again for available space, more data would be sent. The process would continue until the complete message has been sent. SC123 is working on a standard to describe the system, and hopes that in future years, mariners will find it to be a useful service.

RTCM is proud of its 60-year history of cooperation with the U.S. Coast Guard, other federal agencies, and international bodies, all working to further the science of maritime communication and navigation and benefiting the safety and welfare of all of those that use or depend on maritime transportation.

RTCM Annual Assembly Meeting and Conference

The RTCM Annual Assembly Meeting and Conference, which is open to both RTCM members and nonmembers, is structured to provide attendees with an overall update on the changing world of maritime radiocommmunications and radionavigation. The program includes a series of paper presentations, panel sessions, workshops, and RTCM special committee meetings dealing with issues of current concern to the maritime community.

Other organizations such as the International Electrotechnical Commission, the National Marine Electronics Association, the U.S. National GMDSS Implementation Task Force, and the NOAA SARSAT Beacon Manufacturers Workshop also typically hold meetings in conjunction with the RTCM assembly. All attendees are invited to participate in all sessions. Through the cooperation of RTCM members exhibitors, the latest radiocommunications and radionavigation equipment capabilities and services technologies are on display.

Registration materials and information can be found on RTCM's website at www.rtcm.org.

About the author:
Mr. Robert Markle has been president of the Radio Technical Commission for Maritime Services since 2002. Before joining RTCM, he concluded a 27-year Coast Guard civilian career as chief of the Lifesaving and Fire Safety Standards Division, where he administered U.S. programs on standards and enforcement for Coast Guard-approved equipment of all types, including emergency radio beacons and navigation systems. Since 1975, he has served on numerous committees working on international maritime safety standards, and chaired a number of them.

Endnotes:
[1] RTCA continues to operate today as RTCA, Inc.
[2] From annual reports of the Federal Communications Commission, and the Inland Marine Radio History Archive (www.imradioha.org).

Advances in Visual Aids to Navigation Technology

Leveraging technology to improve navigational aid performance and reduce risk.

by Mr. Robert Trainor
U.S. Coast Guard, Office of Navigation Systems

Since the first known lighthouse in Alexandria, Egypt, visual aids to navigation have been established throughout the world to help mariners determine their positions, guide their ships to the great ports, and to warn them of hazards. In North America, the first recorded visual aid to navigation was Boston Light, built on Little Brewster Island in 1716.[1]

Cask and spar buoys deployed in the Delaware River and Boston Harbor in the late 1700s were probably the first registered floating aids to navigation in America.[2] Today's aids to navigation share the same purpose as that ancient lighthouse in the Mediterranean (Figure 1) and those early North American aids—promoting safety at sea. While their purpose hasn't changed much over time, the aids themselves and how they're serviced and maintained certainly has, especially over the past three decades.

The U.S. Coast Guard, per United States Code 14USC81, administers the United States aids to navigation (AtoN) system and is responsible for its development, establishment, operation, and maintenance. The Coast Guard has consistently sought new equipment, techniques, and methods to provide all waterways users with a reliable, cost-effective system of aids to navigation that will enable them to fix their vessels' positions, determine safe courses to steer, and avoid unseen dangers to the degree of accuracy appropriate to the level of risk.[3]

To the casual observer, the buoys and beacons along our nation's coasts look pretty much the same as they did 30 years ago, except perhaps that black buoys are now green and the black and white (skunk) mid-channel buoys are now red and white. A little closer look, however, will unveil that an extensive and ongoing technological transformation is taking place, not just on the buoys and beacons themselves, but with servicing and maintenance practices as well.

Figure 1: "Der Pharos in der Vorstellung des Vertassers," artist's rendition of the Pharos of Alexandria Lighthouse.[4]

Is the Buoy Where the Coast Guard Says it Is? Determining an accurate geographic position at sea has challenged mariners since humankind first ventured off land. The accuracy of an aid to navigation's geographic position is important to professional mariners and casual boaters alike because they all depend on these aids to help them determine their position.

Until the late 1970s, the instruments, methods, and techniques of positioning floating aids to navigation hadn't really changed much since the days of sail (Figure 2). The most accurate way to position a buoy

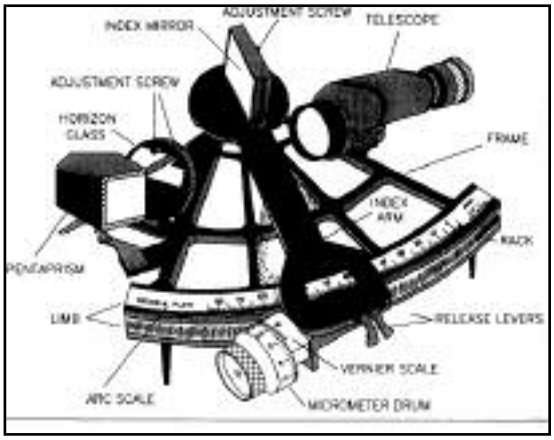


Figure 2: Drawing of a survey sextant, the primary aids to navigation positioning instrument prior to differential global positioning system technology. USCG graphic.

in the early 1970s (to verify that it was on its charted position) was to plot two horizontal sextant angles with a three-arm protractor on the largest scale chart available for the area. When the two angles—defined as a two line of position (LOP) fix—intersected in the black dot of the buoy's chart symbol, then the buoy was considered to be on "charted position." The fix was checked by adding at least one more LOP, such as an angle, bearing, or range.[5]

But was the buoy really where it was plotted? While instruments used to position buoys had slowly improved over the years, the process still contained inherent errors. For example, observations of the same sextant angle often varied between different sextants as well as between different personnel. Cartography had also improved over the years, but the chart was still only as good as the printing press, the ink, and the paper it was printed on. Varying chart scales, editions, and conditions greatly affected the accuracy of plotting a fix in relation to the black dot. For example, on a 1:40,000-scale chart, the black dot's diameter represents about 27 yards. The buoy might plot in the black dot, but where was its anchor (sinker)? And would the buoy still be on charted position with a change in tide or current?

Figure 3: A lighted buoy, before solarization. USCG photo.

In some cases the position of the black dot on the chart varied from one chart edition to the next. If the buoy's black dot could move, then so could the symbols for the objects that were used to obtain the fix. To add to these potential inaccuracies, observer offset (the distance and bearing from the angle-taker to the buoy) and buoy excursion (the distance and bearing from the buoy to the sinker's position) were not adequately considered when plotting the fix. The aggregate of these inaccuracies meant that there was a fairly good chance that the buoy was not actually set where it had been plotted. Setting an entrance or sea buoy within 30, 50, or even 100 yards of its charted position might not pose a significant risk to the mariner, but closer to shore, where channels are typically narrower, traffic heavier, and hazards closer aboard, even a 20-yard error could lead to disaster.

Recognizing the problem, the Coast Guard commissioned a study in the mid-1970s to improve its capability to position aids to navigation by researching and applying available technology. This led the Coast Guard to implement new positioning methods that facilitated stricter, more accurate positioning standards. Some of these improvements included:

- Replacing the term "charted position" that previously defined an aid's position with an "assigned position" (AP). The AP definition eliminated errors introduced by chart inaccuracies by assigning a specific geographic location expressed in latitude and longitude with accuracy to the thousandths of a second.

- Accuracy classifications were developed for buoys. For example, an aid within the area expressed as the radius of a circle in yards around the AP of an aid to navigation is considered to be "on station."[6]

- Three-arm protractors were replaced by a computer program that accounted for observer offset and excursion and trapped other potential inaccuracies. Instead of plotting the fix on a paper chart, the computer program took into account many of the possible inaccuracies and delivered a "most probable position" (MPP) solution of the buoy's sinker expressed in latitude and longitude, the range and bearing from most probable position to assigned position, and whether or not the buoy plotted on station.

- Better documentation, training development and delivery, and distribution of new positioning equipment to servicing units.

While these efforts significantly improved the Coast Guard's AtoN positioning performance, a lack of a sufficient number of surveyed objects in certain areas and poor visibility, due to weather and darkness, still hampered this process. So in the continuing effort to improve the process of positioning aids to navigation, the Coast Guard built on the Department of Defense's global positioning system (GPS) technology, and by the early 1990s had developed and deployed the differential global positioning system (DGPS). Today, the Coast Guard is able to position most aids to navigation in virtually any condition of visibility, day or night, with an unprecedented degree of accuracy.[7]

DGPS integrated with the automated aid positioning system computer software has significantly improved AtoN positioning accuracy. The cumulative result of these efforts has enabled the Coast Guard to confidently answer, "Yes, the buoy is set where we said it was set." In addition to promoting waterway safety by providing the mariner with a more reliable signal, these improvements have considerably enhanced the efficiency of positioning buoys, freeing up valuable Coast Guard assets for other waterway safety and homeland security missions.

Tapping Into the Sun's Energy

By the late 1960s, light signals on buoys and beacons had already undergone significant improvements (Figure 3). Gone were lead acid batteries; mechanical flashers; four-place, gear-driven lampchangers; and bulky glass lenses. These were replaced by air-depolarized primary batteries (batteries that once expended could not be economically recharged); solid-state flashers; six-place, spring-loaded lampchangers; and acrylic molded lenses. Although pleased with these improvements, the Coast Guard was not content, and continued numerous initiatives to improve aid signal efficiency and reliability. One of these initiatives aimed to introduce solar power into the aids to navigation system.

Buoys have always relied on natural sources of energy to power their sound signals. The restless motion of the sea causes tappers to strike a sound buoy's bell, to produce a distinguishable sound signal. Similarly, whistle buoys operate with air generated by the buoy moving with the rising and falling motion of the sea. Tapping into the sun's energy to power light signals, by comparison, is a comparatively recent development in maritime aids to navigation.

Prior to the Coast Guard's solar program initiative, air-depolarized primary batteries powered lighted aids. These primary batteries required replacement every 12 to 36 months, depending on the light's characteristic and nominal range. Replacing the batteries, or "recharging an aid," was a time-consuming and laborious undertaking. For example, when a lighted buoy required recharging, it was typically hoisted aboard a buoy tender (ranging from a 65-foot inland buoy tender to a 180-foot seagoing buoy tender), depending on the buoy and mooring size. Once securely aboard, the buoy's battery pocket was accessed, the 215- to 508-lb. battery rack was removed, a new battery rack was inserted, the pocket was resealed, and the seal verified via an air test. For a large buoy, the entire process could take several hours. In addition to the time and effort required to recharge aids to navigation, the annual hazardous waste in the form of expended batteries was approximately 950 tons nationwide.

Figure 4: A solarized mid-channel buoy. Note the solar panels and single red sphere topmark. USCG photo.

In terms of improving servicing and logistics efficiency, converting even half of the nation's lighted aids to navigation to solar power promised a tremendous return on investment. For example, a lighted buoy before conversion to solar power, with a particular lamp size and characteristic, located on the Gulf Coast, required that a buoy tender replace the 508-lb. primary battery rack (containing 10 three-cell primary batteries) every two years. That same buoy after conversion to solar power would need just one 35-watt solar panel and two 60-lb. rechargeable solar batteries, which, under normal conditions, wouldn't need replacement for five years. Also, once an external battery box was developed, a three-person aids to navigation team would be able to recharge most lighted buoys in protected waters more economically and efficiently than a cutter could.

The Solar Initiative Program was launched in 1983, with a goal to convert approximately 10,000 Coast Guard lighted aids to navigation (nearly 60 percent of the total) from primary batteries to solar power. In just five years that goal was achieved and "solarization," as the con-

Figure 5: A Coast Guard construction tender putting the finishing touches on a new solar-powered lighted beacon. USCG photo.

version effort came to be called, continued unabated, resulting in over 16,000 (about 94 percent) of the Coast Guard's lighted AtoN converted to solar power (Figures 4 and 5). The program is not over yet, as Coast Guard ocean engineers continue to develop solar solutions for the remaining six percent.

In addition to streamlining servicing procedures, the Solar Initiative Program has enhanced the Coast Guard's commitment to protecting the environment by significantly reducing its generation of hazardous waste. Since solar batteries are recycled after their useful life span (and so avoid hazardous material disposal fees), the Coast Guard saves approximately $576,000 annually.

What's New With Light Signals on Aids to Navigation?

Technological advances for lighting equipment, a critical component of nearly 50 percent of the nation's visual aids to navigation inventory (not including western river buoys), have also been realized. Coast Guard ocean engineers have teamed up with aids to navigation operators to actively explore and implement new technologies to improve the performance of these light signals. One of the more recent initiatives is the deployment of light-emitting diodes (LED) lighting equipment on maritime aids to navigation (Figure 6).

The primary advantages of LEDs are that they last 100 times longer than incandescent lamps and use a fraction of the power to emit similar light intensity. Both of these advantages provide the opportunity to deploy self-contained LED lanterns on lighted buoys and beacons. These self-contained LED lanterns encase a battery, solar panels, and light into one unit. Currently the Coast Guard is experimenting with several different types of these self-contained LED lanterns that weigh between 12 and 48 lbs., are slightly larger than a football, and can be programmed to emit a specific light characteristic consistent with any of the Coast Guard's standard light rhythms.

Figure 6: A foam buoy equipped with a self-contained LED light, marking a wreck in Yaquina Bay, Ore. Courtesy of www.solarmarinelights.com.

The anticipated longevity, reliability, and portability of these self-contained LED lanterns could enable the Coast Guard to increase servicing intervals, reduce buoy footprint (a lighter smaller lighting package may not require the support of the large steel buoy that was designed to carry much heavier loads), and employ smaller servicing units.

These examples of technological advances in visual aids to navigation hardly tell the whole story. Improved buoy coatings, lighted ice buoy improvements, non-ferrous buoy hulls, programmable flashers, five-year dayboard film, more efficient long-range lights, day/night centerline ranges, fog detectors, remote monitoring systems, and many other initiatives are all examples of leveraging technology to improve navigational aid performance.

While our maritime aids to navigation system has changed over the past 30 years, one thing hasn't—the Coast Guard's continued commitment to provide safe passage for all waterway users.

About the author:

Mr. Robert Trainor is an aids to navigation specialist in the U.S. Coast Guard Office of Navigation Systems, Visual Navigation Division. He previously spent 31-plus years serving on active duty. His duty assignments included tours as commanding officer of two Coast Guard buoy tenders as well as numerous other aids to navigation-related positions. His first buoy tender assignment was in 1976 aboard the USCGC Rambler, *whose homeport was in Mobile, Ala.*

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2. U.S. Coast Guard, "A History of Buoys and Tenders," by Amy K. Marshall.
3. U.S. Coast Guard, "Short-Range Aids to Navigation Strategic Plan," 2006.
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6. Aids to Navigation Manual (COMDTINST M16500.1C), 1996.
7. The advertised accuracy tolerance of DGPS is 10 meters, but typically delivers tolerances to within one to three meters.

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Proceedings Magazine, Summer 2007

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Reader's Survey

Navigation

Protecting the North Atlantic Right Whale

National Marine Fisheries Service and the Coast Guard working together.

by Mr. George H. Detweiler, Jr.
Marine Transportation Specialist
U.S. Coast Guard Waterways Management Directorate

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Large Whale Recovery Activities
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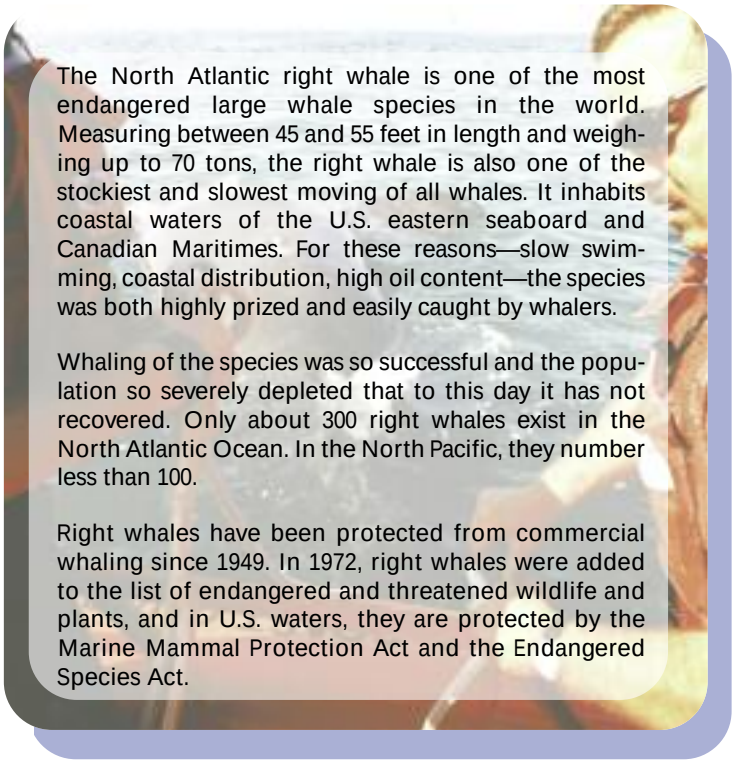
The U.S. Coast Guard's missions are multiple and diverse. One core mission and strategic goal is protection of the marine environment, including the conservation of living marine resources and enforcement of living marine resource laws, including those of the Endangered Species Act.

The Coast Guard and the National Oceanic and Atmospheric Administration's National Marine Fisheries Service (NMFS) work cooperatively to recover endangered marine species. Particularly intensive efforts have been made in recent years to protect a highly endangered whale species called the right whale.

NMFS and USCG Relationship

Under the Endangered Species Act, responsibility for recovering the right whale is delegated to the National Marine Fisheries Service, which develops recovery plans to identify actions necessary to achieve recovery of endangered or threatened species and establishes programs to reduce or mitigate the effects of human activities.

The Endangered Species Act provides the secretary of the Department of Commerce the authority to establish teams to review recovery activities of the right whale and provide recommendations to NMFS on improving such activities. The Coast Guard works in collaboration with the National Marine Fisheries Service to identify and help implement actions to protect the right whale.



The North Atlantic right whale is one of the most endangered large whale species in the world. Measuring between 45 and 55 feet in length and weighing up to 70 tons, the right whale is also one of the stockiest and slowest moving of all whales. It inhabits coastal waters of the U.S. eastern seaboard and Canadian Maritimes. For these reasons—slow swimming, coastal distribution, high oil content—the species was both highly prized and easily caught by whalers.

Whaling of the species was so successful and the population so severely depleted that to this day it has not recovered. Only about 300 right whales exist in the North Atlantic Ocean. In the North Pacific, they number less than 100.

Right whales have been protected from commercial whaling since 1949. In 1972, right whales were added to the list of endangered and threatened wildlife and plants, and in U.S. waters, they are protected by the Marine Mammal Protection Act and the Endangered Species Act.

Two right whale recovery plan implementation teams have been formed: one in the southeastern United States, and one in the northeastern United States. These teams consist of representatives from federal and state agencies, academic researchers, conservation and environmental groups, port authorities, and inter-

ested private individuals. USCG has been an active member of both the southeastern and northeastern teams since their inceptions in 1993 and 1994, respectively.

Right Whale and Vessel Interactions

Impact from certain human activities—specifically, fishing gear entanglement and collisions with ships—continue to endanger the species. Of these, collisions with ships are responsible for more right whale deaths and serious injuries than any other single human activity, and ship strikes are considered the most significant threat to the recovery of the population.

EXAMPLES OF COAST GUARD ASSISTANCE INCLUDE:

- tagging and disentangling a right whale east of Atlantic City;
- disentangling a right whale in Cape Cod Bay;
- assisting an entangled right whale that was named "Kingfisher" in recognition of the efforts of the USCGC *Kingfisher*;
- assisting with an entangled right whale off of the North Carolina coast by Coast Guard Station Hatteras;
- assisting in the successful disentanglement of a juvenile right whale, which was named "Yellowfin" in honor of the USCGC *Yellowfin*.

Small boat crew from USCGC *Kingfisher* disentangles a right whale from fishing gear. Florida Fish and Wildlife Conservation Commission photo courtesy of Ms. Alicia Windham-Reid.

