The Coast Guard Journal of Safety & Security at Sea

PROCEEDINGS

Spring 2019 of the Marine Safety & Security Council

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A MESSAGE FROM THE COMMANDANT

IT is elementary that however well conceived the laws which regulate the operations of an industry may be, the manner in which such laws are administered has a direct bearing upon the ability of the industry to function effectively and efficiently. The importance of the American Merchant Marine to the success of the war effort has been amply demonstrated since Pearl Harbor. And, although it is impossible at this time definitely to state the part which the maritime industry will play in the world economy after the victory has been won, it is obvious to me, and I believe all informed persons will agree, that no program of post-war economic adjustment can succeed without the efficient utilization of the American merchant fleet.

These considerations make it incumbent upon the Coast Guard, as the agency of the Federal Government charged with administration of the laws governing navigation and vessel inspection in the interest of safety at sea, to discharge its responsibility in this regard intelligently, fairly, and openly to the end that there may be a proper balancing of the public interest and the interests of all branches of the industry with the least possible interference with normal operations.

It was with this objective in view that the Merchant Marine Council, with its panels representing all elements of the industry, was created to advise and assist the Commandant on matters relating to navigation and maritime safety, and to provide a forum in which all interested parties may express their views on actions taken or contemplated. This new publication, Proceedings of the Merchant Marine Council, represents another step toward cooperation and collaboration in administration. It will bring each month to the members of the industry and other interested persons information in convenient form concerning action taken by the Coast Guard on matters within the cognizance of the Council. Items of interest on other matters relating to ships and shipping will also be included from time to time. It is hoped that the "Proceedings" will prove to be of value to the maritime fraternity.

R. R. WAESCHE,
Vice Admiral, U. S. C. G.,
Commandant.

PROCEEDINGS

of the

MERCHANT MARINE COUNCIL

UNITED STATES COAST GUARD

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75th Anniversary of *Proceedings*

80th Anniversary of the Coast Guard Auxiliary

Dawn over the Atlantic Ocean's Coast Guard Beach on Cape Cod National Seashore, Massachusetts. Under Vice Admiral R.R. Waesche, the Coast Guard station located here was rebuilt and formally manned beginning January 9, 1937, until its decommissioning and departure of crew September 15, 1958. Today, it is used as an educational and residential facility for NEED—the National Environmental Education Development Program. Photo by Danita Delmont | Shutterstock.com

On Deck

On the Cover: *What began as the Merchant Marine council in January 1944, has endured 75 years of change. The coin on the cover represents the evolution of regulations, policies, and scope of operation, as well as the resiliency of what today is known as the Marine Safety and Security Council and* Proceedings. *Weathering the change for 62 of those 75 years is the icebreaker U.S. Coast Guard Cutter* Mackinaw *(WAGB-83) on the back cover. Built during World War II, it allowed for expedited winter shipping of steel. Decommissioned in 2006, "The Queen of the Great Lakes," is now a maritime museum in Mackinaw City, Michigan.*

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Judge Advocate General's Perspective

by Rear Admiral Steven J. Andersen
Chairman of the Marine Safety & Security Council
U.S. Coast Guard

It is an honor to share this page with my colleague Commodore King and to celebrate with the Coast Guard Auxiliary on its 80th anniversary. The selfless women and men of the Auxiliary are critical to the Coast Guard's mission and we wish them another 80 years of success!

Proceedings is right behind the

Commodore's Perspective

by Commodore Larry L. King
National Commodore
U.S. Coast Guard Auxiliary

Passed by Congress, The Coast Guard Reserve Act of 1939 created a civilian reserve force with four specific responsibilities:

- provide "safety at sea" response for recreational boaters
- increase efficient boating operation
- assist with boating laws and compliance
- support active duty members of the Coast Guard

This civilian reserve force was renamed the Coast Guard Auxiliary in 1941, retaining the specific assignment of promoting recreational boating safety.

Auxiliary—celebrating its 75th anniversary with this edition. In the very first edition of *Proceedings* in 1944, Vice Admiral R.R. Waesche "hoped" that this new publication would prove to add value to the maritime fraternity.

Over 650 issues later, it seems that much has changed since that first edition. Thanks to our fantastic team lead by Executive Editor Samantha Quigley—also an author for this edition—the look and feel of the magazine has never been better. And I don't mean just the change from black and white to color. The graphics are eye-popping, the articles and authors are diverse, and the layout glides the reader through each page. I don't know how many copies of the first edition were printed but I suspect it was nowhere near the 30,000 copies that are now circulated with each issue, not to mention the thousands who read the digital version.

But much has also stayed the same since that first edition. Our then-commandant noted that the manner in which maritime "laws are administered has a direct bearing upon the ability of the industry to function effectively and efficiently." He predicted the large role that the post-war maritime industry would play in the world economy. And he charged the Marine Safety and Security Council to intelligently, fairly, and openly administer the maritime laws and regulations to ensure a proper balance of public and industry interests with the least possible interference.

Vice Admiral Waesche's aspiration remains the goal of the Council and *Proceedings*—to bring value to the Maritime Transportation System. As we pursue that goal, please let us know how we are doing. You will find the best way to contact us at the end of Samantha's article on page 10.

As we enter our 80th year of existence, today's Auxiliary records more than 4.5 million hours of service while completing nearly 500,000 missions in support of active duty personnel annually. In an average year, the Auxiliary assists more than 15,000 distressed boaters, potentially saving hundreds of lives. This wouldn't be possible without the use of privately owned boats—1,670 of them—160 aircraft, and 1,330 communications facilities.

In addition to boating safety efforts and acting as a force multiplier to the active duty Coast Guard, the Auxiliary trains members to Coast Guard certification standards to "gap fill" to alleviate manpower shortages wherever possible. Typically, assist missions include Coast Guard recruiting, communications, watchstanding, food service support, foreign language interpreters, and financial education. Even though the Auxiliary is a lower cost alternative to having active duty members perform these countless tasks, the Commandant's guiding principles establishing a "Ready, Relevant, and Responsive" force apply equally to the Auxiliary. To ensure America's Volunteer Lifesavers remain relevant to active duty personnel, there is a continual quest to enhance the value of the Auxiliary. To meet additional future needs requiring "gap fill," the Auxiliary trains select members in areas of expertise including cyber security, and national incident response, but excluding direct law enforcement or military engagement.

The men and women of the Coast Guard Auxiliary are patriotic Americans who offer time, talent, and personal finances to a very noble cause. They take great pride in their vital role supporting the finest Coast Guard in the world and its missions addressing the nation's complex maritime challenges. There is no doubt this noble cause will continue as we approach our century anniversary.

Circa World War II. Courtesy of NARA

The MSSC and *Proceedings*

A story 75 years in the making

by Samantha L. Quigley
Executive Editor, Proceedings
U.S. Coast Guard

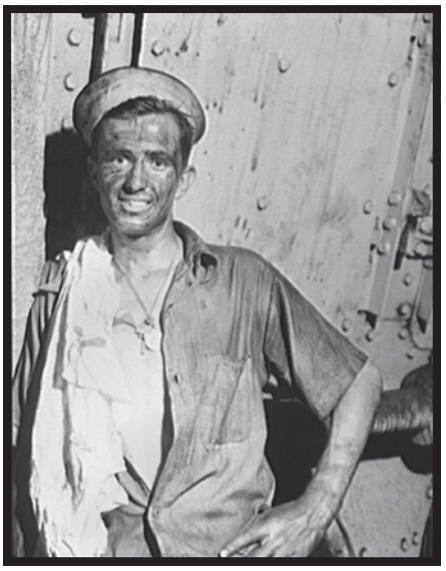
The Council continued its study of a draft of revised navigation laws, intended to eliminate obsolete provisions and to simplify and modernize the patchwork of legislation governing merchant marine personnel and the inspection of merchant vessels. Satisfactory progress is being made and it is believed that a suggested draft will be ready for discussion with the industry and with maritime labor interests in the near future.

With the exception of syntax, the preceding paragraph could have come directly from the minutes of the Marine Safety and Security Council's last quarterly meeting. However, its relevance echoes across 75 years of marine safety and security progress—and 75 years of *Proceedings'* documenting that progress beginning with the January 1944 issue from which the quote originated.

In the Beginning

Since *Proceedings* would not exist without what we know today as the Marine Safety and Security Council (MSSC), it is only fitting to offer a brief history of the council.

Before World War II, the Department of Commerce was responsible for many maritime regulatory functions through its subordinate bureaus. In 1932, two of these bureaus—the Bureau of Navigation and the Bureau of Steamship Inspection—merged forming the Bureau of Marine Inspection and Navigation (BMIN) under the Commerce Department's Investigation and Navigation Regulatory Board (INRB). The 1941 Japanese attack on Pearl Harbor would cause the transfer of specific BMIN functions of the BMIN to the Coast Guard through Executive Order 9083 with the specific charge of protecting American merchant ships and seamen. Additionally, the order directed the newly formed Merchant Marine Council (MMC) to take over INRB's duties on June 1, 1942. Through the end of the war, the MMC—under the auspices of the Coast Guard—contributed to the fight by overseeing efforts to protect mariners transporting supplies from the United States and allied ports to troops at the front.



Merchant mariner trainee, circa World War II. Courtesy of the Library of Congress

Despite best efforts, by war's end, 700 merchant marine vessels and some 8,300 mariners had perished, mostly the target of enemy submarines targeting allied shipping routes. This may have resulted in the first "lessons learned" of modern history—the realization that the old standard of carrying "some life-saving" equipment on board was not adequate. Instead, the MMC's priority became regulating fire protection, life-saving equipment, emergency communications equipment, and ensuring adequate training was available for mariners.

Its work with the maritime industry during the war was a salve for a previously strained relationship. And, as the council began transitioning to a post-war mission in 1943, its focus shifted to matters of safety and security at home, including pilotage rules and structural and engineering issues brought to light during the war. The more cooperative, collaborative relationship with industry led to a persistent new method of rulemaking.

While BMIN responsibilities were never intended to permanently reside with the Coast Guard, we all know the old saying—the reward for good work is more work. Though Congressman Everett Dirksen doubted the Coast Guard's growth, logic and a private, third-party investigation said the Coast Guard was the proper guardian for these responsibilities.

No evidence has been noted that any other agency of the Federal

Government could perform these functions at lower cost or with greater efficiency and better adequacy of service than does the Coast Guard.[1]

BMNI and its authorities were permanently transferred to the Coast Guard in 1946, and the Coast Guard was transferred to the Department of Transportation in 1967.