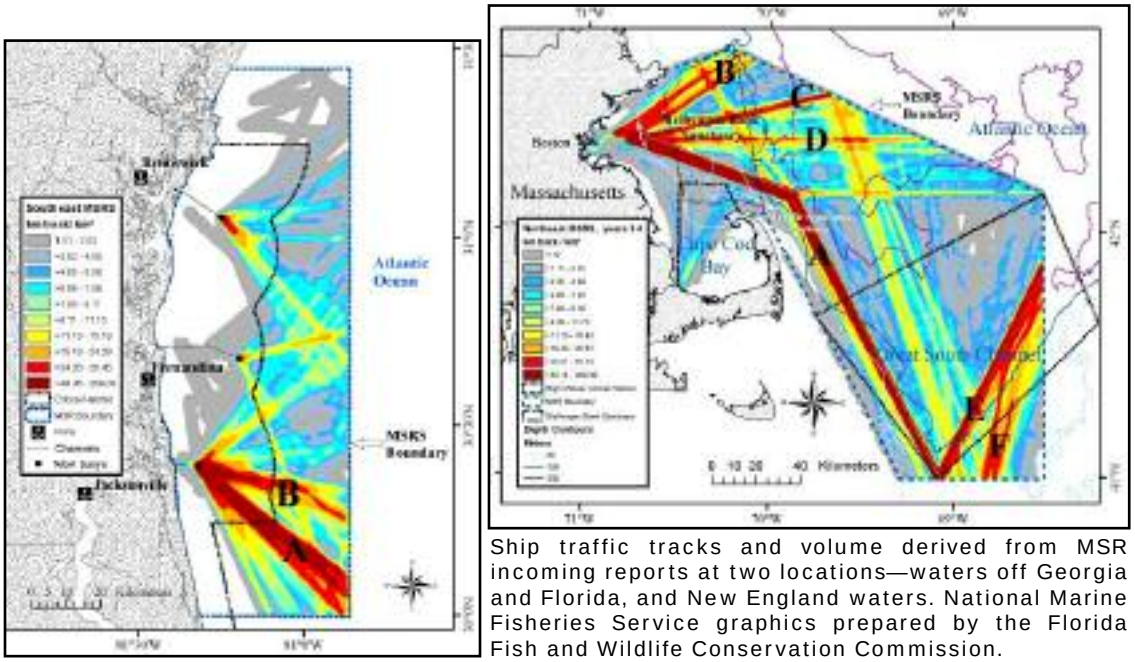
Between 1970 and 2005, 25 right whales died as a result of collisions with ships.[1] This is only a portion of the actual number of deaths because other carcasses may decompose or drift to sea and go undetected. In a population of only 300, this is a significant impact.

More recently, in an eight-week period from mid-November 2004 to mid-January 2005, four dead right whales were found, including one that was killed by a ship and two others that had wounds from previous ship collisions that may have contributed to their deaths. All three whales hit by ships were adult females, two of them carrying full-term fetuses. Another adult female with a full-term fetus was killed by a ship earlier in 2004. The deaths of these females, their female offspring, and therefore their reproductive capabilities, is an impact the species can ill afford. In waters off Georgia, another right whale, a juvenile male, was found dead in January 2007, having suffered a series of deep propeller gashes along its back.[2]

Activities to Reduce Interactions

Data collection: A number of steps have been taken to reduce the threat of ship strikes to North Atlantic right whales. The National Marine Fisheries Service and the Coast Guard undertake these activities in conjunction with other agencies or organizations. In addition to those identified here, ship strike conservation activities have been pursued by federal and state agencies, aquaria, academic groups, and other nongovernmental organizations.

- **Mandatory ship reporting system:** The United States received endorsement from the International Maritime Organization (IMO) to establish two mandatory ship reporting (MSR) systems—one in waters off New England, and another in calving/nursery areas in waters off Georgia and Florida. The systems were designed to reduce the risk of commercial vessels colliding with North Atlantic right whales. The USCG, in conjunction with NMFS, funds and operates these MSRs. The U.S. northeast system operates continually; the U.S. southeast system is in effect from November 15 to April 15. Legislation enacted under the Port and Waterways Safety Act in 1999 requires all commercial ships greater than 300 gross tons to report their position, course, speed, destination, and route to the USCG prior to entering designated right whale critical habitats off New England, Georgia, and Florida. Ships submit these reports via satellite communications to the MSR, which prompts an automated return message to the ship advising it of the endangered status of the right whale, locations of recent right whale sightings, and information on how to minimize the risk of collision. The MSR also stores information from the ship reports to facilitate analysis of vessel traffic patterns in the critical habitats. A compilation of incoming reports also provides the National Marine Fisheries Service with data to assist in identifying measures to reduce future ship strikes. Information on these systems can be found at http://www.nmfs.noaa.gov/pr/shipstrike/msr/.



Ship traffic tracks and volume derived from MSR incoming reports at two locations—waters off Georgia and Florida, and New England waters. National Marine Fisheries Service graphics prepared by the Florida Fish and Wildlife Conservation Commission.

sources also provide sighting information. NMFS assembles the reports and "alerts" are disseminated to mariners via an automated e-mail and facsimile system. USCG broadcast notices to mariners, broadcasts over NOAA weather radio, Army Corps of Engineers Cape Cod Canal traffic controllers, and postings on several web pages serve as such alerts. Shipping agents, pilots, and port authorities disseminate the information to shipping traffic. In the southeastern United States, the survey program is a cooperative effort by the Coast Guard, U.S. Navy, U.S. Army Corps of Engineers, and the states of Georgia and Florida. Sighting location information is gathered and disseminated by the Navy through a number of media, including USCG broadcast notices to mariners, NAVTEX (the USCG international communication system), NOAA weather buoys, and NOAA weather radio.

- **Sighting advisory system/early warning system:** The Coast Guard partners with the National Marine Fisheries Service and other federal and state agencies to support or conduct extensive aircraft surveys for right whales. Surveys began on a regular basis in 1993 in waters off the southeast U.S. coast and in 1997 in waters off New England. They are flown over northeast U.S. waters in major right whale aggregation areas virtually every day weather permits. Surveys cover peak right whale abundance periods in Cape Cod Bay (principally between January and May) and in the Great South Channel (between March and July). Coast Guard vessel operators, research, and other ships operated by the National Oceanic and Atmospheric Administration (NOAA), the Commonwealth of Massachusetts, and other

Small boat crew from USCGC *Elm* successfully disentangles a right whale. National Oceanic and Atmospheric Administration photo courtesy of Mr. Jamison Smith.

- **Port access route study:** As mandated by the Maritime Transportation Act of 2004, the USCG cooperated with the National Oceanic and Atmospheric Administration in analyzing potential vessel routing measures as one among several steps taken to reduce ship/whale collisions. One recommendation contained in the port access route study (PARS) report was for the United States government to submit a proposal to IMO to reconfigure the Boston traffic separation scheme to minimize overlap of whales and vessel traffic. The proposed realignment is expected to provide a significant reduction in ship-strike risk to right whales and all baleen whale species while having little effect on navigation. NOAA estimates that realigning the traffic separation scheme will reduce the risk of ship collisions with right whales by 58 percent and provide an 81 percent risk reduction for other whales.[3] The IMO Maritime Safety Committee has adopted the measure. The PARS report also recommended the establishment of recommended shipping routes in key right whale aggregation areas within Cape Cod Bay and the calving/nursery areas in waters off Georgia and Florida. Positioning of the routes was based on MSR ship traffic data and years of

right whale sighting data. Again, USCG and NOAA worked collaboratively to define and establish the routes. The recommended routes were added to NOAA charts in November 2006 and concurrently announced to mariners via USCG notice.

Real-time operations: Real-time operations are conducted on a routine basis to reduce the threat of ship strikes to North Atlantic right whales.

- **Marine information broadcasts/notice to mariners:** Central to the Coast Guard's fisheries law enforcement mission is the duty to enforce fishing gear restrictions and area closures, some of which are designed to reduce right whale entanglements. As part of the Coast Guard's marine safety mission and in support of efforts to protect right whales, the Coast Guard distributes information to mariners to advise them on minimizing their risk of colliding with right whales. Moreover, Coast Guard vessels and aircraft are required to report right whale sightings to local sighting advisory networks, and Coast Guard radio stations include right whale sightings in urgent marine information broadcasts and the broadcast notice to mariners.

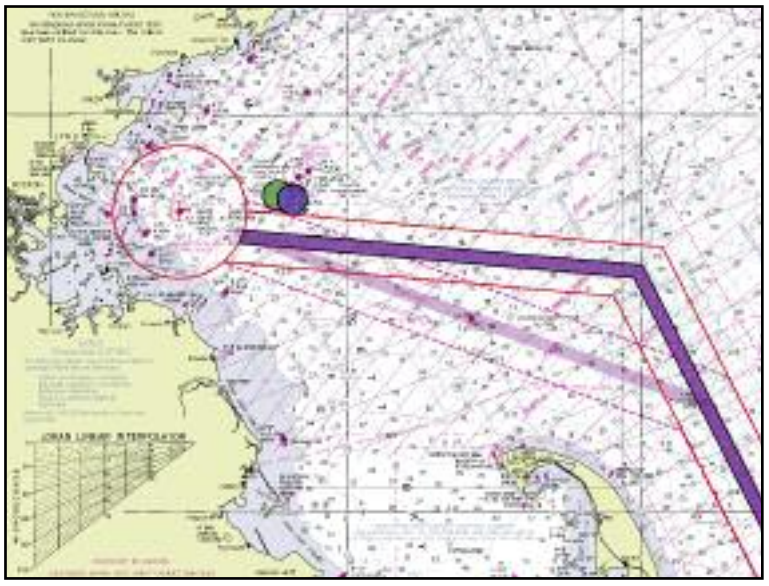
- **Disentanglements/carcass retrieval:** Coast Guard vessels and aircraft provide operational assistance, logistic support, and safety standby for right whale disentanglements conducted by the National Marine Fisheries Service or its authorized agents.

- **Distribution of educational/informational material:** A number of organizations, including NMFS, have developed education and outreach materials for mariners and boaters. Today, NMFS and the USCG distribute placards, brochures, and videos to mariners on ways to reduce ship strikes. Information is provided to pilots, trade associations, port authorities, and during routine USCG boardings.

The Future

In light of their low population size, possibly declining status, life history of the species, and high rate of human-caused deaths and serious injury, the most immediate need for the North Atlantic right whale is the reduction or elimination of ship collisions and fishing gear entanglement.

The ongoing activities and real-time operations must continue and be expanded, if necessary, if the right whale is to survive. NMFS and the USCG are committed to working together, concentrating their efforts and resources so that the right whale can recover and ultimately be removed from the list of endangered and threatened species. Additional information on reducing the threat of ship collisions with whales can be found at www.nmfs.noaa.gov.



Boston approach traffic separation scheme. National Oceanic and Atmospheric Administration graphic provided by Mr. Steve Soherr.

About the authors:

Mr. George H. Detweiler, Jr. retired from the U.S. Coast Guard with over 20 years of service. He returned to the Coast Guard as a marine transportation specialist in the Waterways Management Directorate. His major projects have included conducting port access route studies, creating ships' routing measures, reviewing offshore renewable energy installations proposals, and conducting tribal consultations.

Dr. Gregory Silber coordinates large whale species recovery activities for the National Marine Fisheries Service's Office of Protected Resources. He previously spent five years at the Marine Mammal Commission as the deputy scientific program director. Prior to that, he was the executive director of Friends of the Sea Otter in Monterey, Calif. His master's degree is from San Jose State University's Moss Landing Marine Laboratories. His Ph.D. is from the University of California at Santa Cruz. In the 1980s, he conducted or participated in research on whales and dolphins in Hawaii, the high Arctic, the Aleutian Islands, Mexico, California, and the U.S. East Coast. He has published more than 30 peer-reviewed and popular articles on whales or dolphins.

Dr. Shannon Bettridge is a fishery biologist for the National Marine Fisheries Service's Office of Protected Resources. Previously, she was program manager for the Atlantic Coastal Cooperative Statistics Program. Her master and doctoral degrees are from the University of Rhode Island's Department of Marine Affairs.

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Working Together

The Committee on the Marine Transportation System.

by LCDR Paul M. "Bo" Stocklin, Jr., M.M.A.
U.S. Coast Guard Office of Marine Transportation Systems

Formation of the Interagency Cabinet-Level Committee on the Marine Transportation System

The present generation of MTS challenges has its roots in the period that followed general U.S. transportation deregulation in the 1970s and 80s. This freed up latent capacity in the system, but the resulting growth began the capacity crunch trend that is nearing a critical point today. Beginning in the mid-90s, groups such as Intertanko[1] began to point out the need for a serious assessment of all factors affecting safety using a "waterways management" approach. These efforts led to then-Secretary of Transportation Rodney Slater conducting national listening sessions in 1998 to assess the challenges facing the marine transportation system. Congress also recognized these issues, and directed Secretary Slater and other agencies to "…establish a task force to assess the adequacy of the Nation's Marine Transportation System…to operate in a safe, efficient, secure, and environmentally sound manner."[2]

The resulting report to Congress was delivered in 1999. This report described the value of the marine transportation system to the nation, its components, the growing capacity trends, critical issues, desired end state, and served as a road map for future federal agency action. The need for greater federal coordination was recognized, and resulted in the formation of the Interagency Committee on the Marine Transportation System (ICMTS) in April of 2000 as well as the MTS National Advisory Council (MTSNAC), a federal advisory committee charged with advising the secretary of transportation on MTS matters. The ICMTS provided a framework in which the various agencies could work together on areas of responsibility that overlapped and collaborate on a waterways system approach.

In 2000, Congress recognized a need to revisit overall U.S. oceans policy (see Oceans Policy sidebar). The Oceans Act of 2000[3] established an independent commission on ocean policy to submit recommendations to the president on oceanic issues facing the nation. The ocean commission recognized the ongoing work of the ICMTS, validated many of its conclusions, and recommended to elevate the status of the committee to enhance its effectiveness.[4] President Bush recognized this as well, and in the "U.S. Ocean Action Plan," he did elevate the ICMTS to a cabinet secretary-level committee, to be known as the Committee on the Marine Transportation System, or CMTS.

The U.S. marine transportation system (MTS) is a complex system of waterways; ports; their intermodal connections, vessels, vehicles; and system users. It extends from the outer boundary of the U.S. Exclusive Economic Zone, through its bays and sounds, ports and waterways, to the first intermodal facility inland from the coast. International trade, defense, and diverse industries such as mineral extraction, tourism, and fishing all use this system.

The U.S. marine transportation system carries over 40 percent by value and 70 percent by weight of our export and import cargo,[1] so it's in America's best interest that this cargo be carried efficiently, safely, securely, and in an environmentally sustainable way. Because the MTS is such a large and complex system, many agencies at all levels of government, private industry, and the public have important roles to play in its continued health.

In order to better coordinate these efforts, the president has directed the formation of an interagency working group, the interagency cabinet-level Committee on the Marine Transportation System (CMTS).

The CMTS, in developing a draft national strategy for the U.S. marine transportation system, has identified several distinct challenges. The first is an aging and capacity-constrained infrastructure, which needs to grow to meet future freight demand and relieve congestion on other modes such as highway and rail. Operational inefficien-

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DHS Secretary Michael Chertoff answers questions at a 2005 press conference. He is joined by (from left): Mr. Bernard Grosecloss, the president of South Carolina state port authority; and RADM Brian Peterman, at that time commander of the Seventh Coast Guard District. USCG photo by PA2 Bobby Nash.

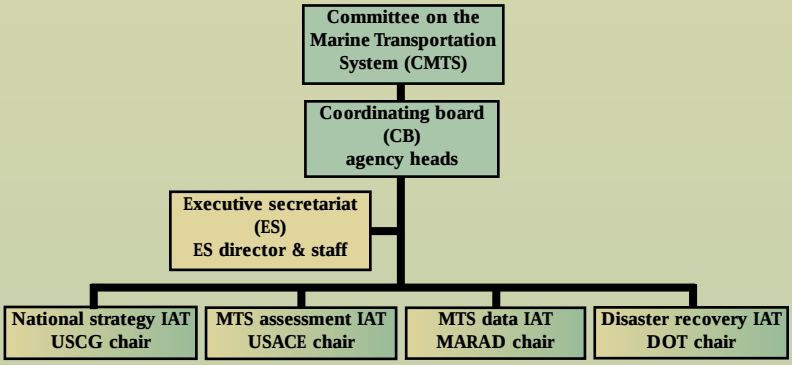
cies make existing infrastructure less able to optimally move goods. Lack of coordinated planning hampers a systems approach. Lack of public awareness of the importance of and challenges to the MTS has contributed to the lack of political will and funding to address deficiencies. The ever-present risk of accidents, and the resultant environmental impact, continues to grow as cargo, size, speed, and number of ships increases. Terrorists continue to seek ways to damage our economy and way of life, and ships and cargo remain vulnerable to these threats. Finally, it is becoming more and more challenging to finance the increasing needs of the marine transportation system infrastructure.

The secretary of transportation chaired the first meeting of the Committee on the Marine Transportation System in July of 2005. Attendees included the other cabinet secretaries and representatives of the 18 departments and agencies involved.

The National Strategy Integrated Action Team (NS IAT) is chaired by the Coast Guard and is developing a national strategy for the marine transportation system. After performing a comprehensive review of past studies, reports, and other docu-

The Committee on the Marine Transportation System is chaired by the secretary of the Department of Transportation. Its membership includes:

- the secretary of the Department of Commerce;
- the secretary of the Department of Defense;
- the secretary of the Department of Homeland Security;
- the secretary of the Department of Treasury;
- the secretary of the Department of State;
- the secretary of the Department of Interior;
- the secretary of the Department of Agriculture;
- the attorney general;
- the secretary of the Department of Labor;
- the secretary of the Department of Energy;
- the chairman of the Joint Chiefs of Staff;
- the administrator of the Environmental Protection Agency;
- the chairman of the Federal Maritime Commission;
- the head of any other federal agency that the committee chair, with the approval of a majority of the voting members of the committee, determines can further the purpose and activities of the committee.



Ex-officio members of the committee, who can participate as non-voting members, include:

- the director of the Office of Management and Budget;
- the chairman of the Council on Environmental Quality;
- the assistant to the president for homeland security;
- the assistant to the president for domestic policy;
- the assistant to the president for economic policy.

Coordinating board:
The coordinating board is comprised of senior-level representatives designated by each committee member (assistant secretary or agency head level). The current chair of the coordinating board is the National Oceanic and Atmospheric Administration administrator, and the chair will rotate annually among the commandant of the U. S. Coast Guard, the maritime administrator, and the chief of the U.S. Army Corps of Engineers.

Executive secretariat:
The executive secretariat is the permanent-staff body of the CMTS, made up of federal employees from member agencies. The executive secretariat serves as a facilitator and technical advisory body to the coordinating board and the integrated action teams.

Integrated action teams:
Integrated action teams (IATs) are responsible for the execution of an issue or challenge that is cross-jurisdictional in nature and cannot be solved by an individual agency. IATs are created as needed, have designated champions, and are approved by the CMTS coordinating board. They are either temporary or permanent, depending upon the issue or challenge that the team has been formed to resolve. The members of each IAT include representatives from the lead agency, member agencies, and other organizations required to satisfy the team's mission. The CMTS has approved four temporary IATs.

ments, the NS IAT brought together a group of 46 agency representatives and industry, environmental, and academic experts to review previous and current issues, identify key challenges, and articulate system goals for improvement. The results are the National Strategy Integrated Action Team goals:

- Improve marine transportation system infrastructure.
- Improve marine transportation system operational efficiency.
- Coordinate national marine transportation system planning.
- Increase awareness of the importance of the marine transportation system.
- Enhance the safety and environmental health of the marine transportation system.
- Enhance the security of the marine transportation system.
- Achieve sustained, adequate, and appropriate marine transportation system investment and appropriate authorities.

MTS challenges grow larger every day, as does the volume of cargo and number of passengers flowing through America's ports and waterways. The CMTS and its predecessors have begun the critical work of bringing people together to solve these problems. However, in order to succeed, the national MTS effort requires that all levels of government, industry, and the public work together for a future marine transportation system that is safe, secure, environmentally sound, reliable, and economically efficient.

About the author:
LCDR Stocklin is a U.S. Coast Guard Academy graduate and has experience as a deck watch officer and operations officer on an Alaskan buoy tender. His marine safety experience includes fishing vessel safety, oil and hazmat response, security, and waterways management activities in the Gulf of Mexico and the Pacific Northwest. LCDR Stocklin has been involved in national-level policymaking, including radiation/nuclear weapons detection and interdiction, oil and hazmat response, and waterways management/MTS responsibilities. He holds a master's degree in marine affairs from the University of Washington.

Endnote:
[1] Bureau of Transportation Statistics, 2004.

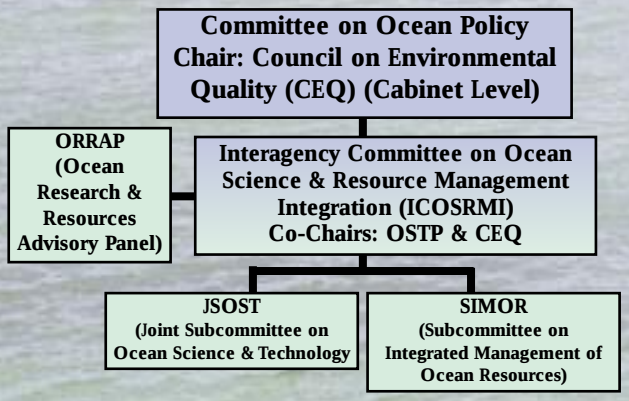
Oceans Policy

by Dr. Jonathan Berkson
U.S. Coast Guard Office of Marine Transportation Systems

The Commission on Ocean Policy, which is led by the chairman of the Council on Environmental Policy, advises the president and coordinates executive branch agencies and departments to advance the nation's environmental and economic oceanic interests.

In September 2004, the U.S. Commission on Ocean Policy released its final report, "An Ocean Blueprint for the 21st Century,"[1] which contained proposals for the establishment of a comprehensive and coordinated ocean policy for the United States. In December 2004, President George W. Bush responded to this report by signing an executive order[2] to create the cabinet-level Committee on Ocean Policy and released the "U.S. Ocean Action Plan," which contained 39 specific actions that the committee would undertake. One such action was to create a cabinet-level committee on the Marine Transportation System.

The coordinated ocean governance structure is shown here. The Interagency Committee on Ocean Science and Resource Management Integration (ICOSRMI) reports directly to the commission. Its members are undersecretaries and assistant secretaries of the federal agencies and departments.



Two subcommittees of ICOSRMI are the Joint Subcommittee on Ocean Science and Technology and the Subcommittee on Integrated Management of Ocean Resources. The former focuses on science and technology, while the latter focuses on marine resource management. A federal advisory committee, the Ocean Research and Resources Advisory Panel, provides independent scientific advice and recommendations to ICOSRMI and its subcommittees.

About the author:
Dr. Jonathan Berkson is currently the marine science program manager for the U.S. Coast Guard. He received a Ph.D. in geophysics from the University of Wisconsin-Madison.

Endnotes:
[1] U.S. Commission on Ocean Policy, "An Ocean Blueprint for the 21st Century–The Final Report of the U.S. Commission on Ocean Policy," October 2004, available at www.oceancommission.gov.
[2] Executive Order 13366 (Committee on Ocean Policy), December 17, 2004, available at http://www.whitehouse.gov/news/releases/2004/12/20041217-5.html.

Locks and Dams

Critical infrastructure for the inland river system.

by Mr. David V. Grier
Navigation Business Line Manager, Institute for Water Resources, U.S. Army Corps of Engineers

As the world's leading maritime and trading nation, the United States relies on an efficient maritime transportation system to maintain its role as a global power. The government's involvement in navigation projects dates to the early days of the U.S., when rivers and coastal harbors were the primary paths of commerce in the new country. One of the missions of the U.S. Army Corps of Engineers (USACE) is to facilitate safe, reliable, and economically efficient navigation. USACE does so by constructing and maintaining channels and harbors and regulating water levels on inland waterways.

Its role in navigation dates back to 1824 when Congress authorized the clearing of snags in rivers and other needed improvements. The mission grew to include dredging of rivers and harbors and, eventually, to the construction of locks and dams to provide reliable year-round navigation channels. The first such projects occurred on the Ohio River in the 1880s. Today, navigable inland waterways provide a cost-effective means for moving major bulk commodities, such as grain, coal, and petroleum. Inland navigation is a key element of state and local government economic development and job creation efforts, and is essential in maintaining economic competitiveness and national security. The present system of locks and dams dates from the 1930s on much of the upper Mississippi, Illinois, and Tennessee Rivers.[1]

Modern higher-lift dams with 1,200-foot lock chambers were started on the Ohio River in the 1950s to replace a turn-of-the-century 53-lock system. Work on this modernization continues today. Other waterways were also added over the last 40 years or so, including the McClellan-Kerr Arkansas River navigation system; the Columbia-Snake; the Tennessee-Tombigbee; and, most recently, the Red River.[2] However, the era of new waterway construction is essentially over. Now the emphasis is on operation and maintenance. USACE maintains the lock and dam infrastructure that is already in place (Figure 1).

The U.S. Army Corps of Engineers operates and maintains about 12,000 miles of inland and intracoastal waterways that are made navigable by 196 commercially active locks and dams. These waterways reach deep into the nation's heartland. The

Figure 1: Lock lengths for inland and intracoastal waterways. Graphic courtesy of U.S. Army Corps of Engineers.

Mississippi River, its tributaries, and the Gulf Intracoastal Waterway connect Gulf Coast ports such as Mobile, Ala.; New Orleans, La.; Baton Rouge, La.; Houston, Texas; and Corpus Christi, Texas with major inland ports. These include Memphis, Tenn; St. Louis, Mo.; Chicago, Ill.; Minneapolis, Minn.; Cincinnati, Ohio; and Pittsburgh, Pa.

In the Pacific Northwest, the Columbia-Snake River system allows navigation 465 miles inland to Lewiston, Idaho.[3] It has a 14-foot minimum channel, compared to nine feet on the Mississippi, and is served by a unique barge fleet. On the Atlantic, the Atlantic Intracoastal Waterway provides a protected shallow-draft channel connecting coastal communities from south Florida to Virginia and the Chesapeake Bay.

MAJOR COMMODITIES

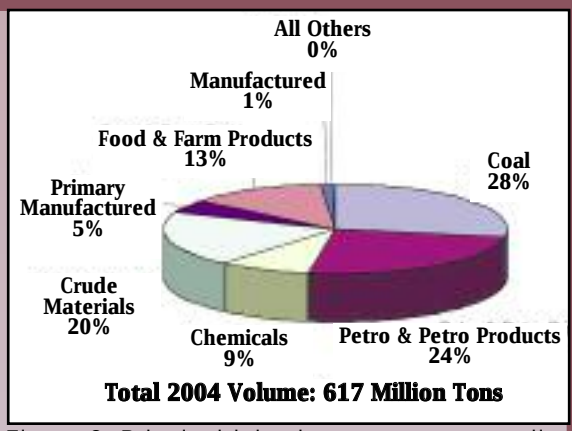


Figure 2: Principal inland waterway commodities.

Barges are well suited for the movement of large quantities of bulk commodities and raw materials at a relatively low cost. The inland and intracoastal waterway system handles about 300 billion ton-miles of cargo annually, or about 18 percent of all intercity freight ton-miles (tons shipped multiplied by the distance shipped).[1] These are raw materials or primary manufactured products that are typically stored for further processing or consumption or trans-shipped for overseas markets.

- Coal is the largest commodity by volume moving on the inland waterways. America's utility industry depends on the inland waterways for more than 20 percent of the coal it consumes. The American public depends on coal for more than 50 percent of its electricity needs.
- Petroleum is the next largest group, including crude oil, gasoline, diesel fuel, jet fuel, heavy fuel oils, and asphalt. About 22 percent of domestic petroleum is shipped by water.
- Another large group includes grain and other farm products, most of which moves by waterway to ports on the lower Mississippi or Columbia Rivers for export overseas. In fact, America's farmers depend on the inland waterways for more than 60 percent of farm exports.
- Other major commodities moving on the waterways include crude raw materials, such as metal ores or stone, sand, and gravel used in construction; chemicals, including fertilizers; and primary manufactured goods, such as steel and cement.[2]

Endnotes:

1. "Inland Navigation, Value to the Nation" brochure, U.S. Army Corps of Engineers, Institute for Water Resources, May 2000. Unpublished update, April 2005.
2. Ibid.

Waterways: The Most Efficient Mode of Freight Transportation

The inland waterways are mainly valued for their ability to efficiently convey large volumes of bulk commodities moving long distances (Figure 2). In this system, towboats push barges that are lashed together to form a "tow." A tow may consist of four or six barges on smaller waterways, and upwards of 40 barges on the Mississippi, below its confluence with the Ohio. A 15-barge tow is the most common on the Ohio, upper Mississippi, Illinois, and Tennessee Rivers. Such tows are an extremely efficient mode of transportation, moving approximately 22,500 tons of cargo as a single unit. A single 15-barge tow is equivalent to about 225 rail cars or 870 tractor-trailer trucks. If the cargo transported on the inland waterways each year had to be moved by another mode, it would take an additional 6.3 million rail cars or 25.2 million trucks to carry the load.[4]

Imagine adding this traffic and the associated air pollution to the already congested rail lines and highways that pass through our communities. The ability to move more cargo per shipment makes barge transport both fuel efficient and environmentally advantageous. On average, a gallon of fuel allows one ton of cargo to be shipped 70 miles by truck, 420 miles by rail, or 530 miles by barge.[5]

Locks

U.S. inland and intracoastal waterways include 196 commercially active lock sites with 241 lock chambers. Some locks have more than one chamber, often of different dimensions. These locks provide the essential infrastructure that allows tows to "stair-step" their way through the system and reach distant inland ports. The locks can generally be categorized by three different sizes, as expressed by length. About 15 percent of the lock chambers are 1,200 feet long; 60 percent are 600 to 1,200 feet long; and 25 percent are less than 600 feet long.[6]

Most lock widths are 110 feet. The 1,200-foot locks can accommodate a tow of 17 barges plus the towboat, while the 600-foot locks can accommodate, at most, eight barges plus the towboat. The lock size and tow size are critical factors in the amount of cargo that can pass through a lock in a given period of time.

Maintaining and Modernizing an Aging System

More than half of the commercially active locks and dams operated by USACE are over 50 years old. Many of the 600-foot locks on the system were built in the 1930s or earlier. These projects are approaching the end of their design lives and are in need of modernization or major rehabilitation. Since many of today's tows operate with 12 or more barges, passing through a 600-foot lock requires the tow to be "cut" into two sections to pass the lock (Figure 3). Such multiple cuts can be time-consuming and cause long queues of tows waiting for their turn to move through the lock. Queuing delays at locks cost the towing industry over $150 million annually in unproductive idle time.[7]

An additional challenge is lock reliability. Aging infrastructure requires increased maintenance and is at

greater risk for equipment and component breakdowns. This problem can be seen in the significant increase in both scheduled and unscheduled "unavailability" time at locks. Such downtime at locks more than doubled over the past decade to an annual average of over 100,000 hours system-wide between 2001 and 2006.[8] Such service interruptions are costly and can put the operations of major shippers, such as utilities, at risk of a shutdown.

In the 1960s the U.S. Army Corps of Engineers began to modernize the locks on the Ohio River and add 1,200-foot chambers that permit a typical tow to pass in a single lockage. This modernization process continues with the construction of a new dam with twin 1,200-foot locks at the confluence of the Ohio and Mississippi Rivers and second 1,200-foot chambers at McAlpine and Myers Locks and Dams on the Ohio. Modern 1,200-foot chambers are also being constructed at Kentucky Lock on the Tennessee River and at Inner Harbor Lock on the Gulf Intracoastal Waterway at New Orleans.

Other modernization projects are underway in Pennsylvania, West Virginia, and Tennessee. In addition, several major rehabilitations of existing locks are also underway (Figure 4). Altogether, this ongoing work represents an investment of nearly $6 billion in inland waterway modernization that will be completed over the next 10-20 years, depending on the availability of funds.[9] At most lock projects, half this investment will come from fuel taxes paid by the inland towing industry. These projects include not only modern navigation facilities, but also important investments in environmental restoration and management.

Annual capital spending for new construction and major rehabilitations on the inland waterway system has increased from less than $200 million in recent years to over $350 million in 2006.[10] This will help accelerate completion dates for ongoing lock modernization, many of which are several years behind their original completion schedules due to earlier funding shortfalls. The Inland Waterways Users Board, a federal advisory body, has noted that postponing waterway modernization projects has already cost the nation in excess of $6.7 billion in lost economic benefits.[11]

System modernization studies are underway throughout the inland waterways, including on the upper Mississippi River and Illinois waterway, Ohio River, the Gulf Intracoastal Waterway, and the McClellan-Kerr Arkansas River navigation system. Over the next few years, these studies will identify the navigation and environmental actions needed to support the inland waterway system for the next 50 years. Timely completion of current inland navigation projects and justified future navigation improvements will allow America to meet the transportation challenges of the future while protecting and enhancing our nation's treasured river heritage.

Figure 3: "Double-cut" lockage on the upper Mississippi River. Photo courtesy of the U.S. Army Corps of Engineers, Rock Island District.

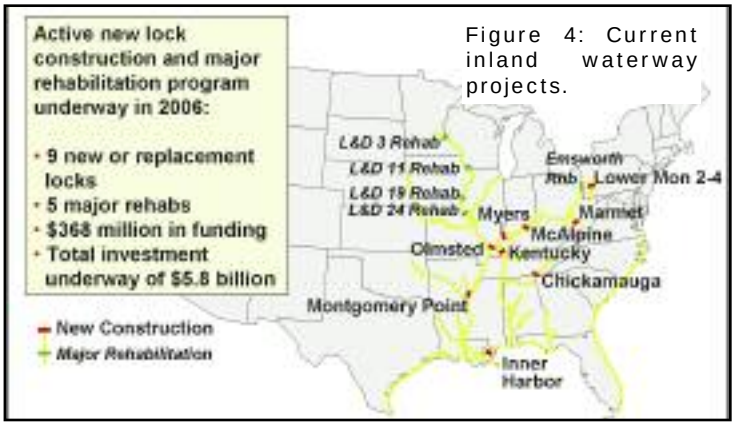


Figure 4: Current inland waterway projects.

About the author:

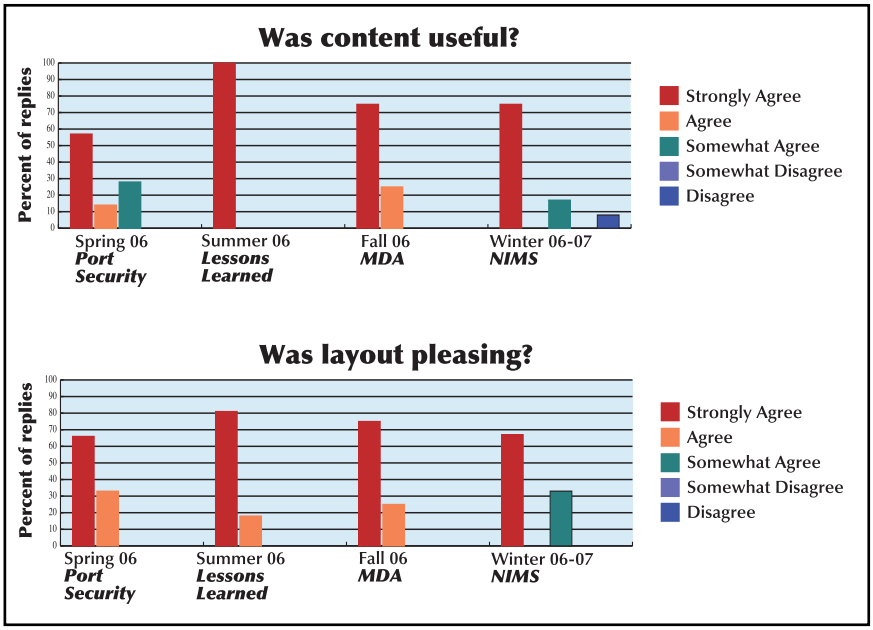
Mr. David Grier has worked for the Army Corps of Engineers since 1980. He has participated in numerous studies for maintaining and modernizing navigation infrastructure and is on the support staff for the Inland Waterways users board. He was appointed navigation business line manager at the Institute for Water Resources in 2004.

Endnotes:

1. "The 1992 Inland Waterway Review," U.S. Army Corps of Engineers, Institute for Water Resources, Report No. 92-R-7, p. 15.
2. Ibid., p. 16.
3. "The U.S. Waterway System—Transportation Facts," U.S. Army Corps of Engineers, Institute for Water Resources, Navigation Data Center, Annual, http://www.iwr.usace.army.mil/ndc/index.htm.
4. "Inland Navigation, Value to the Nation" brochure, U.S. Army Corps of Engineers, Institute for Water Resources, May 2000.
5. Ibid.
6. Ibid.
7. Lock Performance Monitoring System, U.S. Army Corps of Engineers, Institute for Water Resources, Navigation Data Center, calculation by author of total hours of delay and average tow operating costs.
8. Internal OMBIL database calculation, U.S. Army Corps of Engineers, Institute for Water Resources, Navigation Data Center, Dec. 2006.
9. "Inland Waterways Users Board 20th Annual Report to the Secretary of the Army and the United States Congress," with appendices, March 2006, U.S. Army Corps of Engineers, Institute for Water Resources, http://www.iwr.usace.army.mil/usersboard/IWUBReport2006.pdf.
10. Ibid.
11. Ibid.

Proceedings Magazine

READER'S SURVEY What You're Saying



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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

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

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

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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Reader's Survey

What We're Doing

Proceedings Magazine
READER'S SURVEY

"…way too much data all at once. Help us get through it in bite-sized chunks. The sheer volume of reading…is overwhelming…"

We are adding sidebars to many articles that contain "must-read" information. (Look for text with special graphic treatment, set off from the main text of an article.) We are also adding more charts, tables, and graphics to illustrate and emphasize important information.

"I would like to read about real-life incidents…"

"How about a regular column on casualty investigations?"

"Would like more (many more) casualty reports…"

We will be adding a regular "Lessons Learned" section to *Proceedings*, where we will delve into marine casualties. We will explore how each incident occurred, outline the U.S. Coast Guard marine casualty investigation that followed, describe the lessons learned through the investigation of these incidents, and document any changes in maritime regulations that occurred as a result.

"Would like to see a little more on seamanship and seaworthiness and maybe a little less on homeland security and law enforcement."

"I'm involved with smaller vessels."

"Single-topic issues are really boring!"

Look for "special focus" sections in upcoming editions, where we will explore varied topics in addition to the main issue topic. We will also continue to include "Mariner's Seabag" feature articles in future issues.

In an ongoing effort to improve the magazine, we began including a reader's survey in each Proceedings, *beginning with the Fall 2005 issue. Since then, staff has tracked your responses, while simultaneously reviewing the magazine for their own ideas to improve it.*

Fortunately, we all agree on the best ways to improve Proceedings! *We will be working to make the information easy to get off the page. We will also be adding new features and special focus sections.*

Keep watching: Over the next few editions, we will incorporate these improvements.

Please keep your comments coming, as we strive to make Proceedings *an even more useful tool for its readers.*

Mr. Albert G. Kirchner, Jr.
acting executive editor

Most importantly: We're listening!

We appreciate hearing your opinions and ideas. Keep them coming!

Go to www.uscg.mil/proceedings,
click on "Reader's Survey," and tell us what you think.

Foreign Trade Vessels on the Great Lakes

The Coast Guard's regulatory role.

by Mr. Paul M. Wasserman
Director, Great Lakes Pilotage, U.S. Coast Guard Office of Marine Transportation System, Waterways Management Directorate

The Great Lakes/St. Lawrence Seaway system, spanning approximately 2,300 miles, is a significant waterborne highway for foreign trade and commerce into and out of America's heartland. Each year thousands of transits are made between ports on the Great Lakes by approximately 1,400 commercial vessels engaged in foreign trade.[1] One little-known mission of the U.S. Coast Guard is to regulate private associations of U.S. pilots charged with providing safe navigation for these ships.

Foreign trade vessels are oceangoing ships that are either owned or operated by foreign companies, or Canadian- or U.S.-owned or operated companies operating on registry endorsements and engaged in international trade. These vessels regularly enter the Great Lakes to deliver foreign cargoes to U.S. and Canadian ports and load cargoes destined for foreign countries. These vessels differ from

OPEN FOR BUSINESS

Foreign trade shipping is relatively new to the Great Lakes. Prior to 1825, all shipping on the Great Lakes was exclusively between ports of the United States and Canada and conducted by either U.S. or Canadian flag vessels that are still referred to today as "lakers." These vessels were, in large part, landlocked and could not exit the system, due to navigational limitations of the St. Lawrence River.