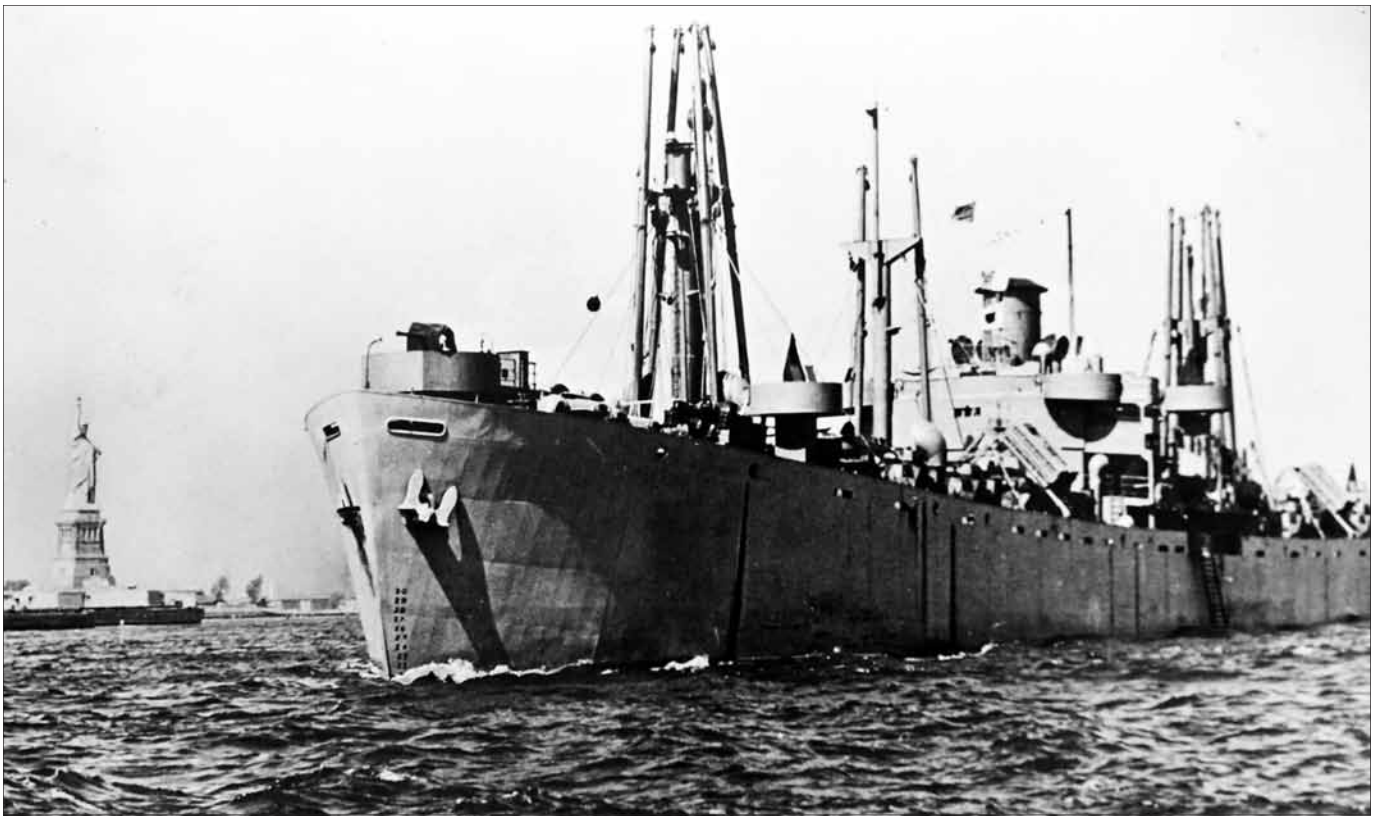
The MSSC post-WWII

While the Coast Guard wields global influence through its participation in the International Maritime Organization, a United Nations entity that works to regulate the merchant shipping industry, its primary responsibility during WWII was addressing concerns at home.

As the shipping and maritime industry advanced in the years after the war, so did the MMC—sometimes leading the charge. Radar, a game changer, is just one example of technological progress that required careful scrutiny and regulation to keep mariners from relying on it too heavily. But technology was just one piece of the safety puzzle for which the MMC was responsible. An emergent offshore drilling industry led to new legislation to address oil pollution risks.

Each of these new challenges facing the shipping industry informed the council as it fulfilled one of its primary responsibilities, advising the commandant. In the 1970s, that included advising on the implementation of international agreements, like the International Convention for the Prevention of Pollution from Ships, and finding a common ground regarding the safety of the maritime industry. Not off the hook at home, the council's breadth of responsibility increased again with the Federal Boat Safety Act of 1971, the Bridge to Bridge Radiotelephone Act, and the Ports and Waterways Safety Act.

All of this eventually prompted a name change—The Merchant Marine Council became the Marine Safety Council—to better reflect the council's missions. This moniker would remain until the September 11 terror attacks, which saw the Coast Guard transferred from the Department of Transportation to the newly established Department of Homeland Security with a considerably broader mission. As a reflection of the expanded scope of Coast Guard missions, the Marine Safety Council became the Marine Safety and Security Council. Regardless of what it has been called, its original core mission—advisor to the commandant on all things regulatory—has never changed.



America's Statue of Liberty in New York Harbor seems to salute this new U.S. "Liberty" ship manned with young Americans, who have just completed merchant marine training under the U.S. Maritime Service program. With full hatches and a capacity deckload of supplies and munitions, the vessel headed for the open sea to join the endless bridge of merchant ships carrying victory cargoes to Allied war fronts throughout the world. U.S. Maritime Service training centers turned out thousands of skilled sailors in 1942 and 1943 and, in the latter year, produced an average of five crews of trained seaman every day to man America's vast 24,000,000-ton Merchant Marine fleet. Courtesy of the Library of Congress

THE MERCHANT MARINE COUNCIL
of the
UNITED STATES COAST GUARD

Vice Admiral R.R. Waesche, U.S.C.G.
Commandant of the Coast Guard

The Council

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Engineer-in-Chief, United State Coast Guard
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Chief, Merchant Marine Personnel Division, U.S.C.G.
Commander Robert A. Smyth, U.S.C.G.R. . . . . *Executive Secretary*
Additional Members as Appointed by the Commandant
Captain Kenneth S. Harrison, U.S.C.G.R. . . . . *Legal Advisor*
Chief Counsel, United States Coast Guard

Eighth Commandant of the Coast Guard R.R. Waesche was largely responsible for the merging of many of the services, including the Coast Guard and the U.S. Lighthouse Service, to form the modern-day Coast Guard. He served from 1906–1946. Coast Guard photo

Proceedings

During the 75 years the MSSC has advocated for safety, security, and stewardship, *Proceedings* has been documenting the process. On the first pages of this issue you'll find the cover of the inaugural issue and a letter from then-Commandant R.R. Waesche explaining the publication's purpose, which originated as a digest of each council meeting. While the content has evolved with technology—regulations are posted online faster than we can publish them—*Proceedings* remains the go-to publication for topics related to the MSSC's mission.

While equipment and methods have certainly evolved, reading the inaugural issue is like reading a list of today's priorities.

One of the first articles, Ice-Breaking Activities, Winter of 1943–44, is especially poignant. The article focused on closing Great Lakes navigation for the season so focus could shift to keeping coastal harbors and waterways free of ice and commerce flowing. This recurrent mission has not only remained a top priority, but has broadened with the steady increase in shipping through the polar regions. The icebreaking fleet—then, primarily 180-foot icebreakers and "tender-class" ice-breaking cutters—has changed with the mission. To date, the Coast Guard has just one deployable heavy icebreaker commissioned in 1976, *Polar Star,* a 399-foot polar-class icebreaker. In 2019, Congress appropriated $655 million for the first new Polar Security Cutter, $20 million for program costs, and long lead time materials for a second polar security cutter. In 2010, engine failure rendered a second heavy icebreaker, *Polar Sea,* commissioned in 1978, not deployable. *Polar Sea* is currently a source of spare parts for *Polar Star.*

Proceedings' first issue also tackles the dangers of improper handling and transportation of gasses. This has garnered fresh focus as America experiences an "energy renaissance," associated with renewed U.S. crude oil and natural gas production. So much so, the Coast Guard created the Liquefied Gas Carrier National Center of Expertise to address considerations for the safe transport, storage, and processing of liquid gas cargoes.

Through all of this, *Proceedings* has been the purveyor of need-to-know information with regards to maritime safety and security. When technology began allowing mariners near instantaneous access to new rules and regulations, or changes to the existing versions, *Proceedings* headed in a new direction, providing readers with more in-depth articles about marine safety and security topics, including how new regulations and changes might

Coast Guard crew members patrol New York Harbor after the collapse of the World Trade Center on September 11, 2001. Coast Guard photo by Petty Officer 3rd Class Tom Sperduto

impact them. Occasionally, a specific historic incident, like the Titanic, would get a new spotlight because a lesson learned influenced a new safety measure.

Other times, we've looked into the less tangible areas of marine safety. For instance, in the complex cyber world, malicious actors can spoof locations on radar, making a vessel appear to be someplace it's not. Those who choose to use the internet and interconnected networks to facilitate attacks can accomplish everything from taking down safety systems to redirecting payments for goods. Defending against these attacks is often as difficult as locating the perpetrators.

While much of *Proceedings'* content is focused on big picture issues—commercial regulations, environmental protection, maritime law or border and national security—we also work to ensure the safety of recreational boating. With a growing number of personal recreational vessels on America's waterways, it's important that both sides—commercial and recreational —operate safely and in an environmentally responsible manner.

Of all the myriad topics *Proceedings* has addressed in 75 years, the one thing it understands with great certainty is its role in informing, educating, and even, on rare occasions, entertaining. We also know that Team Coast Guard relies on the USCG Reserve and USCG Auxiliary to accomplish its many missions. This is why the MSSC and *Proceedings* are thrilled to highlight the all-volunteer Coast Guard Auxiliary in this issue as it marks its 80th anniversary.

The *Proceedings* staff hopes the magazine that emerged from humble beginnings remains the go-to for all things related to maritime safety and security. We also hope you're enjoying the small changes we've been incorporating over the last 18 months as we prepared for this major milestone. Comments and ideas are always welcome, as are subscription requests. Please send all to HQS-DG-NMCProceedingsDist@uscg.mil.

About the author:
Proceedings' *Executive Editor Samantha Quigley, a Ball State University graduate, began her career in community newspapers before becoming a* Stars and Stripes *copy editor in 2002. She also worked as a writer/editor with the Defense Department's* American Forces Press Service *and as editor in chief of the USO's* On Patrol *magazine, before moving into her current position.*

Endnote:

1. Robert Erwin Johnson, "Guardians of the Sea," U.S. Naval Institute, 1987, page 263

Circa World War II. Courtesy of NARA

Ready, Relevant, and Evolving

The 75-year evolution of the Coast Guard's marine safety mission

by LCDR Luke Petersen
Coast Guard Congressional Fellow
House of Representatives Subcommittee
on Coast Guard and Maritime Transportation

Maggie Chan, Ph.D.
2018 John A. Knauss Marine Policy Fellow
House of Representatives Subcommittee
on Coast Guard and Maritime Transportation

The Coast Guard was in a much different place 75 years ago. After being established by combining the Revenue Cutter Service and Lifesaving Service in 1915, and then absorbing the Lighthouse Service in 1939, its identity was still in flux.[1]

World War II was underway and the Coast Guard was operating as part of the Navy. Members of the Coast Guard were playing major roles in the European and Pacific Theaters, including D-Day.[2] Following President Roosevelt's transfer of the Bureau of Marine Inspection and Navigation to the Coast Guard in 1942, the service was also incorporating a new mission set.[3]

When the war concluded in 1945, the Coast Guard, unsurprisingly, reverted to Department of Treasury oversight.[4] At the same time, the fate of its new marine safety activities remained certain. Over the years, marine safety has become a core Coast Guard mission even as the overall service and marine safety operations have continued to evolve.[5]

The *Morro Castle* is shown burning at sea. This tragedy resulted in 124 fatalities and led to the establishment of the Bureau of Marine Inspection and Navigation. Photo courtesy of the Library of Congress

Beginnings of a Mission

The Bureau of Marine Inspection and Navigation was itself the result of combination and evolution. In 1932, Congress merged the Steamboat Inspection Service—created in 1871—with the Bureau of Navigation, created in 1884.[6] In 1936, Congress renamed the new agency the Bureau of Marine Inspection and Navigation, and revamped its missions in response to two high-profile maritime disasters. The burning of the SS *Morro Castle* resulted in 124 fatalities and the collision of the SS *Mohawk* and SS *Talisman* claimed 45 lives.[7] The bureau's new authorities and requirements included traveling inspectors, marine boards of investigation, and vessel plan review. This was the beginning of today's Coast Guard Marine Safety Center.[8]

Shortly after the creation of the bureau, Admiral R. R. Waesche, the new Coast Guard Commandant, proposed transferring the bureau to the Coast Guard.[9] The chief of the bureau did not look favorably on the idea and nothing came of it at the time.[10] However, at the start of World War II, the idea became a reality in order to expedite the prosecution of the war effort and ensure military engagement with the huge growth of the U.S. fleet and the merchant marine.[11]

Post-War Positioning

With the war effort complete, debate continued regarding where the bureau—and its authorities—should reside. One option was that it remain within the Coast Guard, functioning as it had during the war. Another option was to de-couple it from the Coast Guard and return it to the Department of Commerce. This was supported by maritime

labor unions and others who "felt that a military organization ought not to be given such authority over a privately owned and manned merchant marine."[12]

There was significant congressional interest, with support on both sides of the issue. In the spring of 1945, one congressional committee advocated for the permanent transfer of the Bureau's missions to the Coast Guard, finding that "only the permanent transfer of those responsibilities would enable the Coast Guard to perform them efficiently."[13] However, not everyone in Congress agreed with that sentiment. Congressman Everett Dirksen believed the Coast Guard was growing unnecessarily, and beyond its proper missions.[14] To address his concerns, Congress directed a private, third-party investigation of the Coast Guard which concluded:

> *No evidence has been noted that any other agency of the Federal Government could perform these functions at lower cost or with greater efficiency and better adequacy of service than does the Coast Guard.*[15]

Following the war, Admiral Waesche worked hard to build support for the Coast Guard, including the permanent transfer of the marine safety mission from the bureau. As part of his efforts, the Coast Guard prepared the following mission statement:

> *To enforce all applicable Federal laws upon the navigable waters of the United States and its possessions and upon the high seas; to develop and promulgate safety requirements for the construction, manning and operation of vessels (other than public vessels) under the jurisdiction of the United States; to develop, establish, maintain, and operate aids to navigation and rescue facilities to promote safety on the navigable waters of the United States and on and over the high seas; and to maintain a military readiness to function as a specialized service with the Navy in time of war.*[16]

Congress eventually accepted that summary of the mission, codifying it almost word for word in 1949, and stating that they believed it to have outlined generally, in one section, the broad scope of the functions of the Coast Guard.[17]

In May 1946, President Harry S. Truman submitted Reorganization Plan No. 3 to Congress, which included the proposal to permanently transfer the functions of the bureau to the Coast Guard. In his accompanying message to Congress, he stated those "functions are related to the regular activities and general purposes of the Coast Guard.[18] … The Coast Guard administered them successfully during the tremendous expansion of wartime shipping, by virtue of improvements in organization and program, many of which ought to be continued."

The Coast Guard rose to the occasion during the war and improved marine safety for the nation. As Congressman Schuyler Otis Bland said at the time, "The nation has now for the first time a single agency which is charged with the administration of all maritime safety procedures."[19] In less than five years after temporarily taking on the marine safety functions performed by the bureau, the Coast Guard not only became proficient but fully integrated these functions, creating a new mission and reaffirming the multimission identity of the service. Going forward, the Coast Guard would not just respond to calls for help or enforce laws on the seas, but would also have a marine safety role focused on preventing maritime casualties.

Transitioning the Service and Evolving a Mission

With World War II over, U.S. shipbuilding decreased and the need for new U.S. mariners slowed as well. However, for the Coast Guard, its newest mission grew in size and complexity. Each decade has brought new wrinkles, requirements, and challenges in the marine safety world. At the same time, the Coast Guard has continued to grow in size, budget, and complexity and move around within the government.

The 1950s saw a large expansion of the vessels regulated by the Coast Guard and individual states. The Small Passenger Vessel Act was enacted in 1956, requiring all vessels for hire carrying six or more passengers to be inspected by a Coast Guard marine inspector and to meet detailed safety requirements and minimal manning requirements with Coast Guard licensed operators.[20] Furthermore, the Federal Boating Act of 1958 required the registration of every boat powered by machinery more than 10 horsepower and engaged

Men signing up to become U.S. Merchant Mariners during World War II in New York City. The Bureau of Marine Inspection and Navigation was moved to the Coast Guard due to the criticality of mariners to the war effort. Photo courtesy of Arthur Rothstein

Over the past 75 years, the Coast Guard has been a part of four different departments within the Federal government—the Department of the Navy (1944–1945), the Department of Treasury (1946–1967), the Department of Transportation (1967–2003), and the Department of Homeland Security (2003–present).

individual states in the registration process.[21] The sheer number of craft involved led the government to encourage states to undertake this responsibility so long as they adopted standards similar to federal requirements.[22]

In 1966, President Lyndon B. Johnson proposed creating a new Department of Transportation (DOT) because, "America today lacks a coordinated transportation system that permits travelers and goods to move conveniently and efficiently from one means of transportation to another, using the best characteristics of each."[23]

The Coast Guard did not want to move to the new department, but senior leaders recognized that actively resisting could result in the service being dismantled. Instead, they developed a strategy of professionalism and collaboration, with an eye towards growing the Coast Guard. Captain Mark Whalen, the commander of the task force on the Department of Transportation, summarized the strategy.

> *I feel our approach should be that we have expertise, loyalty, ability and military professionalism which a DOT must have to operate effectively, and that with the above we can perform certain functions of other agencies forming the DOT better than they now do and should acquire such functions. All levels of Coast Guard personnel should be directed to at all times reflect this attitude.*[24]

The strategy was successful and the Coast Guard transferred to the new department fully intact on April 1, 1967, even adding additional duties regarding bridge permitting.[25] The marine safety mission continued to be manned by military members and civilian employees, and laws and technology in the maritime realm continued to advance in scope and complexity.

The 1970s saw a great expansion of Coast Guard marine safety authorities, including the authorization of new regulatory regimes, traffic controls, and requirements for shoreside waterfront facilities. The first major changes came with enactment of the Federal Boat Safety Act of 1971 which aimed "to improve boating safety and to foster greater development, use, and enjoyment of all the waters of the United States."[26] This radically changed the safety environment by providing the commandant the ability to implement safety requirements through regulation, rather than requiring Congress to pass a law for each requirement. Among other things, it "created a more flexible regulatory authority for the Coast Guard to address safety issues concerning the use of boats and associated equipment in a more timely manner."[27]

Moving beyond vessel safety issues, the Ports and Waterways Safety Act of 1972 gave the Coast Guard more responsibilities, including:

> *… authority to protect against oil spills by controlling vessel traffic in our inland waters and territorial seas, by regulating the handling and storage of dangerous cargoes on the waterfront, by establishing safety requirements for waterfront equipment and facilities, and by setting standards for design, construction, maintenance, and operation of tank vessels.*[28]

That authority was expanded two years later with the passage of the Deepwater Port Act of 1974. This act established "the necessary legal framework for licensing the construction and operation of port facilities in naturally deep water distant from our coastlines, where supertankers can unload their cargo into underwater pipelines."[29]

The 1980s saw an expansion of the Coast Guard's role in protecting the environment, a partial codification of shipping laws, and the beginning of reliance on third-party inspectors. The decade began with the United States implementing the International Convention for the Prevention of Pollution by Ships—MARPOL 73/78—which had been adopted by the International Maritime Organization in the prior decade—through the Act to Prevent Pollution from Ships. This provided the Coast Guard authority to regulate the environmental impact of U.S.-flagged vessels and foreign vessels operating in U.S. waters.[30]

In 1983, Congress codified subtitle II of Title 46, United States Code.[31] While largely a technical exercise which consolidated many pieces of previous legislation to provide for similar drafting and common terminology, the codification also made additions to existing law. Though its impact may not have been foreseen at the time, one of the biggest changes has turned out to be the provision of new authority for the Coast Guard to

delegate the inspection and examination of United States vessels to third-party classification societies, and rely on the reports and documents of those third-parties.[32] History has shown the provision of this authority to be a turning point for the Coast Guard's marine safety mission, significantly altering its roles and activities.

The start of the 1990s was colored by the March 1989 *Exxon Valdez* oil spill. The result was the Oil Pollution Act of 1990 (OPA 90), which greatly expanded the Coast Guard's environmental role and established much broader requirements on vessels in U.S. waters.[33] At the same time, Congress also directed the Coast Guard to revise the U.S. Port State Control program to eliminate substandard vessels from U.S. waters, further growing the marine inspections workload.[34] Despite that increased demand, budget woes during the mid-1990s forced the Coast Guard to implement streamlining, which resulted in the elimination of more than 4,000 positions across the service.[35] One of the Coast Guard's methods to meet mission demands was the Alternative Compliance Program, which delegated additional safety and vessel maintenance functions to the classification societies, using the authority provided in 1983.

While the Coast Guard stemmed the tide of reductions around the turn of the century, there was little reason for optimism regarding the potential for growth. That changed with the terrorist attacks of September 11, and the Homeland Security Act of 2002 which established the Department of Homeland Security and transferred the Coast Guard to the new department.[36] Despite strong congressional support for the creation of the department—the bill passed by wide margins in both chambers—there was concern regarding the potential that the new focus on the security mission could degrade the service's other missions. Section 888 of the act enumerates the missions and states that the "Secretary may not substantially or significantly reduce the mission of the Coast Guard or the Coast Guard's capability to perform those missions, except as specified in subsequent Acts."[37]

Since transferring to the Department of Homeland Security, the Coast Guard's marine safety mission has continued to face challenges, including increased complexity and demand, and budgetary pressures. In addition to these pressures, new requirements for examining fishing vessels and inspecting towing vessels greatly increased the number of vessels under Coast Guard regulation. In 2010, an explosion on the Deepwater Horizon oil rig killed 11 people and resulted in a major oil spill in the Gulf of Mexico. This event challenged the service's response capabilities.

During the 115th Congress, both the HAMM Alert Maritime Safety Act and the Vessel Incidental Discharge Act of 2018 added further complexity to the statutory basis of the marine safety mission.[38]

Future: Adjusting to the Ever-Changing World

The Coast Guard continues to evolve as does its marine safety mission. At the same time, there is continued discussion regarding where the service best fits in the federal government. Representative Duncan Hunter (R-CA), former chairman of the House of Representatives Subcommittee on Coast Guard and Maritime Transportation, believes that the Coast Guard "is a military organization that deserves its place—with word, respect, and funding—among the rest of America's military under the command of the Department of Defense."[39] However, such a transfer would likely require explicit protection of the Coast Guard's marine safety mission. Despite occasional discussion of a possible transfer, no legislation has been introduced.[40]

Coast Guard Cutter *Rush* patrols the area around *Exxon Valdez* after it ran aground in Prince William Sound, Alaska, March 23, 1989. Coast Guard photo

Chief Warrant Officer Eddie Martinezlopez inspects gear on an oil platform helipad about 160 miles off Galveston, Texas, in June 2016. Inspecting oil platforms ensures companies are following proper safety procedures and staying within environmental protection guidelines. Coast Guard photo by Petty Officer 3rd Class Dustin R. Williams

There is no doubt that Coast Guard marine safety personnel will continue to face myriad challenges in the years to come, nor is there any doubt that the Coast Guard will meet those challenges. Similarly, there is no doubt that the mission remains essential to the service's identity. As Admiral Waesche said in congressional testimony 75 years ago, "It is only natural that the agency responsible for rescue activities should be concerned with the prevention of marine casualties."[41]

Authors' Note: The views expressed herein are those of the authors and are not to be construed as official or reflecting the views of the U.S. Coast Guard or the U.S. House of Representatives.