In 1825, construction of a small canal along the St. Lawrence River was completed, which opened the system for the first time to a limited number of small, shallow-draft foreign trade vessels.[1]

In 1954, the U.S. and Canadian governments entered into an agreement to substantially expand the St. Lawrence River by constructing a series of locks, widening the river in places, and dredging portions of the river to allow access to the Great Lakes system to substantially larger foreign trade vessels.[2]

When the system opened in 1959, foreign trade shipping blossomed on the Great Lakes. Navigation of the system is, however, limited to nine-month seasons (from late March to late December), due to icing conditions on the lakes.

Endnotes:
[1] Great Lakes Pilotage Review (1972), U.S. Department of Transportation, page1-1.
[2] Ibid., pp. 1-6 and 1-7.

"laker" ships that engage exclusively in domestic trade on the Great Lakes and only rarely leave the Great Lakes system.

Pilots and Pilotage

Safely guiding these foreign trade vessels into and out of the ports and waterways of the Great Lakes is a group of approximately 45 expert U.S. mariners licensed by the Coast Guard as Great Lakes registered pilots and approximately 39 similarly trained and licensed Canadian pilots. (This article deals exclusively with the U.S. pilotage system on the Great Lakes.)

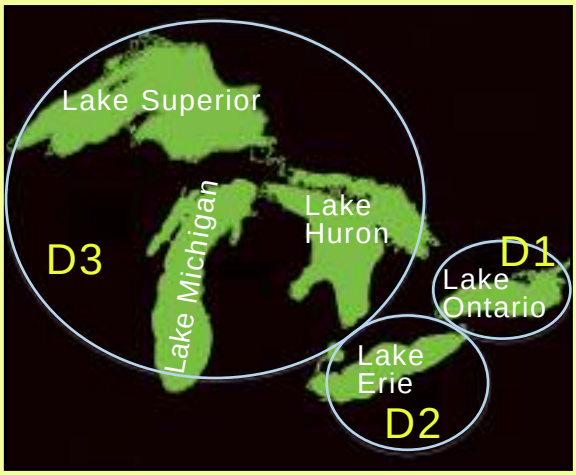
Pilotage of foreign trade vessels on the Great Lakes is unique. Throughout the United States, the Coast Guard issues endorsements on licenses to qualified mariners to act as pilots aboard commercial vessels engaged in the coastwise trade. With few exceptions, the responsibility for licensing and regulating pilots servicing foreign trade vessels belongs to the states. With the notable exception of the Great Lakes, the states determine not only the training and licensing requirements for pilots serving foreign trade vessels, but also how they may organize their operations, supervision, and compensation.

On the Great Lakes, USCG licenses pilots and regulates the operation of private pools of pilots; approves pilot training plans; oversees daily pilot dispatch and operations; and, perhaps most interestingly, actively engages in making the rates pilots may charge foreign trade vessels for their services. The Great Lakes Pilotage Division of the U.S. Coast Guard Office of Marine Transportation System, Waterways Management Directorate performs this function.

Regulation and Rates

Prior to 1959, the United States and Canada exercised little more than regulatory authority over navigation safety and the licensing of mariners on the Great Lakes. The Great Lakes system is comprised of a shared border between the United States and Canada with no international waters separating the two nations, and the operation of the seaway requires extensive cooperation between the two nations. To facilitate the supervision of pilotage in this area, a system of federal pilotage was created in place of traditional state pilotage commissions.

While provision of pilotage service is shared with Canada, the Canadian system is significantly different from the U.S. system. In the U.S., there are approximately 45 pilots organized into three geographically separate districts, operated by private associations within a federal system, subject to close Coast Guard regulation.



PILOTAGE POOLS

Pilotage on the Great Lakes is accomplished through a system of "pilotage pools" to assure adequate and efficient pilotage services. Voluntary associations of U.S. registered pilots operate these pools over three distinct geographic areas. The district one pilotage pool services the St. Lawrence River and Lake Ontario; the district two pool services Lake Erie, the Detroit River, Lake St. Clair, and the St. Clair River to Port Huron, Michigan; and the district three pool services Lakes Huron, Michigan, and Superior and the St. Mary's River.

Certificates of authorization to operate a pool are issued to each of the three pilotage associations and are valid until suspended or revoked by the Coast Guard. While there have been changes in pool certifications of pilotage associations, the districts have never changed. There are many requirements associations must achieve to be certified to operate a pool. An association must demonstrate that it possesses the ability, experience, financial resources, and other qualifications necessary to enable it to operate and maintain an efficient and effective pilotage service.

The associations must further submit work rules for the operation of the pool, agree to abide by the pilotage regulations, and be subject to such other provisions the Coast Guard may stipulate, regarding operations and the costs that may be charged in connection with the pools.

In Canada, there are approximately 39 salaried pilots who are employed by their government and receive a salary. The Canadian government negotiates its rates with industry to recoup the associated costs. In the U.S., rates are set using a formula similar to those used in setting rates for public utilities. Canada and the U.S. are signatories to a memorandum of arrangements, under which the two systems are coordinated. The U.S. Office of Great Lakes Pilotage and the

M/V *Kwnterbank* proceeds under the Mackinaw Bridge on the Straits of Mackinaw.

Canadian Great Lakes Pilotage Authority work closely together and with industry to ensure the seamless operation of the respective pilotage programs.

The present federally regulated system was created by the Great Lakes Pilotage Act of 1960. The act authorizes the secretary in whose department the Coast Guard operates to exercise extensive authority and to establish rates pilots may charge for their services. This authority has been delegated to the Coast Guard.

Safety First

In carrying out this statutory authority, the Coast Guard's mission is to ensure safe, efficient, and reliable pilotage service, giving due regard to the costs associated with the provision of these services and the public interest. The Coast Guard is also required to oversee the qualifications, training, and registration of pilots.

To do this, USCG establishes regulations specifying the minimum qualifications for a mariner to be accepted into a pilot training program, requires that each pilotage association establish a pilot training plan, and establishes criteria for approving and registering pilots. The Coast Guard is also responsible to oversee pilot dispatch and working conditions and to coordinate the operation of the pilotage systems with the Canadian government.

Finally, USCG is responsible to establish the rates pilots may charge for their services. Each pilot association is required to submit annual financial statements. Every five years, the Coast Guard audits the books and records of each pilotage association. These financial reports and audits are used in the Coast Guard's annual rate reviews, which must be completed by March of every year. Where a review discloses that the rate is no longer adequate to raise sufficient revenues to meet the expected costs of operation, or if the review indicates that an existing rate is likely to create a surplus of revenue, the Coast Guard will commence a new rate making.

The Coast Guard's paramount goal in regulating pilotage on the Great Lakes is to ensure the safe navigation of vessels into and out of the system. This mission must be balanced among industry's need to quickly and efficiently move vessels through the system, the need for pilots to receive fair and reasonable compensation, and the public interest. USCG attempts to satisfy these needs by engaging in an aggressive outreach program aimed at enhancing the involvement of all stakeholders in the decision-making processes and encouraging all interested parties to participate in the rate-making function.

In addition to the Coast Guard's outreach program, the pilotage statute requires the secretary of the department in which the Coast Guard operates to create a Great Lakes Pilotage advisory committee that is responsible to advise, consult with, report to, and make recommendations to the secretary concerning matters relating to Great Lakes pilotage. The membership consists of the president of each of the three

M/V *Goviken* upbound at Sault lock on the St. Mary's River.

M/T *Songa Maya* departs Marathon, Ontario on Lake Superior.

pilotage associations, a member representing the interests of vessel operators that contract for pilotage, a member representing the interests of Great Lakes ports, a member representing shippers, and an individual with a background in finance or accounting.

The interests served by the Coast Guard's pilotage office are diverse, but these competing interests share three common goals—safety of navigation, economic profitability of the system for both industry and pilots, and stewardship of the system that provides the means of financial support to tens of thousands of U.S. and Canadian citizens. It is challenging to craft regulations and determine appropriate rates that satisfy the widely divergent interests of both industry and the pilot associations. The key to success, however, is in enhancing the relationship among all stakeholders and by maintaining meaningful dialogue between all parties and the Coast Guard.

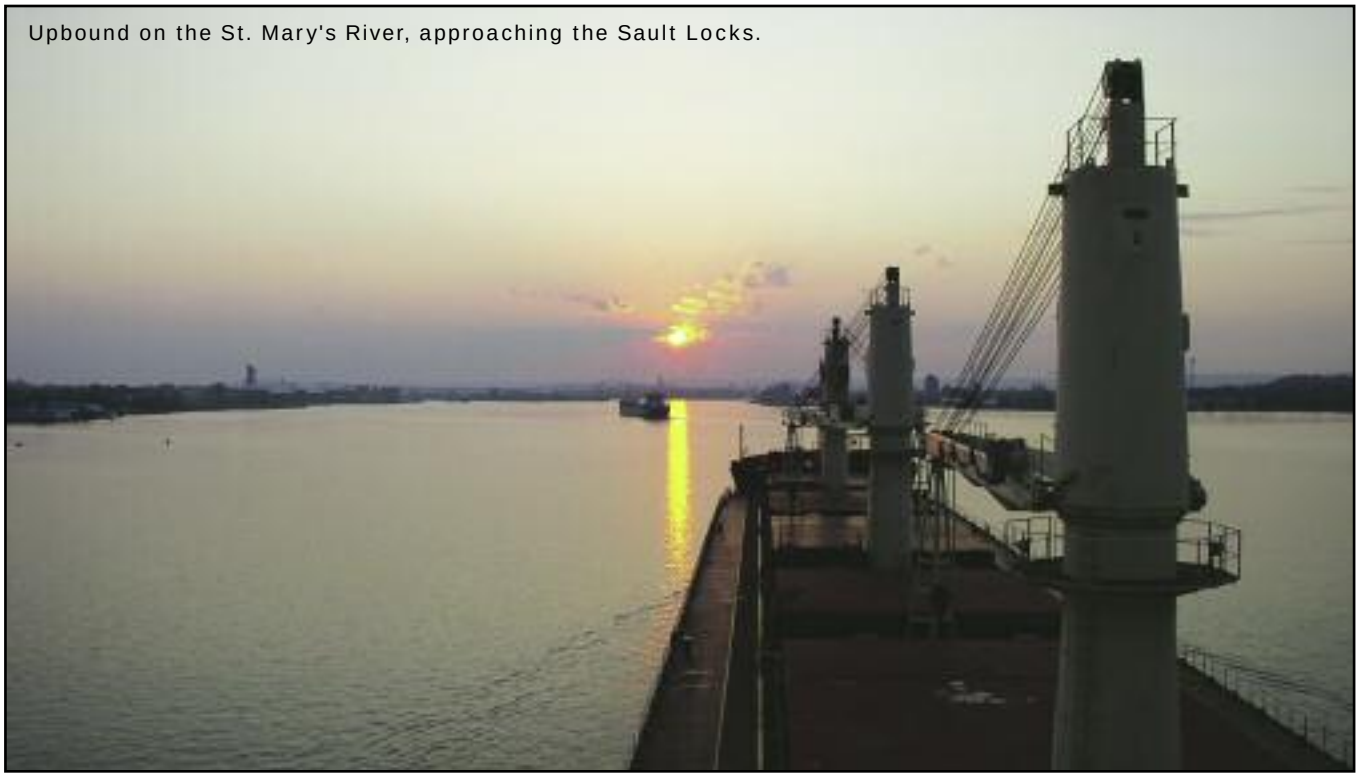
About the author:

Mr. Wasserman is currently the Coast Guard's director of Great Lakes Pilotage. Prior to this assignment, he served as an attorney in the U.S. Coast Guard Office of Maritime and International Law in Washington, D.C. Mr. Wasserman has more than 25 years of experience in the maritime field. Prior to joining the Coast Guard, he practiced maritime and international law as a trial attorney with the U.S. Department of Justice and in private practice. Mr. Wasserman served in the U.S. Navy's Judge Advocate General's Corps in both active and reserve capacities, retiring in 2002 with the rank of commander.

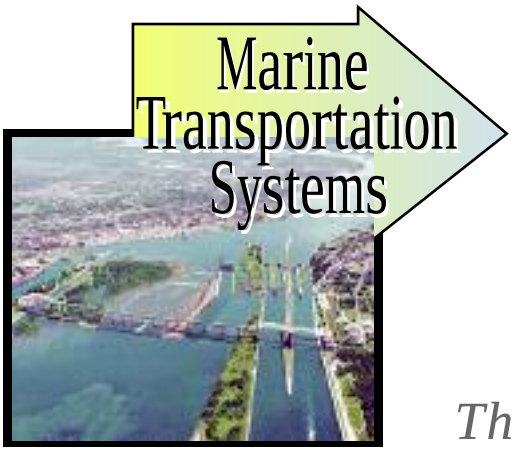
Endnote:

1. Please see the Great Lakes St. Lawrence Seaway System's 2007–2008 directory, jointly prepared by the St. Lawrence Seaway Development Corporation and the St. Lawrence Seaway Management Corporation, Harbor House Publishers, 2007, pp. 9, 15.

All photos courtesy Captain Edward Harris, U.S. district three registered pilot.



Upbound on the St. Mary's River, approaching the Sault Locks.



AIS in Waterways Management

The Saint Lawrence Seaway Development Corporation's experience using automatic identification system technology.

by Mr. Craig H. Middlebrook
Deputy Administrator, Saint Lawrence Seaway Development Corporation

The St. Lawrence Seaway poses unique challenges to the efficient operation of a vessel traffic control system. The seaway begins at the St. Lambert lock in Montreal, Que., and extends 423 miles to Long Point, Ont., on Lake Erie. Traveling that distance, a vessel transits 15 locks and crosses the international boundary between Canada and the United States 27 times. More than 4,000 lakers and ocean-going vessels, primarily bulk carriers, carrying over 40 million tons of cargo, transit the seaway during the navigation season from late March to late December.[1]

To provide a seamless journey, the U.S. Saint Lawrence Seaway Development Corporation (SLSDC), a wholly owned government corporation within the U.S. Department of Transportation, and its Canadian counterpart, the St. Lawrence Seaway Management Corporation, jointly operate an integrated traffic management system. This system features two vessel traffic control centers in Canada (St. Lambert, Que. and St. Catharines, Ont.) and one in the U.S., in Massena, N.Y.

In 2002, the St. Lawrence Seaway became the first inland waterway in North America to integrate a new waterways management tool, the automatic identification system (AIS), into its vessel traffic management system (Figure 1). The challenges to implementing AIS in the seaway included cost, availability of standardized equipment, coordination among U.S. and Canadian agencies, obtaining the necessary VHF frequencies, and evaluating the reliability of a new technology. The benefits of this new technology, however, have been substantial.

Figure 1: The coverage area for AIS in the St. Lawrence Seaway. Graphic courtesy of the St. Lawrence Seaway Development Corporation.

AIS uses global positioning system (GPS) technology and VHF digital radio transceivers to share vital marine navigation data from ship to ship, shore to ship, and ship to shore, in real time. Vessels equipped with AIS transponders can be tracked and monitored by the seaway's vessel traffic control centers and can transmit and receive data from the centers. Using the automatic identification system, vessels can receive real-time data on lock order turn, water levels, current and wind speed and direction, and seaway advisories, all of which can be accessed instantly via an onboard computer. The information is displayed on an electronic chart display information system (ECDIS) map of the seaway (Figure 2).

Figure 2: AIS data can be displayed on an onboard laptop computer. Graphic courtesy of the St. Lawrence Seaway Development Corporation.

The Saint Lawrence Seaway Development Corporation has statutory responsibility to operate and maintain vessel traffic services in the U.S. sectors of the seaway. It played a significant role in the development and implementation of the automatic identification system.[2] September 2007 marks five years since the seaway fully implemented AIS technology as part of its vessel traffic control system.

A Success Story

The story of the successful development and implementation of AIS into the St. Lawrence Seaway traffic management system is one of personal vision and international partnership. The vision belongs to the SLSDC's director of operations and maintenance, Mr. Stephen Hung, who saw the potential for revolutionizing vessel traffic control by combining differential global positioning system (DGPS) technology with that of AIS through a user-friendly interface.

In 1992, Mr. Hung first explored the use of GPS/DGPS for positioning navigation buoys with a greater degree of precision and efficiency. This led to a pioneering pilot project to determine if Saint Lawrence Seaway Development Corporation vessel traffic controllers could effectively track a ship's movement through the use of GPS receivers and VHF transmitters. The project demonstrated that vessel locations could be determined to an accuracy of better than a quarter of a mile, versus the previous accuracy of one to two miles. In 1993, the SLSDC deployed the first DGPS base station for use on an inland waterway.

Using differential global positioning system technology, the Saint Lawrence Seaway Development Corporation was able to reduce buoy placement time from hours to minutes and increase location accuracy from 50 feet to within 15 feet of the target area. The success of this pilot program convinced Mr. Hung that the potential for a satellite-based positioning system to control navigation in the seaway was not only enormous, but also achievable.

Figure 3: The Saint Lawrence Seaway Development Corporation vessel traffic center in Massena, N.Y. Graphic courtesy of the St. Lawrence Seaway Development Corporation.

Practicality and Partnership

From the beginning, SLSDC looked to off-the-shelf technologies wherever possible. For example, it used existing structures such as bridges and telephone transmission towers as locations for emitters and receivers. The Saint Lawrence Seaway Development Corporation contracted with the Volpe National Transportation Systems Center to develop the AIS vessel communications and tracking network for the seaway. The SLSDC benefited from the center's experience working on a DGPS-based vessel tracking system for the Panama Canal. Like that system, the seaway's network would incorporate GPS/DGPS, communications, controller display, and shipboard AIS. The seaway's AIS-based system, however, would be compliant with international standards.

Given the binational nature of the St. Lawrence Seaway, collaboration with Canadian seaway entities was crucial to the project's success. The Canadian seaway was a full partner in the effort from the beginning. The Canadian inland fleet was already a world leader in the development and implementation of onboard ECDIS-based navigation tools and was willing to share its expertise. The motivation to find partners led the SLSDC and the Canadian seaway to negotiate with the representatives for the waterway's laker and ocean fleets, respectively, the Canadian Shipowners Association and the Shipping Federation of Canada. Given the early successes of the SLSDC's differential global positioning system project and the potential benefits of an International Maritime Organization-compliant AIS-based vessel tracking system, these industry representatives were willing to join the effort by providing test vessels and funding for research and development.[3]

The early emphasis on practicality and partnership ultimately yielded two significant benefits. First, it allowed the flexibility to incorporate advances in technology and standards as they were developed. International standards for AIS were only approved in 2001, yet the seaway's goal was to have its automatic identification system network functional by the end of that year. Moreover, the International Maritime Organization (IMO) requirement that certain commercial vessels be equipped with AIS units did not go into effect until 2004.[4] The seaway made provisions to ensure that AIS users would be in compliance with the IMO requirements that took effect the following year.

Second, this emphasis was very cost-effective. The total cost for developing the AIS-based network in the St. Lawrence Seaway was approximately $2 million. This amount was shared among the SLSDC, the SLSMC, and the vessel operators as represented by the Canadian Shipowners Association and the Shipping Federation of Canada, who contributed almost 30 percent of the total development cost.

Figure 4: Vessel locations can be viewed via the Internet. Graphic courtesy of the St. Lawrence Seaway Development Corporation.

Safety and Efficiency

On September 5, 2002, the St. Lawrence Seaway's AIS network was officially inaugurated. The seaway's three vessel traffic control centers were completely renovated to incorporate displays of the entire seaway system. In addition, the vessel traffic controller work stations were upgraded to incorporate computer-based control of all vessel traffic control communications (Figure 3). The result was that each vessel traffic control center can now view every ship in the St. Lawrence Seaway in real time. Moreover, each vessel traffic control center can immediately view each ship's coordinates, speed, recent voyage history, cargo contents, and the weather and water conditions in that section of the system. The automatic identification system technology has proven to be extremely reliable. At no time

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Great Lakes Shipping

A Canadian perspective.

by Captain Ivan Lantz
Director, Marine Operations, Shipping Federation of Canada

Although the St. Lawrence Seaway/Great Lakes maritime system, linking the Atlantic Ocean with North America's industrial heartland, is a vital artery for international trade, many people don't think of the waterway itself as having an international character. Depending on where we are geographically located, we tend to see the waterway in terms of its parts—Lake Superior, Lake Huron, Lake Michigan, Lake Erie, Lake Ontario, the St. Lawrence River, the Gulf of St. Lawrence—rather than as a single entity, whose parts encompass both Canada and the United States.