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A Short History of IMO's Maritime Safety Committee

by International Maritime Organization

As the International Maritime Organization's (IMO) first technical body, the Maritime Safety Committee (MSC) celebrated its 100th meeting in 2018. Its current Executive Secretary, IMO's Heike Deggim, looks back at its history and charts some of its most significant achievements.

The MSC consists of all 174 IMO Member States. Its functions, according to Article 28 of the IMO Convention, are to:

> *… consider any matter within the scope of the Organization concerned with aids to navigation, construction and equipment of vessels, manning from a safety standpoint, rules for the prevention of collisions, handling of dangerous cargoes, maritime safety procedures and requirements, hydrographic information, log-books and navigational records, marine casualty investigation, salvage and rescue, and any other matters directly affecting maritime safety.*

The MSC is also required to provide machinery for performing any duties assigned to it by the IMO Convention or any duty within its scope of work which may be assigned to it by or under any international instrument and accepted by the organization. It also has the responsibility for considering and submitting recommendations and guidelines on safety for possible adoption by the IMO Assembly.

William Graham talks with IMCO Librarian Miss Armstrong. Graham, of the United Kingdom, served as secretary-general from 1961–1963. International Maritime Organization photo

Controversy in the Formative Years

The election of the original 14 Members of the Maritime Safety Committee, in accordance with Article 28 of the Intergovernmental Maritime Consultative Organization (IMCO) Convention, during the first session of the Assembly in 1959, proved to be a very controversial matter indeed. While the first Assembly duly elected the members—Argentina, Canada, Federal Republic of Germany, France, Greece, Italy, Japan, Netherlands, Norway, Pakistan, USSR, UAE, United Kingdom, and United States—on January 15, 1959, the result was immediately challenged. The IMCO Convention stated that, "The MSC shall consist of 14 Members elected by the Assembly from the Members' governments of those nations having an important interest in maritime safety, of which not less than eight shall be the largest ship owning nations, …" and although Liberia and Panama were among the first eight countries listed on the registered tonnage table of Lloyd's Register of Shipping Statistical Tables 1958, both failed to be elected.

Noting the divergent views of member governments on the matter the Assembly, then dissolved, deciding to constitute a new MSC in accordance with Article 28 of the IMCO Convention as interpreted by the International Court of Justice in the advisory opinion. It adopted and confirmed the measures taken by the MSC in the course of its sessions during the period 1959 to 1961 (MSC 1 to MSC 3). Consequently, the Assembly elected, on April 13, 1961, a new MSC on the basis of the 1961 gross tonnage figures, consisting of Argentina, Canada, Federal Republic of Germany, France, Greece, Italy, Japan, Liberia, Netherlands, Norway, Pakistan, USSR, United Kingdom and United States, to serve for a period of four years from the date of election.

However, the composition of the Maritime Safety Committee, then the sole technical body of the organization—and the one where the most important decisions were taken—for a long time very much reflected the veto power of the traditional maritime nations. The statutory majority reserved for ship-owning nations, perhaps justifiable for historical reasons in 1948 when IMO consisted of 31 member states, was difficult to justify among a fast

growing membership.

In 1965, the fourth session of the Assembly adopted an amendment to Article 28 of the IMCO Convention (A.70(IV)), increasing membership of the Committee to 16. Of these, eight were to be elected from among the 10 largest ship-owning states; four in such a way as to ensure that "Africa, the Americas, Asia, Oceania, and Europe were all represented; and four from among states not otherwise represented on the Committee." The amendment entered into force in 1968.

The balance of power among ship-owning and ship-trading nations and the rest of the IMO members was finally achieved by the opening of the Committee to all members of the organization in 1978, when the 1974 amendments to Article 28 adopted at the Fifth Extraordinary Session of the Assembly entered into force. The existing text was replaced by one line stating, *The Maritime Safety Committee shall consist of all Members.*

The MSC also exists in its expanded form when it comes to the adoption of amendments to conventions and, in that form, includes all member states, as well as those countries which are party to conventions, such as SOLAS (Safety of Life at Sea), but are not IMO member states.

First Sessions of the MSC

In the meantime, the committee had held its inaugural session in London on January 19, 1959. Participating were the originally elected 14 members and the meeting was chaired by the Secretary-General as temporary chairman and Mr. de Vries, the Netherlands, as acting chairman. The meeting had only three substantive items on its agenda:

- election of officers
- adoption of the provisional rules of procedure
- initial work programme of the MSC

MSC I elected Mr. Moolenburgh, of the Netherlands, as the chairman and Mr. Ghiglia, of Italy, as the vice

The International Maritime Organization, a specialized United Nations agency, turned its London office building "UN blue" in 2015 to mark the UN's 70th anniversary. International Maritime Organization photo

Key Dates in the Work of the MSC

June 1960
International Convention for the Safety of Life at Sea (SOLAS) adopted. The first SOLAS treaty had been adopted in 1948, while subsequent treaties would be adopted in 1974 and 1988.

September 1965
International Maritime Dangerous Goods (IMDG) Code adopted.

October 1974
Fifth Extraordinary session of Assembly adopts amendments to IMO Convention enlarging membership of Council from 18 to 24 and opening MSC to all members of the organization.

September 1976
Convention on the International Maritime Satellite Organization (INMARSAT) adopted by conference convened by IMO, enters into force in July 1979.

April 1979
International Convention on Maritime Search and Rescue (SAR) adopted, enters into force in June 1985.

November 1988
Global Maritime Distress and Safety System (GMDSS) adopted at international conference through amendments to SOLAS. Entry into force in February 1992 and beginning of seven-year phase-in period. Becomes fully implemented on all passenger ships and all cargo ships of 300 GT and above on international voyages in 1999.

May 1991
Secretary-general proposes five-point plan of action to improve safety standards and reduce pollution from ships.

February 1993
IMO group of experts visits South East Asia to advise on anti piracy measures. New SOLAS chapter XI-2 (Special measures to enhance maritime security) and mandatory International Ship and Port Facility Security (ISPS) Code adopted in 2002.

June 1996
Complete replacement of SOLAS chapter III (Life-saving appliances and arrangements) and adoption of International Life-Saving Appliances (LSA) Code.

November 2014
New SOLAS chapter XIV (Safety measures for ships operating in polar waters) and mandatory International Code for Ships Operating in Polar Waters (Polar Code) adopted. MEPC adopts corresponding environmental part of Code and related MARPOL amendments in May 2015. Entry into force of all in January 2017.

May 2016
Approval of interim guidelines on maritime cyber risk management, aimed at safeguarding shipping from threats and vulnerabilities related to digitization, integration and automation of processes and systems. Adoption of resolution on Maritime cyber risk management in safety management systems and guidelines on maritime cyber risk management in June 2017.

June 2017
MSC initiates work on regulating Maritime Autonomous Surface Ships (MASS) and agrees on scoping exercise to ensure their safe, secure and environmentally sound operation.

chairman. It then adopted its provisional rules of procedure and, as recommended by the first assembly, established its first subcommittee, the Subcommittee on Tonnage Measurement. The subcommittee was tasked with devising a new universal system of tonnage measurement.

MSC II met from November 23–25, 1959 and its main task was the discussion of the arrangements for the May 1960 Conference to revise SOLAS 1948, COLREG 1948, and Load Lines 1930. It also reviewed the position in regard to OILPOL 1954 and considered the progress made by the Tonnage Measurement subcommittee.

MSC III met from November 8–11, 1960, and continued the work started at MSC II. It also considered the outcome of the 1960 SOLAS Conference, which adopted the 1960 SOLAS Convention, superseding the 1948 Convention, and the revised collision regulations and considered the 56 recommendations adopted, of which 28 required action by IMCO. Upon request, the committee agreed that Liberia should be invited to attend the session as an observer.

MSC IV met for one day on April 14, 1961, immediately following the election of the new MSC by the second session of the Assembly a day earlier, and re-elected the existing chairman and vice-chairman.

Since then, the MSC has met regularly, at least once annually, to discuss and decide on a huge variety of technical issues, reaching the milestone of its 100th session in December 2018.

Subcommittees

The MSC and Marine Environment Protection Committee

International Maritime Organization photo

(MPEC) are assisted in their work by a number of subcommittees open to all member states.

Over the almost 70 years the MSC has been in existence, a large variety of subcommittees were established and discontinued at various times, reflecting the technical work being carried out by the committee at the time. They worked for longer or shorter periods of time, depending on their tasking.

In 1981, for example, the MSC had 11 subcommittees working under its auspices. They dealt with safety of navigation; radio communications; life-saving appliances; standards of training and watchkeeping; carriage of dangerous goods; ship design and equipment; fire protection; subdivision, stability and load lines; safety of fishing vessels; containers and cargoes; and bulk chemicals, respectively.

The 1959 IMO Assembly. International Maritime Organization photo

The current subcommittees under the MSC are the following:

- Subcommittee on Carriage of Cargoes and Containers (CCC)
- Subcommittee on Human Element, Training, and Watchkeeping
- Subcommittee on Implementation of IMO Instruments (III)
- Subcommittee on Navigation, Communications, and Search and Rescue
- Subcommittee on Ship Design and Construction
- Subcommittee on Ship Systems and Equipment

CCC and III work under the shared responsibility of MSC and MEPC.

The MEPC also has its own subsidiary body, the subcommittee on Pollution Prevention and Response, established in 2013, when the MSC and MEPC comprehensively considered the existing subcommittee structure, resulting in the current setup.

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The Role of Marine Science and Oceanography in the United States Coast Guard

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Letter of Instruction to the Commanding Officers of the Revenue Cutters, June 4, 1791

> *It has also occurred that the cutters may be rendered an instrument of useful information, concerning the coast, inlets, bays and rivers of the United States … in the interests of navigation, reporting the result, from time to time to the Treasury.*

Oceanography has played an important role in the Coast Guard since its 1790 founding as the U.S. Revenue Cutter Service. While this article will focus on the 75-year period from 1944 to 2018, the early efforts were important, and the basis for expansion of United States Coast Guard (USCG) oceanography after 1944.

Early Oceanographic Efforts (1790–1914)

The earliest oceanographic efforts were observations by revenue cutters in support of navigation, as detailed in Alexander Hamilton's *Letter of Instruction to the Commanding Officers of the Revenue Cutters June 4, 1791*. In the few cutter reports that survived the burning of Washington during the War of 1812, observations are descriptive, especially with regards to winds and currents.[1]

As the Revenue Cutter Service added missions, new oceanographic efforts were undertaken to support new operations. Two specific events triggered major changes. The 1867 purchase of Alaska led to the need for information to support safe, effective navigation in ice-covered waters, as well as exploration of the territory, leading to the first oceanographic expedition. Revenue Cutter *Corwin*, with naturalist John Muir aboard[2] was ordered to make "regular connected series" of ocean current observations.

The 1912 sinking of the *Titanic* led to the creation of the International Ice Patrol (IIP), which relies heavily on oceanography.

Evolving Role of Oceanography (1914–1944)

During the 30 years between 1914 and 1944, world events reinforced the need for oceanographic support of new missions. The 1915 merger of the Revenue Cutter Service and the U.S. Lifesaving Service was the first. This period also included World War II, when the Coast Guard was transferred to the Department of the Navy, and the establishment of Coast Guard aviation. Responsibilities under new environmental legislation included the Oil Pollution Act of 1924, the Northern Pacific Halibut Act of 1932, the Whaling Acts of 1932 and 1936, and the 1940 executive order establishing the Ocean Weather Station Program.[3]

The Golden Age of Oceanography (1944–1982)

Oceanographic efforts of the last 75 years began with interagency partners per the statutes or agreements (Figure 1). Ocean measurements, products, and decision-making tools resulting from these efforts support Coast Guard missions (Figure 2). With the Coast Guard's widespread use of oceanography during these

Interagency Cooperation

- 14 U.S. Code § 102 specifies the Coast Guard's duties to engage in oceanographic research.
- 14 U.S. Code § 715 requires the Coast Guard to conduct oceanographic research and to cooperate with other governmental agencies as may be in the national interest.
- 14 U.S. Code § 707 authorizes cooperation with the National Oceanic and Atmospheric Administration for assistance with meteorological services, including observation and dissemination of weather information.
- A Cooperative Strategy for 21st Century Seapower, signed March 2015 by Marine Corps Commandant, Chief of Naval Operations, and Coast Guard Commandant: Increase capabilities in integrated maritime detection, monitoring, and intelligence to improve global maritime awareness … Improve interoperability between Navy and Coast Guard vessels, aircraft, and shore facilities …
- Cooperative Maritime Strategy, signed February 2013 by NOAA Administrator and USCG Commandant: Coordinate activities and resources … Promote information sharing

Figure 1

nearly four decades, the era might be considered the Golden Age of Coast Guard oceanography.

Projects and Programs

World War II Operations

As a component of the Navy, the Coast Guard received oceanographic support from the U.S. Naval Hydrographic Office and U.S. Coast and Geodetic Survey, which had also been transferred to the Navy. Additionally, other U.S. and allied military units—U.S. Army Air Corps and Royal Naval Meteorological Service—provided critical support to operations involving the Coast Guard, including Pacific and European amphibious landings. For example, the June 6, 1944, invasion of Normandy was based on forecasts that indicated the optimum combination of tides and winds.

The Coast Guard, which conducted extensive surveys of ice conditions and the Greenland coast while conducting the Greenland Patrol, contributed oceanographic support to this planning.

Ocean Weather Station Program

The Ocean Weather Station Program was conducted by the Coast Guard in cooperation with the U.S. Weather Service from 1940 through 1977. Using the best technology available before satellites and data buoys, the program used massive resources—21 cutters, like the

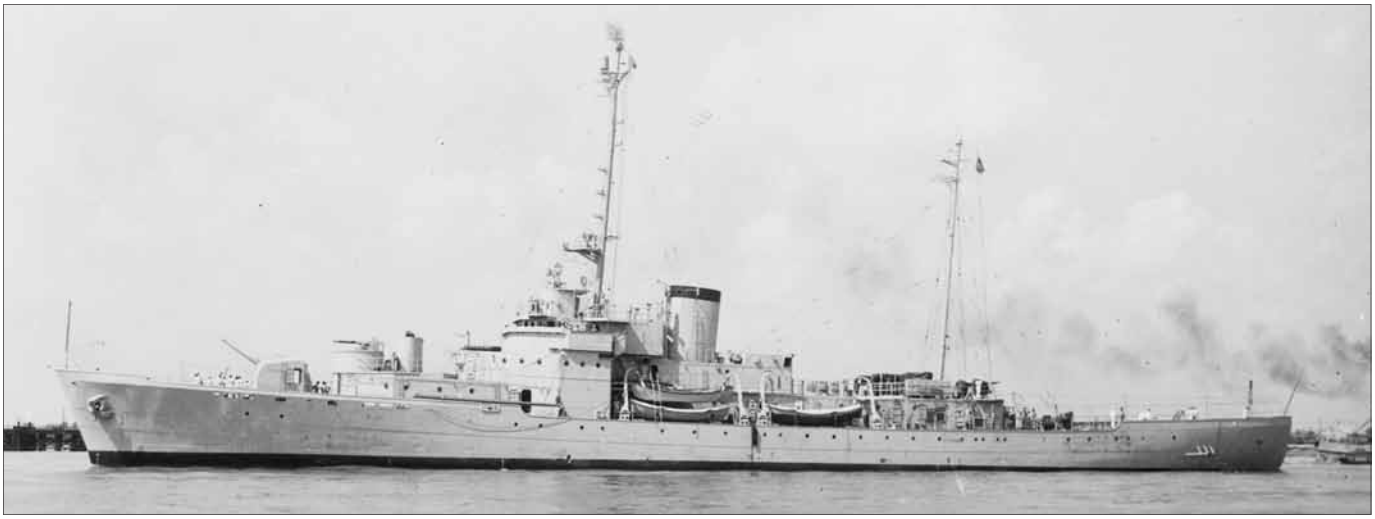
Key

MEP: Marine Environmental Protection
ATON: Aids to Navigation
DR: Defense Readiness
DI: Drug Interdiction
IO: Ice Operations
PWCS: Ports & Waterways Security
LMR: Living Marine Resources
LE: Law Enforcement
MS: Marine Safety
AMIO: Alien Migrant Interdiction Operations
SAR: Search and Rescue

Oceanographic Measurement/Product/Decision Tool	MEP	ATON	DR	DI	IO	PWCS	LMR	LE	MS	AMIO	SAR
Water Temperature, Salinity	X		X	X			X	X	X	X	X
Water Depth	X	X	X	X		X	X	X	X	X	X
Seafloor Bathymetry*	X	X	X	X		X	X	X	X	X	X
Seafloor Character*	X	X	X	X		X	X	X	X	X	X
Ocean Tidal Information	X	X	X	X		X	X	X	X	X	X
Ocean Surface Waves*	X	X	X	X		X	X	X	X	X	X
Ocean Surface Currents*	X	X	X	X		X	X	X	X	X	X
Wind Speed/Direction*	X	X	X	X		X	X	X	X	X	X
Barometric Pressure*	X	X	X	X		X	X	X			X
Fish and Marine Mammal information*	X						X				
Sea Ice Character and Distribution*	X		X		X				X		X
Lake Ice Character and Distribution*	X		X		X				X		X
Iceberg Character and Distribution**	X		X		X				X		X
Iceberg Analysis & Prediction System (BAPS)++			X		X				X		X
Environmental Data Server (EDS) of SAROPSxx	X								X		X
Limits of Known Ice (LAKI)**			X		X				X		
Environmental Reps MGMT Appl. (ERMA)@	X										
Comptr-Aided Mgmt of Emerg Ops (CAMEO)@	X										

➜ USCG role in providing measurement: **only provider; *a provider
➜ USCG role in Product/Decision Tool: xxUSCG Tool; ++USCG/CIS Tool; @NOAA Tool for NOAA advice to USCG

Figure 2
Notional Depiction of how oceanographic measurements/products/decision tools inform the 11 statutory missions of the Coast Guard. X indicates that the particular oceanographic item is especially helpful for the mission. Coast Guard Office of Waterways and Ocean Policy



The USCGC *Bibb* was a 327-foot Secretary-Class, also known as Treasury Class, Coast Guard ship commissioned in 1936 and named for U.S. Secretary of the Treasury George M. Bibb. *Bibb* saw service in World War II and in peacetime spent time on ocean station, as part of the Ocean Weather Ship Program, providing weather information and beacons to trans-Atlantic traffic. During this latter mission, *Bibb* came to the rescue of the airliner, the Bermuda Sky Queen, and transported John Kerry after he was shot while serving in the Vietnam War. Coast Guard Photo

Coast Guard Cutter *Bibb,* on rotational deployments at seven stationary observing ship locations. Overall, the result was the delivery of critical data needed to improve maritime and land weather forecasts, but the program became prohibitively expensive.[4]

Oceanography Mini-Boom of the 1960s

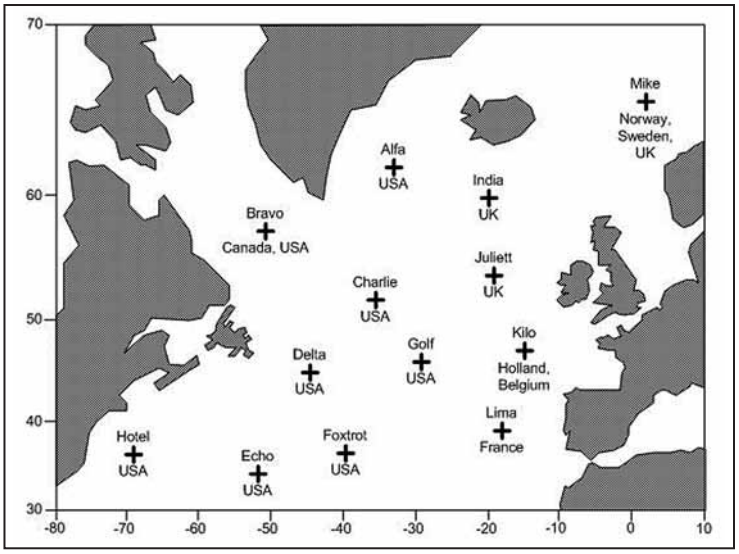
Within the "Golden Age" of Coast Guard Oceanography there was a 15-year mini-boom following the enactment of Public Law 87-396 that expanded Coast Guard functions to allow oceanographic research in cooperation with other agencies. This resulted in additional measurements at ocean weather stations, collateral measurements by cutters during routine operational patrols, and the establishment of an oceanographic unit to process the data. In 1964, the Coast Guard Cutter *Evergreen* was designated as the first Coast Guard oceanographic ship, and increased collaboration with other agencies and academia. Efforts in the polar regions increased when the Navy transferred all icebreakers to the Coast Guard in 1966.

Data Buoy Development Project

In 1967, the Coast Guard initiated the National Data Buoy Development Project to replace the costly vessel-based, aircraft-relayed measurements of the Ocean Weather Station Program. The new system depended on a buoy-based, satellite-relayed network of sensors. The Coast Guard applied advances in satellites, buoy technology, telecommunications, and the miniaturization of electronics in the design of the new system. The program was transferred to the National Oceanic and Atmospheric Administration (NOAA) when the agency was established in 1970. The Coast Guard continues to partner with NOAA by providing buoy tenders and personnel to assist with buoy installation and maintenance.