The international character of the system is perhaps most apparent to those of us involved in ocean shipping, given that any ocean ship headed for the Great Lakes must transit the St. Lawrence River and pass through four locks located on the Canadian side of the seaway before it ever enters U.S. waters. Consequently, it is imperative to have a binational perspective with respect to the Great Lakes/seaway system, with an overall view to ensuring that ships can move as seamlessly as possible through that system, regardless of whether they are in Canadian or U.S. waters.

The St. Lawrence Seaway Development Corporation (SLSDC), which manages the U.S. section of the seaway, closely coordinates its activities with its Canadian counterpart, the St. Lawrence Seaway Management Corporation (SLSMC), especially with respect to rules and regulations, operations, traffic management, navigation aids, safety, environmental programs, operating dates, and trade development programs. The SLSDC and SLSMC have reciprocal and identical regulations, which can be found in a joint book of operations called the *Seaway Handbook*. It is available in hard copy and can also be accessed at www.greatlakes-seaway.com.

The Great Lakes navigational route crosses the Canadian/U.S. border so many times that it would be virtually impossible for the two countries to have separate systems. Safe and efficient trade on the Great Lakes is made possible through a high level of collaboration and mutual respect among Canadian and U.S. authorities and their domestic and international "partners." Indeed, it is this spirit of cooperation, infused as it is with a binational view of the system as a whole, that has enabled commercial navigation on the Great Lakes not only to exist, but to flourish.

How it Works

Most ships headed for the seaway are represented by a Canadian-based agent who acts on the ship's behalf and in the principal's stead. The agent is normally Canadian-based because all seaway-bound ships are obliged to pass through the port of Montreal. This agent is responsible for handling any regulatory infractions and for paying seaway tolls by finding someone to either post a bond, submit a letter of undertaking, or pay cash on the ship's behalf. The Shipping Federation of Canada is an association to which agents representing foreign flag ships in the seaway belong and which encourages collaboration between U.S. and Canadian authorities, with an overall view to avoiding duplication of effort and delays to shipping.

In the mid-1990s, the St. Lawrence Seaway Development Corporation and the St. Lawrence Seaway Management Corporation implemented an inspection regime called the Enhanced Seaway Inspection (ESI) program, under which all foreign ships entering the seaway were subject to an examination by a seaway inspector on the first voyage into the St. Lawrence Seaway in any given calendar year. In certain instances, the U.S. Coast Guard was invited to board the ship at Montreal along with the Canadian and U.S. inspectors, which effectively ensured the ship would not have to stop in the middle of the seaway for a regulatory inspection. This would be akin to asking a truck to stop in the middle of a bridge in order to undergo an inspection. Although the U.S. Coast Guard has no official power to deny ships access to the St. Lawrence Seaway, there is no sense sending a ship into the seaway if it cannot get beyond Massena, N.Y.

The ESI program also played an important role in ensuring that Canada and the U.S. were safe from terrorist threat to commercial navigation after the events of September 11, 2001. Indeed, a high level of collaboration and information exchange between the U.S. and Canada, along with the immediate implementation of a heightened inspection regime, enabled navigation on the seaway to resume within a few hours of those terrible events.

In recent years, the U.S. Coast Guard, the Canadian Coast Guard, and Transport Canada, along with non-governmental offices such as the Shipping Federation of Canada and the U.S. Great Lakes Shipping Association, have established a consultative entity called the Great Lakes Waterways Management Forum. This forum, which includes environmental, port, infrastructure, regulatory, shipping, and human resource interests, involves itself in a gamut of topics ranging from pollution prevention, to fireworks displays, to marina construction, to water levels, to nautical chart requirements, to icebreaking. The forum has worked particularly hard on enhancing outreach and communications to stakeholders, which has led to significant improvements in the information available to all Great Lakes users on just about every subject imaginable.

About the author:
As director of marine operations for the Shipping Federation of Canada, Captain Ivan Lantz is responsible for a wide range of subjects related to the safety and efficiency of commercial navigation, including maritime security, marine pilotage, customs procedures, and St. Lawrence Seaway operations. He works closely with the federation's membership to develop positions on specific issues and provides technical and operational advice to member companies. He also represents the international shipping industry before government authorities, and serves on a number of government councils and advisory committees.

since September 2002 has there been a break in AIS coverage for any significant amount of time.

While the revolutionary nature of controlling vessels in the St. Lawrence Seaway via AIS has become commonplace over the past five years, the benefits of the technology have been noticeable and real. AIS has improved safety through enhanced ship-to-ship communication. By possessing real-time position, speed, heading, and other pertinent information of all vessels in the seaway, a ship's master and pilot have been better able to coordinate the meeting and/or overtaking of other vessels in critical reaches of the seaway.

The AIS vessel traffic system has noticeably enhanced safety in pinpointing the exact location of a grounded vessel. Within seconds of an incident, the vessel traffic controller can now identify vital information on the vessel's cargo, the current, weather, and water levels in the area. The controller can pinpoint where the vessel lies in relation to the international border, can identify the pilot on board, and can also identify the owner/operator/agent. Having such information readily available has improved incident response times. The accurate and continuous ability to monitor vessel speed at any time, at any place, under all weather conditions, is an additional safety benefit.

The seaway's automatic identification system has also improved the waterway's efficiency. By improving speed monitoring, the new system has allowed vessel traffic controllers to closely monitor a ship's squat, or displacement in the water. This has allowed vessels to load to an additional three inches of depth (to 26 feet, 6 inches). Each additional inch of depth allows an additional 100 tons of cargo. AIS has also dramatically increased the ability of seaway vessel traffic controllers to manage ship lockages and vessel tie-ups. Ships can now precisely modify their speed to ensure they arrive at a lock when it becomes available—allowing them to preserve fuel and eliminate costly downtime.

In addition, accurate, real-time vessel location information has resulted in better scheduling for third-party services and the timely dispatch of pilots. By integrating the AIS-based traffic management system into its binational website (www.greatlakes-seaway.com), the SLSDC and SLSMC now allow owners, agents, and fleet traffic managers to access vessel location information via the Internet (Figure 4).

Thoughts for the Future

Stakeholders are looking for ways to build upon the success of the past five years. One of the priorities of the SLSDC's new administrator, Mr. Terry Johnson, is to work with the U.S. Coast Guard and Canadian counterparts to expand automatic identification system coverage to the entire Great Lakes/St. Lawrence Seaway System. To that end, the Saint Lawrence Seaway Development Corporation has signed a memorandum of agreement with USCG to share real-time AIS data. It won't be long before a vessel traffic controller can monitor the movement of any vessel, anywhere in the system.

Over the past five years, the project in the St. Lawrence Seaway has demonstrated that a world-class, IMO-compliant automatic identification system can have significant benefits for vessel traffic management for a relatively modest investment, and that industry partners are willing to share the cost of implementing such a system.

As more waterways in North America and around the world introduce AIS technology into their vessel traffic control systems, the seaway's successful experience in developing and using this new waterways management technology will provide a valuable case study.

About the author:

Mr. Craig H. Middlebrook has worked at the Saint Lawrence Seaway Development Corporation since 1995 in various capacities, including acting administrator and chief counsel. He has received the U.S. Department of Transportation's gold medal award for outstanding achievement and the transportation secretary's silver medal for meritorious achievement.

Endnotes:

1. http://www.usace.army.mil.
2. The SLSDC's authority to regulate commercial navigation in the U.S. sectors of the St. Lawrence River and Lake Ontario derives from U.S. law (33 U.S.C. 981, et. seq.) and a 1954 international agreement between Canada and the U.S. This authority was further codified in the Port and Tanker Safety Act of 1978 (33 U.S.C. 1222, et. seq., as amended).
3. In 2000, cost-sharing agreements were reached among the seaway entities, the CSA, and the SFC whereby an additional charge of $0.006 per gross registered ton would be levied on commercial operators using the seaway during the 2000 and 2001 navigation seasons. The maximum charge per year per vessel was capped at $5,000.
4. On February 28, 2003, the SLSDC published its final rule in the *Federal Register* requiring the use of AIS technology by certain commercial vessels beginning with the 2003 navigation season, which began that year on March 25 [68 Fed. Reg. 9549 (2003)].

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The Marine Event Permit Process

A collaboration among event sponsors, the Coast Guard, and agency partners.

by Mr. Theodore J. Ferring
Marine Permits Program Manager, Oceans and Transportation Policy Division
U.S. Coast Guard Waterways Management Directorate

The Coast Guard approves more than 3,000 marine event permits every year for events ranging from a simple fireworks display to a significant community event, such as the Three Rivers Regatta in Pittsburgh, Pa. The vast majority of these events happen without incident. The advance coordination among event sponsors, agency partners, and Coast Guard representatives is largely responsible for this low rate of incidents.

Process Overview

Marine events tend to block navigation channels, cause interference with adjacent vessel traffic, or prevent larger commercial vessels from navigating designated shipping lanes. Also, adjacent vessel traffic may interfere with the safety or conduct of the marine event. These are the primary reasons the Coast Guard is authorized, under 33 U.S.C. 1233, to issue regulations to promote the safety of life on navigable waters during regattas and marine parades. In 33 CFR part 100, the Coast Guard established regulations to provide notification of and effective control over marine events conducted on the navigable waters of the United States and to promote the safety of life and property in the event area. This authority has been delegated to the district commanders under 33 CFR 1.01-1.

Individuals or organizations wishing to sponsor a marine event submit an approval request for the event to the appropriate commander. Currently, form CG-4423, application for approval of marine event, is used for this process. 33 CFR 100.15, paragraph C, mandates that a new application be submitted 135 days prior to the proposed event.

When submitting a CG-4423, event sponsors provide a detailed description of the nature and purpose of the event. Information on general public interest, the number of participating boats, and the expected number of spectator craft is needed to consider how large, complex, and congested the event will be. Sponsors also attach a section of a chart or a scale drawing showing the event boundaries and placement of course markers/navigational aids to clearly indicate where the event occurs, the event's relationship to the navigation channels, and potential environmental impact. The number of sponsor-provided safety patrol vessels is also listed to ensure that the sponsor has provided adequate protection, or to ascertain whether additional resources are needed to ensure the safety of life during the event.

The information is used to consider potential impact on navigation and whether a permit is needed and may be issued. This information is also used to advise the boating public about the event. The Coast Guard cannot have any doubt regarding the location, sailing courses, or event boundaries separating participants from non-participants or adjacent navigation.

THE PLAYERS

State agencies: Coordination among state agencies is essential to ensure a safe event. In many cases, the states' representatives, such as fish and wildlife commissions or safe boating authorities, may take issue with a proposed event. Local knowledge of endangered species habitats, environmentally sensitive lands, and state-managed lands weigh heavily in any decision to approve or deny a proposed marine event.

Port authorities, shore facilities, lock and drawbridge schedules: Depending on the nature and location of the proposed marine event, these entities might very well be impacted in a negative way. Operations at port authorities and individual shore facilities should be examined during the proposed time of the event. In most cases open communication and dialog results in only minor modifications to the proposed marine event.

Local police and fire departments: Whether you're the sponsor of a proposed marine event or a local Coast Guard representative, coordination with local police and firefighters is essential. In many cases their buy-in is the deciding factor that gets an event approved or denied. In addition to assisting with jurisdictional matters, their expertise in crowd control and response abilities proves invaluable in both planning and maintaining control of an event.

Don't forget about the Coast Guard Auxiliary: Because of the number of marine events held annually and resource limitations, the use of Coast Guard vessels is often limited to events that may pose extra or unusual hazards or impede the normal flow of marine traffic. While some restrictions apply (see 33 CFR 100.40), local Coast Guard commanders are authorized to utilize the Coast Guard Auxiliary to patrol approved marine events.

If the permit request is for a first-time event, the Coast Guard also must develop environmental documentation appropriate for the event, either from additional environmental information provided by the sponsor or based on experience with other similar events in similar locations. This environmentally related information enables the Coast Guard to properly assess potential environmental impact and the applicant's efforts to mitigate or avoid environmental damage, and to develop appropriate environmental documentation and permit conditions.

Once the necessary information has been provided from the sponsor, the Coast Guard seeks input from its state and local agency partners. While the Coast Guard has final approving authority, participation and buy-in from these partners are critical for a safe event. These agencies frequently provide resources that otherwise might not be available from the Coast Guard alone.

Interagency Coordination

Many proposed events require little or no oversight by the Coast Guard. When this is determined to be the case, 33 CFR 100.10 encourages district commanders to enter into agreements with state authorities.

Concurrent jurisdiction allows the states to regulate certain marine events on the navigable waters of the U.S. when it is clearly within its capability to do so. Regardless of who ultimately controls a marine event, close coordination and liaison with local boating authorities helps ensure proper control and safety of all marine events.

NO DOESN'T ALWAYS MEAN "NO"

What? The Coast Guard denied your application? Did you submit the application on time? What was the reason cited for denial? "No" doesn't necessary have to be the final word if you're in close communication with the local Coast Guard representative. Based on the reasons for denial, applicants may suggest a different location, alter the timeframe, or modify the event to improve safety.

Also, applicants must consider the impact their proposed event will have on the local community. If lack of resources is preventing the event from proceeding, additional sponsors sometimes help applicants address and correct any control or safety concerns cited by the Coast Guard.

When Does the Coast Guard Say "No"?

There are numerous reasons why a district commander may not approve an application for a marine event. These include:

- obstructing navigation or impeding commercial traffic, which results in an unsafe condition or unsafe congestion;
- conflicting activities in the same area, such as another event, dredging, etc.;
- inadequate safety measures for the nature of the event;
- exposing a wildlife refuge or other environmentally sensitive areas to adverse impact;
- sponsoring organization with a past record of

High-speed boat racing on the Allegheny River during the Three Rivers Regatta. Photo courtesy of the Pittsburgh Three Rivers Regatta.

irresponsibility or gross violations of the terms of approval;
- late submission of application.

What Happens When the Coast Guard Says "Yes"

So you did your homework. You provided all the necessary information. You coordinated the event with every possible agency and/or entity that potentially could be affected by your event. The Coast Guard verified the information provided and said "Yes." Now what?

First, an approved marine event does not dismiss the sponsor from ensuring the safety of the event and its participants. The local Coast Guard representative will designate a patrol commander. The patrol commander will coordinate communication frequencies and protocol, establish a chain of command for the event, and direct patrols and other assets onscene to effectively control the event and promote safety.

Depending on the permitted event's scope and duration, these actions can take place the day of the event or several weeks prior. Large events will require several meetings with the sponsor and other participating agencies. During this planning process, the sponsor needs to collaborate with all participating parties more than ever to ensure all participants are working toward the same goal: a safe event.

About the author:
Mr. Theodore J. Ferring is a retired USCG lieutenant commander. He served 14 of his 26 years in the marine safety program at Marine Safety Offices in Jacksonville, Pittsburgh, and Miami, as well as the National Pollution Funds Center.

Fireworks at the confluence of the Allegheny, Monongahela, and Ohio Rivers. Photo courtesy of the Pittsburgh Three Rivers Regatta.

Conflicting Links

Waterways management and bridges over the navigable waters of the United States.

by Mr. Nicholas E. Mpras
Chief, U.S. Coast Guard Office of Bridge Administration

The Coast Guard works to ensure safe and reasonable unobstructed passage of commercial, national defense, emergency responder, and recreational vessels under bridges on the nation's waterways. At the same time, the Coast Guard must see that national transportation goals are met.

To meet these objectives, the Coast Guard issues permits for constructing or modifying bridges, orders obstructive bridges to be altered or removed, regulates bridge navigational lighting and movable bridge operation, and considers potential impact on all transportation systems and the possible resulting environmental quality.

Conflicts

The increase in vessels and port capacity continues to necessitate greater bridge clearances, yet construction of high-level or movable bridges to provide these clearances is often resisted by bridge sponsors who think it will be too costly. In addition, environmental groups are becoming more vocal concerning the potential environmental consequences of bridge construction. All these issues must be considered with every bridge project. Other problems often occur:

- Customers' needs and desires vary and generate conflict not only between land and sea transportation representatives but also between environmental groups and developers.
- Bridges across U.S. navigable waters facilitate land traffic, but obstruct navigation.
- Drawbridge operating schedules conflict with both water and land transportation. When the bridges open, they restrict land traffic; when they close, they restrict water traffic.
- Attempts to satisfy any single interest competes with the needs of other interests. The conflict among competing users increases the demand on the Coast Guard for resolution.

Deterioration

A substantial amount of the nation's bridges are functionally obsolete and structurally deficient.[1] As bridges become substandard and/or dangerously deteriorated, they must be replaced for public safety, and to satisfy the needs of commerce, transportation, and defense. Failure of our bridge system affects national defense; economic well-being; personal safety; and access to educational, cultural, professional, and recreational facilities.

Pressures

The demands on the Coast Guard's Bridge Administration Program are expected to increase. A number of new international bridge projects are anticipated since the passage of the North America Free Trade Agreement. New bridges between Canada, the United States, and Mexico will be needed to facilitate international commerce.

Pressure to process permit applications quicker will increase. Also, Congress and the marine industry will be pressing to alter bridges that restrict commercial vessel passage. Requests to limit drawbridge openings will also increase as land traffic gets more congested. That is the downside. The good news is the Coast Guard is working to keep America's waterways open. There will always be conflicts, but the Coast Guard will be there to balance the needs of land and sea transportation, so that everyone can enjoy freedom of movement with maximum safety and minimum inconvenience.

About the author:

Mr. Nicholas Mpras has more than 30 years of experience in the Coast Guard's Bridge Administration Program. He has served as chief of the permits branch from 1975–1986, the Bridge Administration Division's assistant chief from 1986–1991, and chief of the Office of Bridge Administration since 1991.

Endnote:

1. "Exclusive Bridge Inventory Report," November 2006, *Better Roads* magazine.

Lessons Learned on the River

The Big Bayou Canot disaster.

by Mr. Matthew Robertson
Bridge Management Specialist, U.S. Coast Guard
Office of Bridge Administration

At 2:53 a.m. on September 22, 1993, Amtrak's *Sunset Limited* derailed as it crossed a bridge approximately 10 miles north of Mobile, Ala. Forty-two passengers and five crewmembers were killed, and 103 passengers were injured. The subsequent investigation discovered that barges being pushed by a towboat struck the bridge only minutes before the train crossed.

The pilot of the towboat *Mauvilla* had held his U.S. Coast Guard-issued pilot's license for three years. He had piloted tows up and down the Mobile River many times and had relieved the vessel's captain earlier that night.

Figure 1: View of the accident site.

Lost in Fog
In the early morning of September 22, the towboat was pushing six barges north, up the river, in dense fog. Due to zero-visibility conditions, the pilot decided to tie up along the bank until the fog lifted. He was unaware that the vessel had entered Big Bayou Canot, a smaller tributary of the Mobile River. He later testified that he did not see the entrance of Big Bayou Canot on his radar screen, though he did see what he assumed was another tow that had swung out from the bank.

The object in the towboat's path was the Big Bayou Canot railroad bridge. Owned by CSX Railroad and built in 1909, the bridge has a vertical clearance of only seven feet. In the past the bridge had made use of a moveable swing span to allow large vessels to pass through, but this capability had since been disabled as commercial traffic along the bayou diminished.

Dangerous Assumption
The pilot could not determine the distance of the object based on the radar because he wasn't sure of the scale setting and he had not made adjustments to the radar prior to assuming piloting duties. He could not refer to nautical charts because there weren't any on board, nor were they required by law. The pilot wanted to butt up against what he thought was another tow and tie off until the fog lifted.

As the tow's barges approached the object, the pilot put the engines in reverse to slow down. He reported feeling a bump, as did the captain and the rest of the crew. The "bump" occurred at 2:45 a.m.

The lead barges in the tow had actually struck the Big Bayou Canot Bridge and displaced the girder span portion of the bridge. The impact was enough to displace the girder section 38 inches to the west, causing the girder to obtrude into the train's path.

The Incident
The train struck the displaced girder and derailed at 2:53 a.m. while traveling at 72 miles per hour. As a result, the first two engines entered the bayou and ignited. The lead engine was buried in roughly 46 feet of mud, while the third locomotive also entered the bayou, shearing off its fuel tank.

All three engines and their fuel tanks spilled diesel fuel, lubrication oil, gear oil, and more into the bayou. The dormitory (a transition car) and baggage cars were gutted by fire. Two passenger coach cars were derailed; one partially in the water, the other completely submerged.

Lessons Learned
The National Transportation Safety Board and Coast Guard completed thorough investigations and issued recommendations to the entities responsible. All of these recommendations were adopted:

- To use radar beacons, radar reflectors, and other devices so that bridges are identifiable on radar. It was also recommended that bridges should be properly lit with navigational lights.
- To develop formal radar training courses and mandate licensing requirements to ensure that towboat operators are properly trained.
- To require all uninspected towing vessels to carry appropriate navigational devices (charts, compass, radar, etc.) onboard in the wheelhouse.