International Ice Patrol

Since 1914, the International Ice Patrol has patrolled the western North Atlantic to warn mariners of the iceberg danger with just two exceptions—during World Wars I and II. Although IIP's Safety of Life at Sea (SOLAS) mandated mission has not changed, today's IIP capability is a far cry from a century ago. In the early days, from 1914 to 1946, patrol vessels without radar roamed through the foggiest parts of the Grand Banks to locate icebergs. IIP



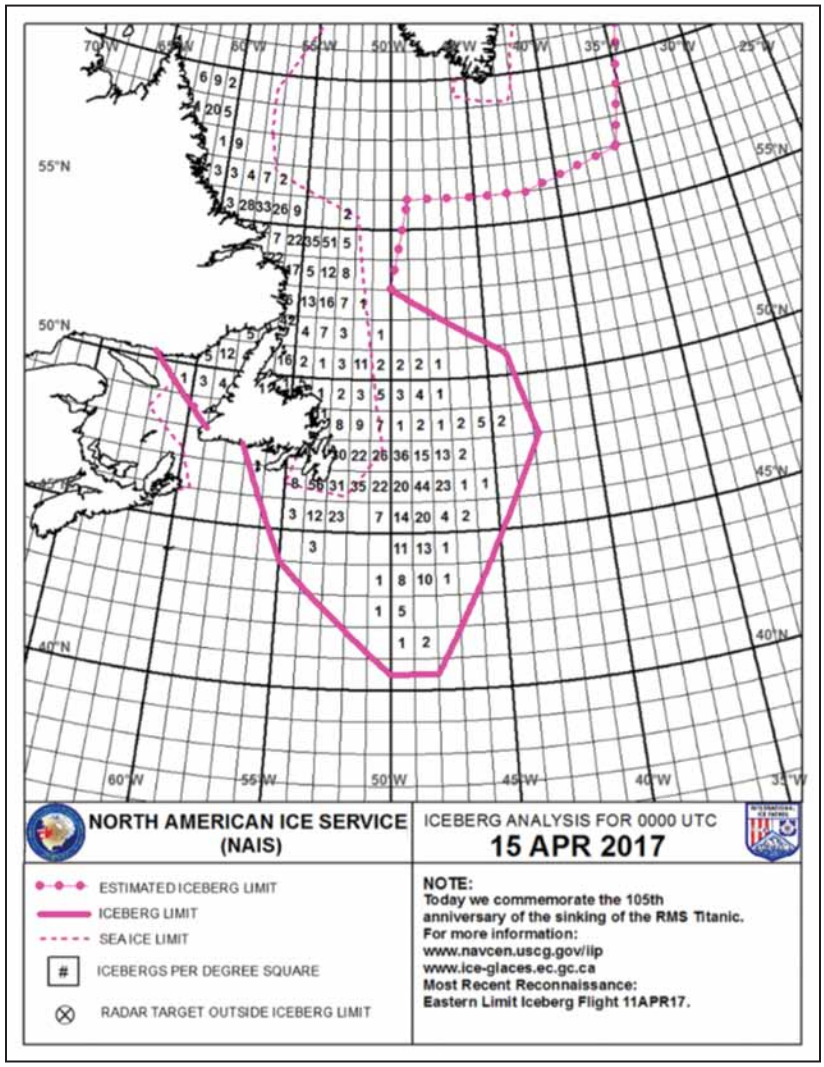
This chart details the locations of weather ships in the North Atlantic Ocean after the 1946 International Civil Aviation Organization conference in London. Weather ships' primary mission was to take surface and upper air weather measurements and report them at specific intervals. Public domain illustration by Bob1960evens

began using radar-equipped aircraft to conduct patrols after World War II to cover a greater area and better estimate the total iceberg population.[5,6]

Today, IIP receives iceberg sighting reports from several sources—Coast Guard aerial reconnaissance from forward-deployed HC-130J fixed-wing aircraft, the Canadian government and commercial aerial reconnaissance, and voluntary iceberg sighting reports from ships. In 2017, IIP routinely began incorporating iceberg data from synthetic aperture radar satellites.

To simulate iceberg drift and deterioration, IIP employs numerical models integrated into an ArcGIS-based client-server system called iceBerg Analysis and Prediction System (BAPS). These models use environmental data—wind speed and direction, wave height and period, ocean currents, water temperatures, and sea ice extent—to forecast the location and size of the North Atlantic iceberg population. Sometimes as many as 2,000 icebergs can be tracked at a time.

Model output in hand, IIP is able to establish the Iceberg Limit, a geographic line delineating the iceberg danger area, as shown in the figure below.



Coast Guard illustration by Michael Hicks

As IIP's ability to predict the drift and deterioration of icebergs has improved over the years, so has its need for oceanographic and meteorological information. A few widely spaced oceanographic sections are no longer sufficient. BAPS uses numerous data sources, most provided by its U.S. and global partners. Sea surface temperature data for the iceberg deterioration model are from the Navy Coupled Ocean Data Assimilation provided by the Navy's Fleet Numerical Meteorology and Oceanography Center, along with the Canadian East Coast Ocean Model (CECOM). The Canadian Meteorological Centre (CMC) provides meteorological data—wind speed and direction, air temperature, etc.—using the Regional Global Environmental Multiscale model. IIP also receives wave height and period data from CMC's wave model.

The accuracy of the BAPS iceberg drift predictions depends largely on the accuracy of the ocean currents used to drive the model. The models within BAPS use both historical ocean currents developed from an analysis of many years of ocean drifter data (Murphy, et al., 1996) and modeled data from CECOM. IIP augments historical currents by deploying satellite-tracked ocean drifters from aircraft and surface vessels in key areas.

IIP is working to develop a next generation system to replace BAPS. A new system will allow more seamless application of new environmental sources—like the Navy's Hybrid Coordinate Ocean Model—integrate automated satellite iceberg detection algorithms, and allow IIP watch officers to run ensemble iceberg drift modeling to create a probabilistic, risk-based product.

Ice Charting for Navigation

The U.S. National Ice Center is jointly managed by the Navy, the Coast Guard, and NOAA providing strategic, tactical, and operational ice products and services including sea-ice analyses and forecasts for users world-wide. A Coast Guard petty officer has been embedded on the staff as an ice analyst and duty watch stander since 2006. With duties evolving away from weather forecasting and an increased reliance on satellite imagery and geographic information systems, the billet was converted from a Marine Science Technician Petty Officer to an Intelligence Specialist Petty Officer in 2018. The new position is called a Geospatial Intelligence Analyst.

Polar Icebreaking

The first Coast Guard polar icebreakers, the Wind class, were built during World War II to respond to construction of Axis weather stations in Greenland. Following the war, icebreakers began support of Arctic and Antarctic science missions like Operation High Jump and the follow-on, Operation Deep Freeze.

Throughout the 1970s, polar icebreaking missions expanded to include support of civilian science goals. Comprehensive observation programs such as the World Ocean Circulation Experiment were supported by Coast Guard icebreakers. As a result of annual science missions to both polar regions, much of the scientific knowledge of the Antarctic seas and the Arctic basin came from U.S. Coast Guard icebreakers.

Researchers from the University of Alaska Fairbanks drill a hole in the pack ice to study the microorganisms of the Arctic. The researchers were traveling aboard the Coast Guard Cutter *Polar Sea* in October 2009. Coast Guard photo by Petty Officer 3rd Class Pamela Manns

Recognizing the national need for heavy icebreaker capability, *Polar Star* and *Polar Sea*—the most powerful non-nuclear icebreakers ever built—were constructed in the 1970s. This class of vessels has operated for more than 40 years, transporting researchers to the most inaccessible places in the Earth's oceans, providing strategic presence in the polar regions, and logistics support to remote stations.

In the 1990s, these polar icebreakers were refitted with hydrographic winches and J-frames to deploy conductivity, temperature, depth sensors, and water-sampling rosettes. This was the result of the oceanographic community's interest.

Though *Polar Sea* and *Polar Star* were also capable of pelagic sampling via vertical net hauls, benthic sampling via box cores, and equipped with Van Veen Grab samplers, ultimately they proved imperfect science platforms due to their poor seakeeping ability, even in calm seas.

Oil and Hazmat Spill Response

Oceanographic data and analyses are critical to planning and conducting safe, effective responses to oil and hazardous spills. Key information includes ocean currents—surface and sub-surface—meteorological conditions, and seafloor information. Per the Oil Pollution Act of 1990, the Coast Guard has prime responsibility for managing spill response and cleanup, but NOAA provides scientific advice to the Coast Guard.

During the 2010 Deepwater Horizon oil spill response, data was provided by interagency partners, including the Integrated Ocean Observing System. In addition, the Coast Guard deployed Self-Locating Datum Marker Buoys to obtain surface currents and temperatures. NOAA's Emergency Response Division analyzed this data to provide scientific advice to Coast Guard personnel responding to the disaster.

Protecting Marine Life

The Coast Guard protects marine life by enforcing domestic and international fishery laws, marine sanctuaries, the Endangered Species Act, the Marine Mammal Protection Act, as well as protecting the nation's exclusive economic zone from foreign encroachment. The Coast Guard garners its own oceanographic information critical to performing the operations but also receives data from NOAA and U.S. Fish and Wildlife Service.

However, with the 1970 establishment of NOAA, and hastened by budget cuts, the so-called Golden Age of Coast Guard Oceanography came to an end. This resulted in the decision not to build a proposed research cutter to replace *Evergreen* and, eventually, the 1982 disestablishment of the Oceanographic Unit.

Search & Rescue

By international agreements, the Coast Guard has Search and Rescue (SAR) responsibilities for 28 million square miles of oceans and the Great Lakes. SAR controllers in the Coast Guard's 49 operation centers around the United States, Puerto Rico, and Guam use the Search and

Rescue Optimal Planning System (SAROPS) software to plan searches for survivors.[7] Other countries, including Mexico, Malta, Lebanon, and Vietnam, also use SAROPS to plan maritime search patterns.

Partnerships, Remote Observations, and Analyses (1982–Present)

The Coast Guard supports the Navy to maximize safety and effectiveness of maritime vessels of the armed forces by providing meteorological and oceanographic conditions. The Coast Guard has been cooperating with NOAA's National Weather Service and predecessors for more than 100 years to fulfill U.S. treaty obligations regarding weather and ice conditions under SOLAS. The importance of disseminating weather information to mariners was emphasized in the recent report on the sinking of *El Faro*.[8] The Coast Guard helps NOAA disseminate forecasts and warnings via Coast Guard broadcasting resources, as well as NOAA's Physical Oceanographic Real-Time System reports through automated identification system (AIS) transmitters and vessel traffic service (VTS) watchstanders.

Commissioned in 2000, Coast Guard Cutter *Healy* was designed in concert with scientific stakeholders, and included many features that would have been impossible to refit onto an icebreaker later. *Healy* has 51 berths for scientists—30 more than *Polar Star* and *Polar Sea,* and hosts a team of civilian technicians known as STARC—Science Technicians for ARCtic science—that maintain and operate the suite of oceanographic instruments. *Healy* is a key asset to the extended continental shelf (ECS) mapping effort led by the State Department—an effort most recently undertaken in 2016—and in the joint U.S.-Canadian ECS mapping program that took place between 2008 and 2011.

The Coast Guard currently participates in a number of interagency ocean observing efforts, including the Integrated Ocean Observing System established by the

Search and Rescue Optimal Planning System

Timely and accurate fields of surface winds and sea surface currents are critical inputs to the Search and Rescue Optimal Planning System (SAROPS). To meet these data requirements, the Environmental Data Server (EDS) accesses daily nowcasting and forecasted winds and current fields from NOAA, Navy, and academic sources. The EDS collects the data in their native formats, converts and archives the data fields, and responds to requests from SAROPS users. SAROPS automatically makes minute changes to the various environmental parameters to account for the uncertainty of the forecasts, and uses these inputs to run thousands of individual simulations (called "Monte Carlo" simulations) forecasting the drift of survivors or craft. The simulation results are used to create an optimized search pattern for the time when Coast Guard aircraft or vessels will arrive on scene to conduct their searches. SAROPS optimizes the searches based upon probability density distribution and previous search efforts. The EDS accesses global, regional, and local models of winds and currents, along with other parameters of interest to the SAR controller. Other parameters include air and sea surface temperatures, relative humidity, wave height and direction, visibility, cloud cover, and moon phase. These parameters are used for determining sensor performance and estimating probable survival times. As newer sources of data and models become operational or near-operational, these sources are added to the EDS. The EDS is owned and operated by RPS Group, Kingston, Rhode Island.

The EDS accesses the surface wind fields and meteorological parameters from: NOAA's Global Forecast System, North Atlantic Mesoscale, National Digital Forecast Database, and Great Lake meteorological models. Other sources include the Navy's Global Environmental model, wind data from National Data Buoy Center (NDBC) Coastal-Marine Automated Network stations and moored buoys, and WeatherFlow's meteorologic stations. Sea surface current fields and temperatures available to the SAROPS user include the Navy and NOAA global Hybrid Coordinate Ocean Models, (NYCOM) model, NOAA global HYCOM model, NOAA National Ocean Service Physical Oceanographic Real Time System models for the Great Lakes and seven ports and bays, seven coastal ocean models from the U.S. Integrated Ocean Observing System regional associations (IOOS), U.S. IOOS high-frequency (HF) radar data and predictions based on those data, seven tidal models, and trajectories from Coast Guard's Self-Locating Datum Marker Buoys (SLDMBs).

SLDMBs are Coastal Ocean Dynamic Experiment/Davis-style surface drifters with Global Positioning Systems (GPS) that transmit every 30 min via the Iridium satellite system. SLDMBs are deployed by both Coast Guard surface and air assets during SAR cases to obtain real-time surface current data in the search area. SAR controllers use the trajectories from the SLDMBs to choose between surface current products—available for that particular case—to determine which model product is performing best. For each SLDMB deployed, the EDS performs a cross comparison with the co-located surface current model to estimate a skill metric every 6 hours. These skill metrics are stored and can be retrieved by oceanographers to examine over all skill of a particular ocean model for estimating surface currents.

Coast Guard Petty Officer 3rd Class Derrian Duryea (left), a rescue swimmer at Coast Guard Air Station Clearwater, Florida, and Petty Officer 2nd Class Jose Charon, a flight mechanic at Air Station Clearwater, try to locate people in distress in a flooded neighborhood near Jacksonville, Florida, on September 11, 2017. Coast Guard photo by Petty Officer 1st Class Jonathan Lindberg

Integrated Coastal and Ocean Observation System Act of 2009.

The Coast Guard hosts a network of meteorological sensors on aids to navigation (ATON) per agreement with WeatherFlow, Inc. Measurements from 140 ATON are critical to the Coast Guard, as well as other agencies. NOAA's National Hurricane Center reported the data contributes to more accurate forecasts, more timely and informative bulletins, and are important for post-storm analysis and verification studies. The Defense Department's Defense Threat Reduction Center (DTRA) reported that without this data, its ability to accurately monitor and predict plume dispersion in the coastal zone would be severely degraded.

Maritime Domain Awareness

Maritime domain awareness (MDA) is essential for operational commanders to understand relevant threats and make informed risk decisions for Coast Guard missions. To achieve MDA the Coast Guard relies on a four-step process.

- Large amounts of raw data, intelligence, and environmental information are collected in a timely manner from a variety of sources
- Data are collated, sorted, and fused into meaningful and understandable information
- Information is analyzed into actionable and reliable intelligence
- Information is disseminated to Coast Guard operators and planners, as well as federal, state, local, and industry partners

Oceanographic factors have a major effect on operations and safety, and environmental data is an important input to the common operational picture—a graphical tool for achieving situational awareness. Useful environmental layers include physical, biological, chemical, geological, and geophysical properties of the atmosphere, ocean, and seafloor.

Marine Science Training and Education

Coast Guard military and civilian staff apply different marine science disciplines—physical, biological, chemical oceanography, marine meteorology, marine geology, and geophysics—to properly support Coast

A Coast Guardsman watches from a small boat detached from the Coast Guard Cutter *Resolute* as oil is flared off the Q4000 at the site of the Deepwater Horizon response. Coast Guard photo by Petty Officer 1st Class Matthew Belson

Guard missions.

Science backgrounds range from undergraduate and/or advanced degrees to enlisted C schools and specialty schools. All Coast Guard Academy cadets are required to complete a basic marine and environmental science course, as well as basic physics and chemistry courses, and about 15 percent major in marine and environmental science. Some skills are acquired through on-the-job training, Officer Candidate School, or a Prospective Commanding Officer Course. The Marine and Environmental Sciences major at the Coast Guard Academy integrates oceanography, chemistry, biology, physics, and math to provide a technical, multidisciplinary education. This is closely aligned with the Coast Guard's missions of fisheries law enforcement, environmental response management, search and rescue operations, oil spill cleanup, and ice operations.[9] The curriculum also includes hands-on training at sea.

Advanced education in marine science oceanography consists of Coast Guard officers in a post-graduate program completing a master's degree in physical oceanography or marine meteorology. Students have attended Naval Postgraduate School, University of Rhode Island, Columbia, University of Washington, University of Hawaii, University of Miami, and others. Graduates are assigned to the Coast Guard Academy as instructors in marine science, or to IIP as branch chiefs or Deputy Commander.

Enlisted marine science technicians (MSTs) use marine science skills in executing their duties involving oil or hazardous material response, safety and security inspections, and ensuring compliance with environmental laws. After their initial training at MST schools, they are assigned to units responsible for vessel and facility inspections, as well as emergency response, marine safety units and detachments, and the Marine Safety Lab. MSTs assigned to the International Ice Patrol and *Healy* receive additional training at the U.S. Naval Weather School and/or cross-training on oceanographic research vessels.

Future Plans

As oceanographic data acquisition moves from vessel observations to satellite remote sensing and unmanned *in situ* data acquisitions, the USCG will continue to support these efforts. Per the *El Faro* report,[9] the Coast Guard

will continue to cooperate with NOAA on dissemination of weather information. We expect increased interest in polar regions, as well as increased use of geospatial methods in oceanographic applications.

About the Authors

Jonathan Berkson, Ph.D., is the marine science program manager for the Coast Guard, coordinates marine science activities and ocean observations, and advises on marine science and technology issues. He received a Ph.D. in geophysics from University of Wisconsin-Madison. Prior to working with the Coast Guard, he conducted research in marine geophysics and underwater acoustics at Naval Research Laboratory in Washington, D.C., NATO's Undersea Research Laboratory in La Spezia, Italy, and University of Wisconsin's Geophysical and Polar Research Center.

CDR William Woityra manages icebreaking policy at Coast Guard headquarters. A career icebreaker sailor, he served on four Coast Guard icebreakers in the Arctic, Antarctic, and on the Great Lakes. He recently completed a Fulbright Scholarship in Finland studying icebreaker design, operations, and management with the Finnish Transport Agency. He holds advanced degrees from the University of Rhode Island, Chancellor University, and IMO International Maritime Law Institute.

CDR Kenneth Boda is Deputy Chief of Cutter Forces. He served aboard USCGC Polar Sea, *USCGC* Eagle, *and has served as a marine science instructor at the Coast Guard Academy. He is a graduate of the Coast Guard Academy and holds master's degrees from Columbia University and the Naval War College.*

Arthur Allen has been the oceanographer for the U.S. Coast Guard Office of Search and Rescue for 15 years. Prior to this assignment, he worked with the Coast Guard Research and Development Center for 20 years on search and rescue problems. He holds a bachelors in Aquatic Science and Engineering from the University of Massachusetts and a master's in physical oceanography from Dalhousie University.

Michael Hicks is the chief scientist of the U.S. Coast Guard International Ice Patrol. Prior to this assignment, he worked for the aviation branch of the Coast Guard Research and Development Center. He is a prior commander of the International Ice Patrol, retiring from active duty in 2007. He earned a master's degree in oceanography from the Naval Postgraduate School.

LCDR Victoria Futch is an assistant professor at the Coast Guard Academy. She previously served aboard USCGCs Sassafras *and* Sequoia *in Guam and USCGC* Maple *in Alaska. She holds a master's in physical oceanography from the University of Hawaii.*

Meteorological Instruments on Coast Guard Aid to Navigation: Aerovane (wind speed and direction), air temperature, data logger with internal pressure sensor, as well as a solar panel and box inclosing battery, cell phone modem and CPU. Photo courtesy of WeatherFlow

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Icebreaking History, Platforms, and Activities

by CDR William Woityra
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U.S. Coast Guard

Since 1944, the Coast Guard's icebreaking mission has taken on a greater significance than ever before. Originating with a 1936 Executive Order from President Roosevelt to ensure the delivery of heating oil on the Hudson River, icebreaking has become a reliable and efficient means of sustaining the industrial base of the Great Lakes states during the winter navigation. In addition, significant demand is supported in the Northern and Southern polar regions. Since 1965, when the Navy surrendered the mission and cutters *Staten Island, Southwind, Burton Island, Edisto,* and *Glacier,* the Coast Guard has been the sole operator of the U.S. icebreaking fleet. Ice operations remain relevant and especially needed in an era of dynamic weather patterns and unpredictable environmental change. Ice ops is codified as one of the Coast Guard's 11 statutory missions in U.S. Code.

The Coast Guard bears responsibility to carry out its duties "on, under, and over the high seas and waters subject to the jurisdiction of the United States." This includes the ice covered waters of the Great Lakes in winter, as well as Alaska in the Arctic.

Today the Coast Guard operates in polar regions for several reasons, including:

- Fulfillment of the Coast Guard's core missions—maritime security, safety, and stewardship
- Port-Coastal-Waterways Security, Search and Rescue, Law Enforcement, and Marine Environmental Response in icy waters
- Support of other government agencies
- Facilitation of commerce—escorting ships through icy channels for economic purposes

As the sole purveyor of icebreaking services for the government, the Coast Guard must be responsive to requests from the interagency to support their missions, as befitting national needs. This includes scientific support for the National Science Foundation or the National Oceanic and Atmospheric Administration, and diplomatic missions for the State Department.

Crew members aboard the Coast Guard Cutter *Morro Bay,* a 140-foot icebreaking tug temporarily assigned to the Great Lakes, prepare to pull alongside the Canadian coast guard ship *Samuel Risley* in Lake Erie to transfer a rescued snowmobiler February 2, 2011. Photo courtesy of Canadian coast guard ship Samuel Risley

Domestic Icebreaking

The 140-foot icebreaking tug fleet remains the workhorse of the domestic icebreaking mission. Built from 1979 to 1987, the nine Bay-class cutters succeeded the 110-foot harbor tugs. The Bay-class cutters, staffed by a crew of 19 are homeported in Detroit, Sault Ste. Marie, and St. Ignace, Michigan, as well as Sturgeon Bay, Wisconsin; Cleveland; Bayonne, New

The Coast Guard Cutter *Mackinaw* (WLBB-30), a 240-foot heavy icebreaker, breaks ice near Marine City, Michigan, along the St. Clair River on January 28, 2015. The cutter was operating as part of Operation Taconite, the ice breaking operation for the northern Great Lakes. Coast Guard photo by Daniel R. Michelson

Jersey; and Rockland, Maine. They are extremely versatile platforms, keeping channels open in the winter, freeing beset 1,000-footers, and performing law enforcement and security missions the rest of the year. The 140s are equipped with a low pressure air "bubbler" hull lubrication system that enables them to break up to 36 inches of ice. Two cutters, *Bristol Bay* and *Mobile*, are fitted with aid to navigation (ATON) barges to support the annual deployment and retrieval of floating aids in Coast Guard District Nine. The entire fleet is currently filtering through a 13-month service life extension project (SLEP) at the Coast Guard Yard, which is scheduled to be complete by 2020. The project will extend the fleet's expected service life well into the 2030s.