Out of this tragedy a great deal was learned, and navigation practices have improved. As a result, the probability of another tragedy like the accident at Big Bayou Canot is unlikely, fortunately, and the nation's waterways and railways are safer.

About the author:
Mr. Matthew Robertson has been a civilian with the USCG Bridge Administration Program for more than five years. Additionally, he serves as a marine science technician in the Coast Guard Reserve.

Photo courtesy of http://dangerahead.railfan.net/gallery/mobile.htm.

Bridging Borders

International crossings in a post-9/11 world.

by Mr. Matthew S. Robertson
Bridge Management Specialist, U.S. Coast Guard Bridge Administration Program

Along with a refocused emphasis on immigration issues, the September 11, 2001 terrorist attacks have redefined the country's outlook on homeland security. This is especially apparent when traveling by air or when crossing international boundaries. For example, a passport is now required for all citizens reentering the United States from Canada or Mexico. Measures such as protecting infrastructure like bridges have also been taken to increase security at border crossings.

The Coast Guard's Bridge Administration Program (BAP) is known for its responsibility, as delegated by Congress, to approve or deny the locations and plans of new or modified bridges and causeways across navigable waters of the United States. Lesser known is the program's responsibility regarding bridges and causeways that cross international borders between Mexico, the United States, and Canada. Under the International Bridge Act of 1972 (33 U.S.C. 535), the Coast Guard was charged to partner with the Department of State to solve technical matters regarding the preparation of environmental documents for international bridges.

The United States requires two permits for international bridges. For the first, the president has delegated his authority under the International Bridge Act to the Department of State to issue what is called the Presidential Permit. The Coast Guard assists the Department of State to ensure that the environmental documentation for the permit is in concurrence with all applicable laws and regulations, such as the National Environmental Policy Act.

The environmental documentation prepared for the permit also satisfies the requirements for the specific location and plans subject to the second permit process, the Coast Guard Bridge Permit approval process, which occurs later. The Coast Guard's permit includes the navigational and environmental responsibilities of the permittee, construction commencement and completion dates, and details about the bridge's design and navigational clearances.

International Coordination and Cooperation

Both permit processes necessitate a great deal of cross-border and intragovernmental coordination. To facilitate this coordination, the Department of State established a binational work group from several departments and agencies. This group, known as the Binational Committee on Bridges and Border Crossings, functions as an advisor under the International Bridge Act and supports the State Department during consultations with Mexico and Canada on border crossing matters. The commandant, represented by the chief of the Bridge Administration Program, is the sole Coast Guard representative, and is also the senior member on the binational committee. The Coast Guard provides extensive advice on policy, regulations, environmental requirements, and timetables for the committee. The current BAP chief, Mr. Nicholas Mpras, explains, "Ultimately, we try to keep things streamlined and simple to provide timely responses, comply with all applicable laws and regulations, and help in any way we can." Other U.S. agencies on the committee include the Federal Highway Administration,

General Services Administration, and Immigration and Customs Enforcement.

The focus of the committee has changed significantly since 9/11. Homeland security issues have come to the forefront. "Immigration and customs and bridge security issues now take up most of the time during the meetings," says Mpras. Methodologies to prevent terrorists from entering the United States have been introduced, including new inventions, like electronic monitoring to prevent contraband. The committee works to determine what kind of security presence is needed at each crossing.

Challenges

Homeland security issues are only some of the challenges facing international bridge projects. International coordination is one of the most challenging aspects of every project. Even after the Presidential Permit has been issued by the Department of State, it can take several years before the project is ready to be constructed. The decision to issue or deny the Coast Guard Bridge Permit is not made until both countries (the U.S. and Canada or the U.S. and Mexico) have agreed upon the location, design, and timing of the project. Since each country permits only half of the bridge, international coordination is essential. Imagine, for example, if the two halves were constructed a foot off-center.

There are many other facets that must be resolved before a project can proceed. Funding can be a major stumbling block. One country may be prepared financially while the other has not made the project a priority. Additionally, the bridge is only one aspect of the project. Inspection facilities must be constructed in each country, and an adequate number of inspectors must be available before an international crossing can be opened. The queue to enter or exit the country can be quite long at some existing international crossings because of new, more stringent regulations that were not in place when the crossings were constructed.

In the Public Interest

International bridge projects are often influenced by politics on all levels (local, state, regional, national, and international), which can result in lengthy delays. The Bridge Administration Program seeks to quickly resolve any disputes within its purview and works with all parties to ensure the process is legally sound and runs smoothly. "The Coast Guard is a neutral party," says Mpras. "We are neither proponents nor opponents of bridge projects. We are here to serve the public. There is no room for personal agendas."

While every international bridge project faces similar roadblocks and challenges, the majority are ultimately approved and constructed. New crossings or modifications to existing bridges continue to be proposed every year. At the Texas/Mexico border alone, 22 bridges have been constructed, three have been issued both Presidential and Coast Guard Bridge Permits, and three are in the preapplication stages.

While there are fewer crossings across the U.S./Canadian border, they are nonetheless essential to North American trade. For instance, a new crossing has been proposed across the Detroit River between Detroit, Mich., and Windsor, Ont. The existing Ambassador Bridge is one of North America's busiest international crossings. More than 10,000 trucks and 4,000 autos cross the Ambassador Bridge each day, along with over 25 percent of all merchandise trade between the United States and Canada.[1]

The Coast Guard's permit only authorizes the construction of a bridge to the international border, generally in the center of the waterway. It is the other country's responsibility to permit the portion of the bridge on its own side of the border.

International crossings are vital to trade in North America. The Coast Guard's Bridge Administration Program works diligently to ensure proposed crossings comply with all applicable environmental and navigational laws and regulations. The program continues to serve as an invaluable conduit to our nation's most important links. As such, BAP forges essential partnerships, such as those with the Binational Committee on Bridges and Border Crossings, and develops coordination at every level to streamline and simplify the process.

About the author:
Mr. Matthew Robertson has been a civilian with the Bridge Administration Program for five years. Additionally, he serves as a marine science technician first class in the Coast Guard Reserve.

Endnote:
1. http://www.cbp.gov.

Bridges Are the Critical Links in Shaping Tomorrow's Waterways

Alteration of a bridge over the Mobile River.

by Dr. Kamal Elnahal, P.E.
Senior Project Manager, U.S. Coast Guard Office of Bridge Administration

It has been said that a waterway is no more efficient than the most inefficient and restrictive bridge within the waterway system. A case in point is the CSX Transportation (CSXT) swing bridge across the Mobile River at mile 13.3, near Hurricane, Ala. This obstructive bridge creates a critical choke point in a large navigable waterway system.

Figure 1: Navigable rivers in Alabama. Map courtesy of the University of Alabama Cartographic Research Lab.

The Mobile River (Figure 1) is a significant part of the navigation system that extends from the Gulf Coast at Mobile, Ala., to the mid-continental United States by way of the Tennessee-Tombigbee waterway, which is connected via the Ohio River to the Mississippi River system (Figure 2).

The Bridge

The existing bridge is a multispan, single-track structural steel railroad bridge that was built in 1927. The bridge structure consists of three 208-foot-through truss spans (one on the north approach, two on the south approach); an 80-foot-through plate girder span; and a 330-foot-through truss swing span supported on a large pivot pier (Figure 3).

Although the bridge is designed to provide two navigation openings when the swing span is in "open to navigation" position, shallow water renders the left descending span unusable. The right descending navigation span is the only usable navigation span, which provides only 146 feet and seven inches of horizontal clearance.

On average, 16.5 million tons of cargo per year are transported past this bridge. The delays and allisions caused by this bridge cost the navigation industry over $8.2 million per year in extra costs.[1]

Navigation Problems

The marine industry launched numerous complaints with the Coast Guard between 1986 and 1997 concerning the obstructive character of the CSXT bridge. The navigational characteristics of the river do not allow for a straight approach because the bridge is located within a bend, which changes the direction of the river and the navigation channel by about 90 degrees. This physical change makes it extremely difficult for down-bound tows to become properly aligned to safely transit the bridge and the bend immediately below the bridge.

Additionally, wind conditions adversely affect navigation. During winds in excess of 35 knots, the bridge must be locked in the "closed to navigation" position.

Figure 2: The Tennessee River and interconnected inland waterway system. Map courtesy of the University of Alabama Cartographic Research Lab.

This not only curtails the movement of commercial tows to either above or below the drawbridge, but also eliminates a critical equipment and evacuation route for public and emergency responders. Upon the forecast of a tropical storm, commercial tow companies must start moving barges and floating equipment above the bridge three to four days in advance. This is a costly practice, but also a necessary precaution.

This single restrictive bridge seriously degrades the improvements provided by the locks, dams, and modern navigation system in the entire Black Warrior-Tombigbee waterway system. Neither the Warrior-Tombigbee nor the Tennessee-Tombigbee waterways will be able to reach their full potential until the bridge is altered to allow navigation to transit the bridge freely, easily, unobstructed, and safely.

Coast Guard Investigation of the Obstructive Character of the Bridge

The frequent collisions occurring between commercial vessels and the bridge and the unreasonable delay caused by the bridge prompted the Coast Guard to investigate the alleged obstructive character of the bridge. Based on the Coast Guard investigation and the positive benefits-to-cost ratio, it was determined that the bridge was an unreasonable obstruction to navigation and its alteration under the Truman-Hobbs Act was necessary to allow vessels to pass through the bridge.

The Office of Bridge Administration completed a decision analysis in March 1999 and concluded that the alteration of the bridge qualified for federal funding under Section 3 of the Truman-Hobbs Act (33 U.S.C.A. Sec. 513). On June 17, 1999, the Coast Guard issued CSX Transportation an "order to alter." The order required replacement of the swing span of the bridge with a vertical lift bridge that provides at least 300 feet horizontal clearance and 55 feet minimum vertical clearance above ordinary high water when the bridge is in the open position.

Design of the New Bridge

The Office of Bridge Administration oversaw the alteration of the bridge and worked closely with CSXT to develop the plans, specification, and bid documents. HDR Engineering Inc., Jacksonville, Fla. was selected to design the bridge and provide the engineering services during construction. The design was completed in December 2005. The goals of the design as set by the Coast Guard's engineering division were to find the least costly construction scheme that would serve present and future navigation needs while minimizing the disruption of rail and marine traffic and permitting the retention of the existing bridge during construction. Navigation safety and mobility were the highest-priority goals of the design.

The existing swing span will be replaced by a new 365-foot lift span that will provide the navigation clearance stated in the order to alter. Two new double-leg lift towers will be constructed. To reduce the construction cost, the existing north rest pier will be retained, modified, strengthened, and reused to support the front leg of the north tower. Also, the two existing truss spans adjacent to the swing span will be shortened and reused to allow room for the new lift span (Figure 4).

A new fender system will be constructed to protect the north tower from ship collisions. The existing south rest pier will be retained to protect the south tower. Based on the results of the geotechnical investigation, it was determined that the use of driven piles for the new bridge foundation presented a risk for settlement to the existing bridge that would continue to carry traffic during construction of the new bridge. Therefore, cast-in-place, concrete-drilled shaft foundations were chosen for the foundation of the new bridge.

The designers' main challenge was to develop a construction sequence, a method to remove the existing swing span, and a method to install the new lift span while minimizing impact on rail and marine traffic.

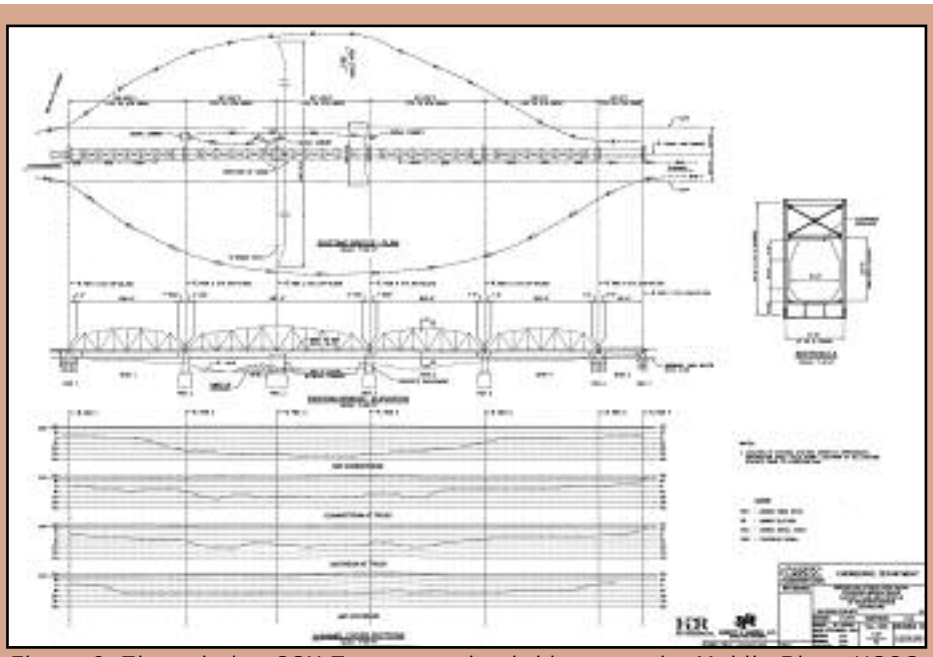

Figure 3: The existing CSX Transportation bridge over the Mobile River. USCG graphic.

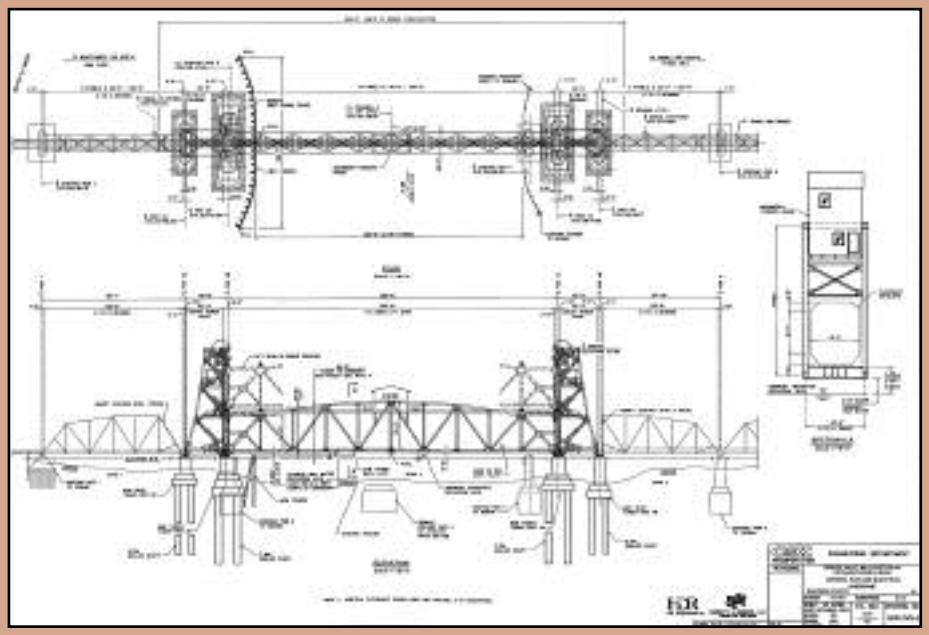

Figure 4: The selected design concept of the new CSX Transportation bridge. USCG graphic.

The existing bridge will remain in service during the construction. Twenty-two trains, including two Amtrak trains, cross the bridge daily. Train detours and delays would severely interrupt CSXT operations and would be very costly.

The construction plan includes installation of the substructures, followed by construction of the lift towers. The contractor will assemble the new structural steel lift span on barges or at the shore near the bridge. Thirty hours' closure for both rail and marine traffic will be allowed for the contractor to lower the existing swing span and float it out while floating in the new left span and erecting it. The contractor will connect the lift span to the counterweights on the tower, balance it, and complete the remaining work during short track closure periods.

Safety rules will be set so that the construction will not endanger or interfere with the movement of trains or vessels. The contractor will also have to follow certain procedures to keep the navigation channel open throughout the duration of the construction, except for very few defined periods that will be allowed to complete critical construction activities.

Bidding and Plans for Completion

The project was advertised for construction on February 24, 2006. To date, the project has received $44.7 million in federal funds.[2] Bids received for the projects were significantly higher than the estimated construction cost and the available federal funds. Costs increased due to the high demand for construction labor and equipment in the Gulf Coast created by Hurricane Katrina and continuing increases in the price of structural steel and reinforcing concrete. CSXT has been requested to reject all bids, modify bid documents to minimize construction costs, conduct a value engineering review to the plans and specifications, eliminate costly design items, and re-advertise the project. It is expected that the project will be ready for re-advertising this fall and construction will start during the winter of 2007-08. The construction of the new bridge could take two years. It is expected that the project will receive additional funds during fiscal years 2008 and 2009.

About the author:
Dr. Kamal Elnahal has served in the U.S. Coast Guard Office of Bridge Administration for 15 years. He holds a master of engineering in civil engineering from the University of Virginia and completed his Ph.D. in structural engineering at the University of Maryland in 1988. Prior to joining the U.S. Coast Guard, Dr. Elnahal worked as a bridge engineer at the Virginia Department of Transportation, where he designed several state highway bridges.

Endnotes:

1. U.S. Coast Guard Eighth District, St. Louis, Mo., "Detailed Report on the Obstructive Character of the CSX Transportation Bridge, Mile 13.3, Mobile River, Near Hurricane, Ala.," March 4, 1999.
2. U.S. Coast Guard, Alteration of Bridges (AB) Budget.

Is That Bridge Green?

The Coast Guard's role in the bridge permit process.

by Ms. Shelly Sugarman
Permits Division Chief,
U.S. Coast Guard Office of Bridge Administration, Bridge Permits Division

Mr. Allen Garneau
Bridge Management Specialist,
U.S. Coast Guard Office of Bridge Administration, Bridge Permits Division

A state turnpike commission has proposed construction of a limited-access toll expressway to connect two state routes. The project is expected to reduce highway accidents and congestion by drawing traffic onto the new expressway. A four-lane bridge over a navigable waterway of the U.S. is part of the proposed project. With the proposal in place, the commission is going to need various state and federal permits prior to construction. One of these is a bridge permit from the U.S. Coast Guard's Bridge Administration Program, but what happens if the local community has concerns over how the bridge piers impact the river bottom, or if shading caused by the bridge might impact existing fish spawning grounds? What vehicle allows for their concerns to be heard?

Federal law prohibits the construction of any bridge across the navigable waters of the United States unless first authorized by the Coast Guard.[1] As part of the permitting process, the Coast Guard is required to apply a systematic interdisciplinary approach to assess the social, economic, and environmental effects of such a project. In other words, the Bridge Administration Program (BAP) must ensure that the bridge is "green"—that it does not pose unacceptable impact to the environment.

What Is "Green"?

Conserving natural resources, mitigating undesirable impacts, being cognizant of the environment, environmental awareness—that's "green." There has been a dramatic increase over the past decade in addressing the environmental impact of construction through green or sustainable building technologies. Buildings, homes, and even bridges can now be built green.

Through its bridge permitting process, the Coast Guard is tasked with balancing the needs of land transportation and waterway navigation with the requirement of protecting the environment.

To do this, the Coast Guard must not only ensure that the reasonable needs of navigation are met, it must also make certain that issues such as endangered species, floodplain management, and the effects from bridge runoff are addressed when permitting a bridge project.

The Permit Process

Any individual; partnership; corporation; or local, state, or federal legislative body, agency, or authority planning to construct or modify a bridge or causeway across a navigable waterway of the United States must obtain a bridge permit from the U.S. Coast Guard. A bridge permit application package must be submitted to the Coast Guard district office that has jurisdiction over the proposed project. The district staff will evaluate the permit application package to ensure it contains all of the necessary information including, for example, plans, adequate environmental documentation, other appropriate supporting doc-

umentation, and whether or not the proposed bridge provides for the reasonable needs of navigation.

Many transportation projects cannot be built without a bridge. After determining the application is complete, the Coast Guard district commander undertakes a rigorous independent investigation to determine the possible impact of the proposed project on navigation and the human environment. Entire transportation corridors are often taken into consideration when assessing environmental impact. The BAP examines the projects in their entirety to ensure the requirements of the National Environmental Policy Act have been satisfied, even miles from the bridge site.

As part of the investigation conducted by the district office, scoping and coordination meetings may be required to determine the appropriate level of environmental documentation for the bridge project. In addition, a notice requesting public comment regarding the project, navigation concerns, and the level of environmental documentation will be issued to interested individuals, adjacent property owners, expertise groups, and government agencies.

Through this public notice process, a community impacted by the proposed limited-access toll expressway can voice its concerns regarding river bottom, fish spawning, or any other issues. The district bridge staff will then evaluate and act upon responses to the public notice. Normally, the public comment period is 30 days in length.

Public hearings, held in accordance with the statutory requirements of the National Environmental Policy Act, can offer an added opportunity for the public to provide input to the permit process. These are held when there are substantial issues concerning the proposed bridge's effect on the reasonable needs of navigation. When a project is elevated to the level of issuing an environmental impact statement, the project is known to have significant impact on the quality of the human environment. In this case, the public is afforded the opportunity to comment on both the draft and final document through an invitation in the *Federal Register.*

A decision cannot be made to issue or deny a bridge permit until a completed application has been received by the Coast Guard district office and all public comments have been evaluated and addressed. Also, a water quality certification must be issued or waived by the state certifying office, the provisions of the Coastal Zone Management Act must be complied with, and all environmental and supporting documentation must be completed.

In cases where an environmental assessment or environmental impact statement is required, or a case presents substantial unresolved controversy involving the public or federal, state, or local government agencies, the Coast Guard Office of Bridge Administration issues or denies the permit. Under certain conditions, the USCG district commander can directly issue or deny the permit.

A ship passes under the Fred Hartman Bridge on the Houston ship channel leading to the port of Houston, the busiest port in the nation in terms of foreign tonnage. USCG photo by PA2 James Dillard.

When a permit is issued by the Coast Guard, language within the document requires that construction and maintenance of bridges be in compliance with all applicable environmental laws and regulations. The permit for a limited-access toll expressway

Through its bridge permitting process, the Coast Guard is tasked with balancing the needs of land transportation and waterway navigation with the requirement of protecting the environment.

may include special environmental conditions tailored to fish spawning, but most often such requirements and associated mitigation measures come under the jurisdiction of other federal, state, or local agencies. Ceasing in-water construction activities during fish spawning months is one mitigation measure that may be used for such a project. Another example is purchasing land with functional wetland value in a designated mitigation bank to replace wetlands taken for the proposed project.

Green Bridges and Efficient Waterways

Bridges represent a balance between the competing needs of land and marine traffic. The Coast Guard ensures that this balance is not compromised through the bridge permit process. The needs of the environment and navigation are taken into full consideration before construction on a bridge is initiated.

Pre-application coordination between the Coast Guard and the permit applicant is strongly encouraged. This coordination might identify that the proposed location of the bridge piers will cause considerable shoreline erosion downstream, impacting the riverfront property of private residences. Moving the bridge location a mere tenth of a mile upstream may reduce this impact significantly. Should the risks associated with the new location be determined unacceptable to marine navigation (the proposed relocation may bring the bridge close to a major bend in the waterway, for example), alternate methods must be established to reduce the impact of the erosion at the initial location.

The Coast Guard Bridge Administration Program continues to ensure intermodal mobility, safety, and security. In the final analysis, this is possible only through the availability of various Coast Guard force multipliers such as Captains of the Port; air and small boat stations; reserve and auxiliary assets; and external coordination with local, state, federal, and tribal entities.

About the authors:

Ms. Shelly Sugarman is the permits division chief for the U.S. Coast Guard Bridge Administration Program. She has served in the program since 2002. She holds a bachelor's degree in environmental engineering from Rensselaer Polytechnic Institute and an engineer-in-training certification.

Mr. Allen Garneau has served in the U.S. Coast Guard Bridge Administration Program since 2003. Additionally, he served seven years on Coast Guard active duty, and has been a member of the Coast Guard Reserve since 1998, where he is currently attached to the port safety and security department at Coast Guard Sector Baltimore.

The U.S. Coast Guard patrols New York Harbor near the Verrazano-Narrows Bridge. USCG photo by PA2 Mike Hvozda.

Endnote:

1. All U.S. Coast Guard Bridge Administration Program permitting actions must comply with the provisions of the National Environmental Policy Act (NEPA) of 1969 (42 U.S.C. 4321), as amended. The Council on Environmental Quality's Regulations, 40 C.F.R. parts 1500-1508, are the implementing regulations for NEPA. The National Environmental Policy Act authorizes and directs all federal agencies to provide a detailed statement on the environmental impact of any proposed federal action to include, but not limited to, compliance with the Migratory Bird Treaty Act of 1918; section 106 of the National Historic Preservation Act of 1966; section 307 of the Coastal Zone Management Act of 1972; Executive Order 11990, Protection of Wetlands; Executive Order 11988, Floodplain Management; the Clean Air Act; the Clean Water Act; and the Fish and Wildlife Coordination Act, as amended. Environmental assessments and environmental impact statements are the detailed statements used to describe the direct, indirect, and cumulative impact bridge projects have on the environment protected by these statutes.

Coast Guard Polar Icebreakers

Past, present, and future.

by CDR Thomas Wojahn
Ice Operations Program Manager,
U.S. Coast Guard Division of Ice Operations and Mobility

The United States has extensive economic, environmental, and security interests in the polar regions. Much of the state of Alaska lies within the Arctic circle, and the U.S. maintains geopolitical relations with other Arctic nations. In the Antarctic, the U.S. participates in a number of international agreements, such as the 1961 Antarctic Treaty. Over the decades, repeated high-level reviews have reaffirmed the importance of U.S. presence and leadership in the polar regions.

For the past 140 years, the U.S. Coast Guard has conducted a variety of missions in these regions, and for the past 40 years has been the sole operator of heavy U.S. icebreakers in the harshest marine environments in the world. To continue protecting its interests in the polar regions, the nation must have vessels with the capability to operate in these severe environments.

The U.S. Becomes an "Arctic Nation" and USCG Ice Operations Evolve

The purchase of Alaska in 1867 stimulated the need for vessels capable of operating in ice-covered waters to provide a U.S. maritime presence. The task of patrolling the vast waters of the newly acquired territory was assigned to the Revenue Cutter Service, the predecessor of today's USCG.

Years of studying foreign icebreaker design proved beneficial in 1941 when USCG contracted the construction of the 269-foot "wind"-class icebreakers. *Northwind*, *Southwind*, *Eastwind*, and *Westwind* were completed by 1944. These vessels were not only the most sturdy and powerful icebreakers in the world, but they also possessed a number of innovative design features unprecedented for their time, including fore, aft, and side-heeling tanks and pumps that essentially rocked the ship free from ice. Eventually, a total of seven wind-class icebreakers were built for the U.S. Coast Guard and the U.S. Navy.

All icebreakers returned to the Coast Guard in the 1960s when it was determined that—with its long history of operations in the ice-covered waters of Alaska, Antarctica, Greenland, the Great Lakes, and the East Coast—it was the best service to execute all of the nation's icebreaking missions. Upon the return of the last wind-class vessel, the USCG fleet included eight heavy icebreakers, the seven wind-class icebreakers, and the *Glacier,* which was built for the Navy in 1955.

In 1955, the USCG returned to Antarctica to facilitate the first Operation Deep Freeze (resupply of the U.S. Antarctic program) in support of science and national security missions on the continent, which have continued annually ever since. In 1957, during efforts to resupply northern distant early-warning radar stations, cutters *Storis*, *Bramble*, and *Spar* became the first U.S. vessels to transit the Northwest Passage.

Arctic research aboard USCG icebreakers intensified in the late 1960s and early 1970s, when the prospect of increased oil and gas exploration in the Alaskan Arctic required ecological baseline surveys in the Chukchi and Beaufort Seas. The 1970s brought new challenges with the discovery of oil on the north slope of Alaska, which suddenly added a new dimension to Coast Guard duties in Arctic waters. In 1969, cutters *Northwind* and *Staten Island* escorted the tanker *Manhattan* during its test voyages through the Northwest Passage. In 1971, *Northwind* surveyed the north slope and also freed an icebound convoy of 20 tugs and 40 barges en route to Prudhoe Bay.

The upshot of new needs and aging vessels brought the authorization of the polar-class icebreakers, *Polar Star* and *Polar Sea*, commissioned in 1976 and 1978, respectively. These were the first U.S. polar icebreakers built since the *Glacier*. In the 1980s, the older vessels were decommissioned as the polar-class icebreakers

In 2006, the National Research Council completed an independent analysis entitled "Polar Icebreakers in a Changing World: An Assessment of U.S. Needs," which concluded with seven key recommendations:

1. The United States should continue to project an active and influential presence in the Arctic to support its interests. This requires U.S. government polar icebreaking capability to assure year-round access throughout the region.
2. The United States should continue to project an active and influential presence in the Antarctic to support its interests. The nation should reliably control sufficient icebreaking capability to break a channel into and assure the maritime resupply of McMurdo Station.
3. The United States should maintain leadership in polar research. This requires icebreaking capability to provide access to the deep Arctic and the ice-covered waters of the Antarctic.
4. National interests in the polar regions require that the United States immediately program, budget, design, and construct two new polar icebreakers to be operated by the U.S. Coast Guard.
5. To provide continuity of U.S. icebreaking capabilities, the *Polar Sea* should remain mission capable and the *Polar Star* should remain available for reactivation until the new polar icebreakers enter service.
6. The U.S. Coast Guard should be provided a sufficient operations and maintenance budget to support an increased, regular, and influential presence in the Arctic. Other agencies should reimburse incremental costs associated with directed mission tasking.
7. Polar icebreakers are essential instruments of U.S. national policy in the changing polar regions. To assure adequate national icebreaking capability into the future, a presidential decision directive should be issued to clearly align agency responsibilities and budgetary authorities.

joined the fleet. The two polar-class icebreakers were designed to carry out a range of missions in the Arctic and Antarctic regions, including escorting non-icebreaking vessels through the ice, conducting oceanographic research, and resupplying military and research bases.

After a 10-year effort to develop a national polar icebreaker policy, and following a White House report to Congress regarding U.S. polar icebreaker needs, funding was appropriated for a new USCG polar icebreaker in 1990. This led to the cooperative development of CGC *Healy*, which was built to be a state-of-the-art Arctic research polar icebreaker. *Healy* was commissioned in 1999 and has supported annual Arctic research projects since 2000, with one deployment to support Operation Deep Freeze in 2003.

Future of U.S. Coast Guard Polar Icebreakers

Polar Star and *Polar Sea* are both nearly 30 years old, and years of heavy icebreaking deployments have taken their toll. Extraordinarily severe ice conditions in McMurdo Sound during the past five years have required two icebreakers to complete Antarctic resupply operations. This schedule has accelerated wear on the ships, curtailed maintenance periods, and increased repair costs to the point that both *Polar Sea* and *Polar Star* have exceeded their economical service lives.

In 2005, the Office of Management and Budget decided to shift budget authority for the USCG polar icebreaker program direct costs to the National Science Foundation until a new national policy was determined. In order to fund significant sustainability upgrades on *Polar Sea*, *Polar Star* was placed in "caretaker" status in 2006 until the polar icebreaker policy dilemma is resolved.

Even though we are one of seven nations with territory and claims north of the Arctic circle, fiscal concerns regarding replacement of our two aging heavy icebreakers in recent years have cast significant doubt over U.S. support and commitment in the polar regions, especially when other world powers such as Russia, China, Japan, the European Union, and Korea are bolstering their polar icebreaker capabilities.

Following the National Research Council recommendations (see inset), the USCG is actively pursuing a new national polar region policy to include requirements regarding the need for U.S. maritime surface presence in the Arctic and Antarctic. Additionally, the Coast Guard is working to initiate a polar icebreaker major acquisition, as outlined in the study.

Until the national policy debate on polar icebreakers is resolved and an acquisition is completed, the *Polar Sea* will be used on an annual basis to support the U.S. Antarctic program, and *Healy* will be used to continue its support for Arctic research.

About the author:
CDR Thomas Wojahn is the U.S. Coast Guard's Ice Operations program manager. CDR Wojahn graduated from the U.S. Coast Guard Academy in 1989 and from the Naval Postgraduate School in 1996 with an M.S. in meteorology and physical oceanography. He has seven years' sea time on USCG polar icebreakers, patrol boats, and medium-endurance cutters.

Bibliography:
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Committee on the Assessment of U.S. Coast Guard Polar Icebreaker Roles and Future Needs, National Research Council, "Polar Icebreakers in a Changing World: An Assessment of U.S. Needs," the National Academies Press, 2007.

National Requirements for Polar Icebreaking Capability

U.S. need for polar icebreaking capability should be considered on three levels:

(1) direct mission tasking,

(2) potential contingency operations,

(3) the vital benefit of having a sovereign national presence in the polar regions.

Direct mission tasking: Experience tells us that transporting bulk cargo and fuel and conducting research in a polar marine environment requires polar icebreaker support. Icebreakers have routinely provided these functions for a variety of U.S. agencies. These missions include:

- U.S. Antarctic program resupply,
- Arctic marine polar research,
- Antarctic marine polar research,
- monitoring and regulation of commercial and government vessel activity in the Arctic,
- support of commercial and government vessel mobility in the Arctic,
- national security support missions.

Potential contingency operations: These include unplanned tasking that may require the capabilities of polar icebreakers or other ice-capable USCG vessels. The U.S. has long-standing national interests in both polar regions, and the Coast Guard has observed increasing maritime traffic in the Arctic regions, especially in the U.S. Exclusive Economic Zone and within extended continental shelf regions.

Commercial growth activities such as fishing and ecotourism in the Arctic and Antarctic have increased substantially in recent years. All of these factors will require the Coast Guard to routinely extend its presence in the Arctic and possibly the Antarctic, with the capability to support such USCG missions as:

- enforcement of laws and treaties;
- ports, waterways, and coastal security;
- national security;
- marine environmental response;
- search and rescue;
- protection of living marine resources;
- support for the marine transportation system.

Sovereign national presence: Growing world pressures for food, fuel, and mineral resources will likely force developed nations to look more to the environmentally sensitive polar regions to tap the vast resources that have been sheltered by the polar ice caps. The ability of the U.S. to exert influence and support national polar interests depends heavily on a continuing engagement, manifested in both special and routine operations. A U.S. vessel, crewed by its Coast Guard, enables the broadest and most flexible application of statutory authorities and influence.

This includes projecting capability, power, and influence in the polar regions and supporting U.S. foreign policies in the Arctic and Antarctic. This effect is most clearly illustrated by the U.S. Antarctic program, but it will apply increasingly in the Arctic as human activity there grows. Icebreakers provide the only reliable means of projecting a surface presence, especially in the Arctic Ocean basin.

The Arctic Ocean lacks a process similar to the Antarctic Treaty that guarantees political and environmental stability. Although the U.S. Antarctic program requires polar icebreakers to support its land-based stations, U.S. Arctic policy requires a maritime presence to guarantee U.S. security interests, enforce U.S. laws, and maintain influence in the foreign policy process. As the United Nations Convention on the Law of the Sea (LOS 1982) and related international claims to the Arctic Ocean basin evolve, the U.S. will undoubtedly require an active and perhaps continual presence in the Arctic.

There has been increasing concern about international activities that are growing in the Arctic, not all of which align with U.S. objectives such as:

- growing Chinese polar activities,
- assertive Russian and Danish seabed claims,
- foreign international polar year initiatives that outpace our own,
- Canada's rising nationalism regarding Arctic territory and sovereignty rights.

Other trends, such as growing interests in Arctic maritime shipping routes, rising energy prices, doubling of the world's ice-capable vessel fleet, increasing interest in the Antarctic, and declining Arctic ice conditions indicate that the U.S. will need to have a greater capability in the polar regions to protect and enforce our national interests. One-fourth of the world's energy reserves are located north of the Arctic Circle. This requires that the U.S. be able to project power and influence into the Arctic as energy resources become more scarce.

Icebreaker Innovations

A brief history of technological advancements in icebreaking.

BY DR. ALFRED TUNIK
Naval Architect, U.S. Coast Guard Engineering Logistics Center

Ships have been operating in ice-covered waters for more than a century. This experience has proven that the most effective way to break ice cover is by using the weight of a moving ship sliding on the ice cover, further driven by propeller thrust and inertia.

During the first half of the 20th century, operators found that it is best for an icebreaker to have a generally wedge-shaped bow (Figure 1), although some deviations from this can be effective for particular applications. The operators also learned that propeller wash from either stern or bow propellers can be effectively used in certain ice conditions to improve icebreaking performance. During this time, most icebreaking methods were perfected by trial and error. Shipbuilders mainly incorporated moderate variations of the bow lines to aid in icebreaking.

Figure 1: The Russian nuclear-powered icebreaker *Rossia*, shown here at the North Pole in 1990, features the classic wedge-shaped bow. Photo by A. Tunik.

The booming oil exploration in Alaska in the late 1960s also greatly boosted innovation. First, in 1969 the tanker *Manhattan* was heavily ice-strengthened and fitted with a wedge-shaped icebreaking bow to make an experimental delivery of Alaskan crude oil through the Northwest Passage. This technological achievement manifested an unprecedented, and still unmatched, jump in the size of Arctic icebreakers from 20,000 tons (for example, the nuclear-powered *Lenin*) to almost 150,000 tons in displacement.

Icebreaking technology innovations in the 1970s and 80s followed three major paths:

(1) searching for bow shapes more effective in icebreaking than the wedge;

(2) enhancing the frictional and abrasive resistance characteristics of the hull surface against ice;

(3) efforts to develop less expensive propulsion systems than the traditional diesel electric systems, whose over-torque characteristics are so well suited to icebreaking.

Bow Shapes: In the first area of development, icebreakers fitted with a spoon-shaped bow, a flat-sloped bow or bow attachments, a sledge-shaped bow, and others performed nicely in level ice, but were problematic in other ice conditions and in open water. As a result, the traditional wedge-shaped bow is still the preferred choice, while mildly spooned bows have been successfully used on a few small icebreakers.

Resistance: The efforts to improve frictional resistance resulted in numerous efforts to supply air and/or water to the ice/hull interface of a moving icebreaker. Time has proven that these methods are not as successful in practice as expected.

The development of low-friction, high-ice-abrasion-resistant coatings in recent decades has been a more successful effort. Today, such coatings are used on virtually every icebreaker except those where much more durable and more expensive clad steels are used.

Propulsion Systems: During the mid-1980s significant development efforts were made to develop geared diesel propulsion plants, which proved to be lighter and much less expensive than traditional diesel electric propulsion plants. Geared diesel propulsion plants have proven to be effective in certain ice conditions. However, probably the most significant development in icebreaking propulsion technology was the development of azimuthing propulsion systems.

Azimuthing podded propulsors were developed in the early 1990s in Finland for icebreaking services and installed in many (mostly Finnish-built) icebreakers and icebreaking cargo vessels, including the USCGC *Mackinaw* (Figure 2). Azimuthing propulsors dramatically increase the maneuverability of ships in ice, making it possible for the vessel to perform a U-turn on the spot (zero circulation diameter). Moreover, in astern motion, ships fitted with azimuthing

Figure 2: The USCG icebreaker *Mackinaw*, the first icebreaker in North America to be fitted with azimuthing podded propellers, features two Azipods® at the stern. The *Mackinaw's* stern is an example of the "sledge" shape. USCG Photo.

propulsors benefit considerably due to combining both thrust and wake wash actions of the propellers. They are therefore capable of breaking 5-10 percent thicker ice cover, compared to what the ships can break by moving forward. In addition to the operational impact, the azimuthing podded propulsors made a noticeable impact on the design of icebreakers, eliminating shaftlines and rudders, reducing space required for propulsion machinery, redistributing weights and buoyancy, and changing ice loads on hull structures.

But the benefits brought by azimuthing podded propellers come with a price. As the pod is a heavy rotating unit that is not rigidly fixed to the hull, the propeller-induced vibrations of hull structures are inherently greater, especially in ice conditions, than those caused by traditional shaftline propellers. As a result, complying with the vibration, noise, and habitability standards for ship structures and spaces is a challenge.

The introduction of azimuthing podded propeller propulsion became the basis for the so-called double-acting ship concept, another recent Finnish innovation. A vessel built to the double-acting concept is fitted with azimuthing podded propellers in the stern and is designed to operate by moving astern in the heaviest ice conditions, i.e. breaking ice by the sledge/spoon-shaped stern assisted by the podded propellers, while moving bow-forward in all other conditions. The bow can be shaped either for open water operations only, or for ice and open water conditions. A few double-acting icebreaking vessels (including the Arctic container ship *Norilskiy Nickel*) have already been built to the later version of the concept, and many more are in the order books.

In spite of growing popularity, the operational experience with double-acting vessels is very short yet, and a number of experts are skeptical or cautiously reserved about the extent of claimed economic efficiency. Only a decade of operations will eventually confirm the viability of this idea. Alternatively, it is possible this idea may not prove to be as successful as some other initially well-regarded innovations of the 1970s and 80s, such as air bubbling systems and water jet lubrication systems installed on dozens of vessels for over a decade but almost forgotten now.

Of particular interest for the future is the recent development of the prototype small waterplane area twin hull (SWATH) ferry for the U.S. Office of Naval Research. The vessel is designed for use in Cook Inlet (near Anchorage, Ala.), where ice conditions are usually light or moderate even in the worst seasons. The vessel is designed to break the ice upward with the sharp-nosed, very slim struts of widely spaced semi-hulls (Figure 3). Model tests in an ice testing basin demonstrated very good performance in both continuous breaking of level ice and in maneuvering. If the full-scale trials of the 195-foot ferry will confirm the model test performance, this will open a venue for small SWATH craft exploratory operations in marginal ice conditions.

Figure 3: An ice test of a small waterplane area twin hull ferry model. Photo courtesy U.S. Navy.

About the author:
Dr. Alfred Tunik is a naval architect at the U.S. Coast Guard's Engineering Logistics Center. Dr. Tunik graduated from Leningrad Shipbuilding Institute. For decades, he has been involved in the design and operation of icebreakers, first at the Arctic and Antarctic Research Institute in U.S.S.R., and then at the American Bureau of Shipping in New York, prior to joining the Coast Guard in 2001. He is the author of dozens of papers on icebreaking ships and ice mechanics.

Going for Bust

The challenges facing the Coast Guard domestic icebreaking fleet.

by LT Brendan O'Shea,
U.S. Coast Guard Office of Maritime Transportation, Mobility and Ice Operations

For those who live in areas where ice forms on the waterways, Coast Guard icebreaking operations are critical to the local economy and ensure the year-round delivery of vital supplies. Without the aid of the Coast Guard domestic icebreaking fleet, ice formation on the Great Lakes and on the rivers and harbors of the East Coast would render most vessels inoperable during winter months.

On the Great Lakes, icebreaking allows for an extended shipping season for cargo such as iron ore, coal, and grain. In the Northeast, icebreaking ensures that critical shipments of heating oil are delivered. In addition, Coast Guard icebreakers break ice jams to help prevent flooding in the Great Lakes, the Northeast, and the mid-Atlantic regions.

Ice Operations

The majority of Coast Guard domestic icebreaking operations is accomplished by 10 icebreakers. The icebreakers consist of the newly commissioned CGC *Mackinaw* and nine 140-foot icebreaking tugs (called WTBGs). Additionally, 11 65-foot small harbor tugs provide icebreaking services in shallow waterways.

A successful icebreaking program is one that allows commercial traffic to continue uninterrupted during the winter months. In winter 2006, the Coast Guard did exactly this for the Great Lakes, resulting in the shipment of an additional $750 million in goods.[1]

The Coast Guard domestic icebreaking program measures its effectiveness by recording the number of days that a critical waterway is closed due to excessive ice during an ice season. "Critical" waterways are defined by considering factors such as the amount of commerce moved on the waterway, the availability of an alternate route, and the density of traffic. The domestic icebreaking program has met its critical waterway performance measure (to have no more than two critical waterway closure days per winter) for four out of the past five years. Severe winter conditions, coupled with a decision to try to extend the ice season longer than normal, led to the program not meeting its goal in 2003–2004.

Uncertain Future

Despite its consistent success, the icebreaking program faces a serious challenge. The 140-foot icebreaking tugs commissioned from 1978 to 1987 are rapidly approaching the end of their 30-year service life, with no mid-life extension maintenance scheduled or funded. During the winter of 2004–2005, the icebreaking tug *Mobile Bay* was inoperable for six weeks during the middle of the ice season due to an engineering casualty. During the 2003–2004 ice season, another of the WTGBs, *Morro Bay*, was also inoperable for several weeks.

Replacement parts are typically not readily available because some of the equipment and systems on the icebreaking tugs are outdated and the parts need to be specially ordered, if they are commercially available at all.

The domestic icebreaking fleet has proven itself to be a vital capability for a multitude of missions, and its positive impact on the nation's economy is substantial. The WTGBs are a critical part of ensuring that the nation continues to enjoy the benefits of domestic icebreaking, but unless an extensive maintenance or replacement plan for these assets is put in place soon, they face an uncertain future.

About the author:
LT Brendan O'Shea has served in the Coast Guard for five years. Prior to joining the Mobility and Ice Operations Division, LT O'Shea completed tours on a high-endurance cutter and an icebreaking tug. LCDR Bernard Sandy, a WTGB sailor of eight years, also provided invaluable assistance with this article.

Endnote:

1. CG memo from CAPT M.D. Hudson CGD Nine (dpw) to COMDT (G-PWN) 16500.

Changing Times, Changing Missions

In 1936, President Roosevelt issued Executive Order 7521, directing the Coast Guard to assist with keeping channels and harbors open to navigation by means of icebreaking "in accordance with the reasonable demands of commerce." Since 1936, there have been significant changes to what would be considered the reasonable demands of commerce. Likewise, there have been significant changes in the expectations and roles of Coast Guard icebreakers.

Icebreaking

One example of the changing demands of commerce involves the shipment of oil in the Northeast, particularly on the Hudson River. In order to reduce costs, oil companies have adopted a "just-in-time" approach for oil deliveries, which requires that shipments be delivered within 36 hours. Many storage facilities maintain only a few days' supply on hand. An interruption in the delivery of petroleum products would cause severe hardship for the approximately 20 million Americans who live in the product delivery area.

In 1936, oil facilities maintained a larger reserve supply and may have tolerated a two- or three-day delay in providing icebreaking services. However, the just-in-time delivery concept can no longer tolerate such delays. It is simply unacceptable to allow millions of citizens to run out of heating oil in the dead of winter.

Escorts

WTGBs and small harbor tugs also provide security for military outloads in the Delaware River. Often, these vessels will provide vessel escorts typically provided by other Coast Guard assets when those assets are unable to do so because of the presence of ice.

Stewardship

In addition, ice jams in some areas on the Great Lakes and the East Coast can cause severe flooding if left unattended. For example, the damage done by a flood on the Kennebec River in Maine in 1936 was greatly increased due to an ice jam above the Richmond bridge. As a result of the Coast Guard's efforts in promptly relieving those jams, there have been no floods caused by ice jams on the Kennebec River since that time.

Security

One of the latest challenges to the ice operations mission does not even involve ice. In the last few years, the WTGBs have been increasingly used to conduct the ports, waterways, and coastal security (PWCS) mission. Over the three years following 2001, the average annual PWCS hours for all icebreaking tugs rose by more than 10 times what it had been in the three prior years.[1] In the three years prior to 2001, the annual average employment hours for all of the WTGBs for all missions was 8,475. In the three years following 2001, the average annual employment of the icebreaking tugs rose to 10,771.

Despite such added responsibilities and increased demands, the domestic icebreaking fleet has continued to meet the demands of commerce by keeping the waterways open.

Endnote:

[1] Over the three years following 2001, the average annual PWCS hours for all WTGBs was 4,057, compared to a 325-hour annual average over the three years prior to 2001.

Nautical ENGINEERING Queries

1. In refrigeration systems with multiple evaporators, the metering of refrigerant to each refrigerated space is accomplished by _____.

A. the king expansion valve
Incorrect Answer: The main liquid line valve, or King valve, as originally used to describe this valve in an ammonia type system, is a stop valve normally installed just after the receiver, and is either fully open or fully closed.

B. individual coil expansion valves
Correct Answer: The metering of refrigerant to each refrigerated space in a multiple evaporator system or multiple refrigerated box system is controlled by each individual coil's thermostatic expansion valve, or TXV. The TXV is designed to proportion the flow rate of refrigerant entering the evaporator coil in proportion to the rate of evaporation of the liquid refrigerant in the coil. The valve opens and closes in response to the change in vapor volume and pressure in the sensing bulb clamped to the evaporator coil outlet. To ensure that all of the liquid refrigerant vaporizes by the time it leaves the evaporator coils, the TXV is set to maintain 7-10 degrees of superheat in the refrigerant leaving the coil.

C. a solenoid valve in the liquid line
Incorrect Answer: The solenoid valve is an electro-magnet operated valve installed in the liquid line leading to each TXV employed in a multiple box system. The valve is either fully open or fully closed, and is operated by a thermostatic control switch connected via capillary tubing to a thermal bulb sensing the temperature in the refrigerated space. When the temperature in the refrigerated space drops to the desired set point, the valve closes, and shuts off all liquid refrigerant flow to the thermostatic expansion valve (TXV). When the temperature in the refrigerated space rises above the desired set point, the valve opens, and refrigerant flow is renewed to the TXV.

D. individual back pressure regulating valves on all but the coldest box
Incorrect Answer: The back pressure regulator is located in the run of evaporator outlet coil used in multiple box systems where different box temperatures in one system are maintained by one compressor. The refrigerated box temperature for a vegetable box may need to be 38°F, yet the freeze box temperature may need to be 0°F. If a refrigerant temperature of (minus) -10°F were needed to obtain 0°F, the temperature differential for the vegetable box would be 48°F and the heat release from the vegetables and fruit would be at a rate that would freeze dry and damage them to the point that they would lose their taste and nutrient value. The back pressure valve is adjusted to close and stop the flow of refrigerant through the evaporator to maintain an internal coil pressure above that of the compressor suction pressure, thus preventing the refrigerated space from becoming too cold.

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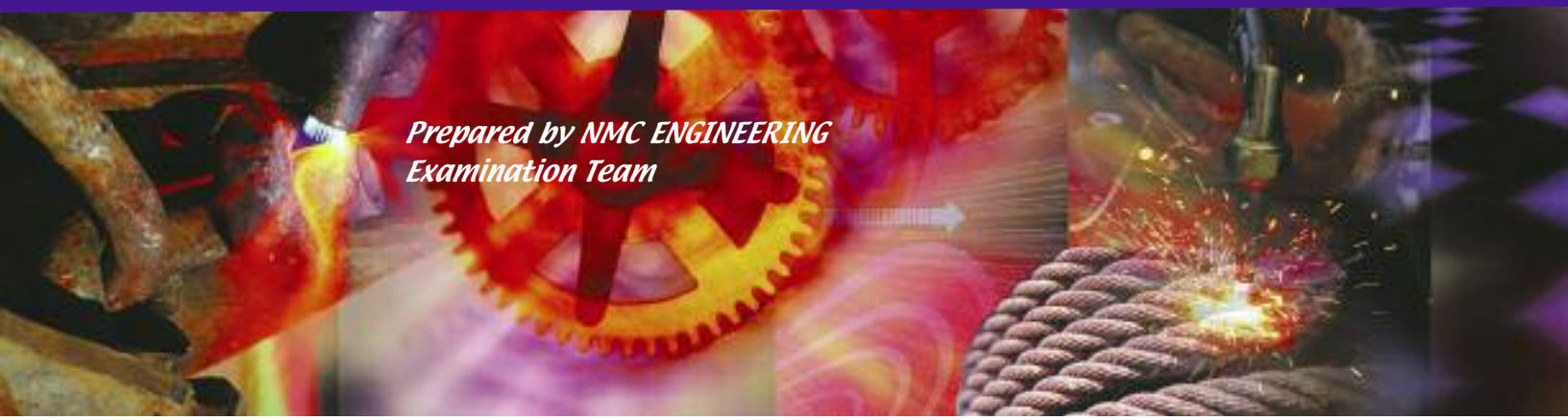
2. The primary purpose of a control desuperheater installed in the steam drum of a boiler is to _____.
Note: A desuperheater is a heat exchanger which reduces the temperature of a portion of the superheated steam leaving the boiler for use in the auxiliary steam system. A control desuperheater, or attemperator, is a heat exchanger that controls the superheat outlet temperature at high boiler loads to prevent the main steam piping, turbines, and the superheater from exceeding the designed operating temperature. Both the desuperheater and control desuperheater are installed below the water level in the steam or water drum, and are generally of the "single pipe" or "multi-tube bundle" design.

A. assure a constant volume of steam flow through the entire superheater under all load conditions
Incorrect Answer: The volume of steam is proportional to boiler load and cannot be "constant" in volume. All of the steam generated by the boiler passes through the superheater, with a portion of the superheated steam redirected



through the desuperheater to supply the auxiliary steam system. This arrangement maintains a flow of steam through the superheater at all times.

B. regulate the temperature of superheated steam by adding moisture
Incorrect Answer: The control desuperheater regulates the temperature of a portion of the superheated steam by absorbing a portion of the heat from the superheated steam by the water in the steam drum.

C. regulate the superheater outlet temperature by cooling a portion of the superheated steam
Correct Answer: The control desuperheater regulates the superheat outlet temperature by cooling a portion of the superheated steam. A manual/automatic control valve redirects a portion of the superheated steam through the control desuperheater located in the steam drum. The control desuperheater removes a portion of the sensible heat of the superheated steam, and then returns it to the last group of passes of the superheater where the mixing of the two flows results in a lowering of the superheated steam temperature.

D. regulate saturated steam temperature through the desuperheater
Incorrect Answer: The control desuperheater regulates the superheater outlet temperature.

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3. In which of the listed hydraulic system components could an O- ring seal be satisfactorily used in providing a seal?
Note: The proper sealing in hydraulic systems is important to prevent fluid loss, keep foreign matter out of the system, and maintain differential between high side and low side pressures. Seals are divided into two general classes, static seals and dynamic seals. The O-ring, a molded synthetic rubber seal with a circular cross-sectional shape, is the most common static seal used in hydraulic systems.

A. High pressure pump shaft casing.
Incorrect Answer: An O-ring is impractical for a rotating shaft, as it can be "grabbed" by the shaft during rotation, and may thin the "O" ring in one area, which would permit pressure oil to leak across this area. Pumps and motors operating in high pressure ranges are generally sealed by mechanical seals which are composed of both of a primary dynamic seal, and a secondary static seal.

B. Low pressure pump shaft casing.
Incorrect Answer: An O-ring is impractical for a rotating shaft, as it may allow leakage (see description to "A" above). Pumps and motors operating in low pressure ranges, are generally sealed by lip seals composed of synthetic rubber that are held in place by a retaining spring.

C. Linear actuator without nylon insert.
Incorrect Answer: An O-ring inserted into the annular groove of a linear actuator without a nylon insert (back-up ring), will extrude and be pinched when exposed to high pressure and excessive linear motion.

D. Relief valve spool.
Correct Answer: An O-ring provides excellent static sealing capabilities, as long as it does not need to move but a few millimeters, otherwise the resultant drag will cause the flexible O-ring material to slip in between the clearance of the two mating surfaces and damage the ring. O-rings are primarily suited for static sealing or limited motion devices, such as valve spools.

Nautical DECK Queries

1. The channel under a bridge is marked with aids from the lateral system. The centerline of the channel is marked on the bridge with _____.

Note: In the U.S. Lateral Aids system Safe Water buoys and marks are distinguished by 1) color: red and white, 2) shape: spherical, pillar, or spar buoys, 3) topmark: single, red spherical, and 4) lights: white light that can be occulting, isophase, a single long flash or Morse "A".

A. a yellow triangle

Incorrect: The yellow triangle, along with yellow square, are markings placed upon buoys on the Intracoastal Waterway to signify the Western Rivers system and are not used as an aid to navigation to mark any channel or a bridge.

B. three white lights

Incorrect: In §118.65, Lights on fixed bridges, for bridges NOT maintaining the lateral aids to navigation system the main channel span of the bridge is marked with a set of three white lights in a vertical line over each green light marking each navigable channel.

C. a black and white diamond

Incorrect: a black and white diamond daymark has no lateral significance in the lateral aids to navigation system. It is used to mark areas such as fish net area, anchorage or dredging.

D. a red and white octagon

Correct: According to 33 CFR Part 118, Bridge Lighting And Other Signals, in §118.110, Daymarks and lateral lighting on bridges, (b) it states "If lateral system lights are required or authorized to mark the main channel, … the centerline of the channel shall be marked with the standard lateral system safe water mark and occulting white light, instead of the lights prescribed in §118.65."

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2. When fighting a fire in a space containing an IMO class 1 hazardous cargo, the most effective fire fighting procedure is to _____.

Note: An IMO class 1 hazardous cargo designates explosives substances and articles. It is broken down into five hazard divisions 1.1 (mass explosion), 1.2 (projection hazard), 1.3 (fire hazard and either minor blast hazard or minor protection hazard or both), 1.4 (no significant hazard) and 1.5 (very insensitive substances with mass explosion hazard). The greatest risk to an IMO class 1 hazardous cargo is fire from an external source heating the explosive substance beyond its ignition temperature. If it is improbable to remove the explosive substance from the scene of the fire, there is a need to cool the explosive substance below its ignition temperature.

A. shut down the ventilation and exclude all air to smother the fire

Incorrect: shutting down the ventilation will cut off the supply of air to the fire but it may take a prolonged time for the fire to extinguish without any cooling affect on the explosive substance.

B. use water from fire hoses or a sprinkler system

Correct: water is the most effective fire fighting procedure because it involves not only fighting the fire but the water cools the explosive substance below its ignition temperature.

C. activate the fixed CO2 firefighting system

Incorrect: fixed CO2 is used primarily to deplete the oxygen fuel necessary for the fire to burn. CO2 has very limited cooling capability.

D. use high-expansion foam

Incorrect: High expansion foam is designed for fires in confined spaces (such as a shipping container). The foam is used primarily to smother the fire but also has cooling capability. However, high expansion foam is impractical to fight class 1 hazardous material fires in a cargo hold where it may be impossible to fully submerge the explosive substance in order to cool it.

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3. If a lifeboat is stowed 40 feet above the light water draft and 200 feet from the bow, how long must the sea painter be?

A. 80 feet

Correct: According to 46 CFR 199.175 (b), Survival craft and rescue boat equipment, 21 (B), Painter, the painter for a lifeboat must be of a length that is at least twice the distance from the stowage position of the boat to the waterline with the vessel in its lightest seagoing condition, or must be 15 meters (50 feet) long, whichever is greater.

B. 160 feet

Incorrect: This sea painter length would equate to four times the distance from the stowage position of the boat to the waterline with the vessel in its lightest seagoing condition. Although there is no regulation limiting the length of the sea painter, 80 feet is the required length of the sea painter for this vessel.

C. Sufficiently long enough to reach the water when the vessel has an adverse list of 15°

Incorrect: Distance to the waterline created by adverse list of the vessel is not a variable when computing sea painter length. The vessel must be capable of launching the lifeboat under unfavorable conditions of trim and with the vessel listed up to 20 degrees either way.

D. One third the length from the bow to where the lifeboat is stowed

Incorrect: Distance from the bow of the vessel to the stowed lifeboat position is not a variable in computing sea painter length.

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4. BOTH INTERNATIONAL & INLAND A 50-meter vessel is towing astern and the length of the tow is 100 meters. In addition to sidelights, which lights may she show to fully comply with the rules?

A. Two masthead lights forward, a stern light, and a towing light above the stern light.

Incorrect: The length of the towing vessel is 50 meters, therefore it requires a white masthead light abaft and higher than the forward masthead lights. Rule 24 (d) and Rule 23 (a) (i) and (ii).

B. A masthead light forward, two masthead lights aft, a stern light, and a towing light above the stern light.

Correct: Because the towing vessel is 50 meters, not less than 50 meters, and two masthead lights are carried aft then the towing vessel is required to carry a masthead light forward, along with sidelights, stern light and a towing light above the stern light. Since the tow is less than two hundred meters no additional masthead light is required on the mast aft. Rule 24 (d) and Rule 23 (a) (i) and (ii).

C. No masthead light forward, two masthead lights aft, a stern light, and a towing light above the stern light.

Incorrect: When masthead lights for towing or pushing are exhibited aft, a forward mast head light is required. Rule 24 (d).

D. Three masthead lights forward, one masthead light aft, and two towing lights in a vertical line at the stern.

Incorrect: Three white masthead lights forward would signify that the length of the tow exceeds 200 meters. The length of the tow is 100 meters. Rule 24 (a) (i).

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