The Bay-class cutters are supported by 225-foot multi-mission buoy tenders, on the Great Lakes and in the Northeast. With crews of 48, these multi-mission vessels—homeported in Port Huron, Michigan; Duluth, Minnesota; Newport, Rhode Island; and other locations—have proven worthy successors of the 180-foot buoy tender fleet. The 225s, which can break tracks through 36 inch-thick plate ice, are also undergoing a midlife maintenance availability at the Coast Guard Yard. They are also undergoing a midlife maintenance availability at the Coast Guard Yard. The final work will be completed in 2024 and will ensure reliability, supportability, and habitability to 2040 or beyond.

Eleven 65-foot small harbor tugs are the backbone of the domestic ice mission in the Northeast and mid-Atlantic during severe winters. Introduced in the 1960s, these tugs are staffed by a crew of six and can break 12-inch plate ice at 3 knots. There are no plans to retire or replace these vessels.

The Great Lakes legend *Mackinaw* (WAGB-83) was retired in 2006 and succeeded by a new cutter of the same name. The new *Mackinaw* (WLBB-30) is 240 feet long with a crew of 55. It can break ice up to 42 inches thick, and with a buoy deck, it participates in the annual "fall retrieve" and "spring restore" of the buoyage system. It is notably the first Coast Guard icebreaker to be propelled by Azipods—a relatively new innovation that encapsulates an electric motor in a rotating watertight enclosure suspended beneath the ship. This enables thrust, and prop wash, to be directed 360 degrees and is very efficient for breaking ice, clearing channels of brash, and freeing beset vessels. The new *Mackinaw* is respected and well loved by Great Lakes mariners and

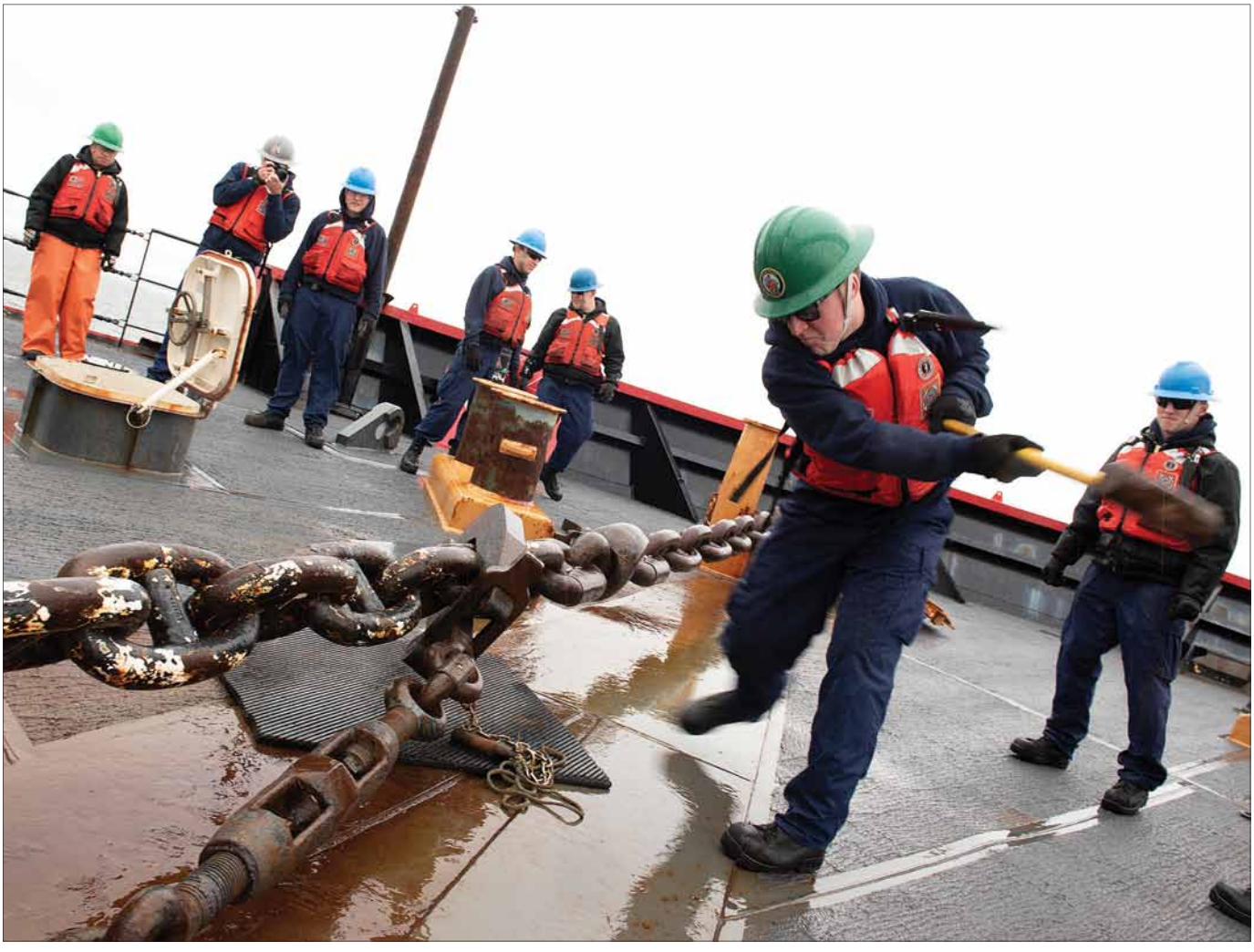
locals alike, who look fondly on the pride of the District Nine icebreaking fleet. *Mackinaw* also follows in the wake of her predecessor, delivering Christmas trees to Chicago every year.

Polar Icebreaking

In the polar regions, icebreaking for sovereignty, national security, and scientific research is accomplished by *Polar Star* and *Healy*. These aging icebreakers now scramble to fulfill the missions and mandates that were performed by a fleet of icebreakers during the cold war era. In 1957, cutters *Storis, Spar,* and *Bramble,* along with the Canadian icebreaker HMCS *Labrador,* completed a transit of the Northwest Passage. Eight years later, the U.S. Navy transferred all of its icebreakers and responsibility for icebreaking to the Coast Guard, supplementing the already sizable Coast Guard fleet. *Polar Sea* transited the Northwest Passage in 1985 and, in 1994, became the first U.S. surface ship to reach the North Pole. Demand for polar icebreaking waned in the 1990s as the cold war ended, but has surged since 2012, as retreating sea ice has created economic opportunities in the newly opened Arctic.

Commissioned in 2000, *Healy* and its crew of 90, operates in the Arctic every summer, projecting U.S. presence and supporting requests for icebreaking from other government agencies, including the National Science Foundation, the Navy, NOAA, NASA, and the State Department. *Healy* has achieved notable accomplishments, including the 2003 discovery of the Healy Seamount, an underwater mountain found at 78°40.0'N 158°00.0'W, or about 400 miles north of Utqiagvik (Barrow) Alaska, and three visits to the North Pole, the most recent a 2015 unaccompanied expedition.

Polar Star, commissioned in 1976 just two years before her sister ship *Polar Sea,* is currently the only



Coast Guard Seaman Evan Pace uses a sledgehammer to remove a pelican hook aboard the Coast Guard Cutter *Healy* while deployed in the Bering Sea in September 2018. The pelican hook wraps around the anchor chain and prevents the movement of the anchor and must be removed to free the ship's anchor. The *Healy* is the only military ship dedicated to conducting ice research in the Arctic. U.S. Coast Guard photo by Senior Chief Petty Officer NyxoLyno

heavy icebreaker in the U.S. inventory. *Polar Star* has a crew of 131. *Polar Sea* remains at Pier 36 in Seattle in a caretaker status, serving as a spare parts repository to keep *Polar Star* running until such time as the new Polar Security Cutters can be built. As a result, *Polar Star* and her crew have set records by making six consecutive Antarctic deployments in support of the annual Operation Deep Freeze resupply missions, and will continue to do so for the foreseeable future.

The new Polar Security Cutter is the next generation in Coast Guard polar icebreaking. The joint CG-USN Integrated Project Office has been working tirelessly for five years to develop and refine requirements and specifications for the acquisition. The request for proposals was released in March 2018 with proposals received in September. The source selection team intends to award the contract for detailed design and construction of the first heavy icebreaker this summer, with options for second and third hulls. Construction of hull one should be complete by 2023, followed by sea and ice trials. The new icebreaker will meet or exceed the operational capabilities of *Polar Star,* including 80-day endurance and the ability to break six feet of level ice at 3 knots. It will feature a modern C4ISR—Command, Control, Communications, and Computers Intelligence, Surveillance, and Reconnaissance—suite including multi-mode radar, to support maritime domain awareness and on-scene command and control, and will have a flight decks and hangars capable of holding two MH-60 helicopters.

An emperor penguin poses for a photo in front of the Coast Guard Cutter *Polar Star* in McMurdo Sound near Antarctica on January 10, 2018. The crew of the Seattle-based *Polar Star* was on its way to Antarctica in support of Operation Deep Freeze 2018, the U.S. military's contribution to the National Science Foundation-managed U.S. Antarctic Program. Coast Guard photo by Chief Petty Officer Nick Ameen

Conclusion

Coast Guard icebreaking has a long and distinguished history, and the future is equally bright. The demand for icebreaking has never been higher, and the service is taking positive steps to ensure it is ready to respond to the requests that only the Coast Guard can fulfill. The service is investing now in the capabilities that will carry out national strategic missions and Coast Guard functions in ice covered waters for decades to come.

About the Author

CDR Woityra is a career icebreaker sailor. He has served on four Coast Guard icebreakers in the Arctic, Antarctic, and on the Great Lakes. He recently completed a Fulbright Scholarship in Finland studying icebreaker design, operations, and management with the Finnish Transport Agency. He currently manages U.S. icebreaking policy at Coast Guard Headquarters.

Cybersecurity in the Maritime Domain

by Gary C. Kessler, Ph.D.
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Embry-Riddle Aeronautical University

Editor's Note: The majority of the articles in this issue address safety and prevention programs and policies that have developed since the inception of the Coast Guard and are at the core of its mission. Today, that mission has evolved to include safety and prevention in cyberspace. It is feasible that when Proceedings marks its 100th anniversary, cybersecurity be as much a core safety and prevention mission as ice breaking. This article describes the cybersecurity challenges and strategies currently facing the maritime industry.

In 2017 and 2018, the maritime industry saw a record number of attempted—and many successful—frauds via email, phishing, or other means. Demonstrated and actual attacks on vessel networks, communication systems, and navigation systems have become practically routine. Port and shipping line networks are increasingly vulnerable to what appears to be increasingly targeted attacks against maritime systems.

The global marine transportation system (MTS) is huge, complex, and uses myriad technologies with a wide range of sophistication. Maritime systems are commonly designed to accommodate predictable failures—e.g., material fatigue due to age and use—but not intelligent actors. There is, and can be, no central management of maritime cyber systems, hence every player has to manage their own network and protect themselves from everyone else. Of course, the maritime industry has some of its own unique cyber vulnerabilities.

An Overview of the Maritime Cyber Landscape

The United States' marine transportation system includes 25,000 miles of navigable channels and waterways, more than 4,100 ports and marinas, 200 ferry operations, and 238 locks. It also includes 12 million recreational boats and tens of thousands of commercial, merchant, military, municipal, and other vessels. Shipping, the method by which 90 percent of global trade moves, is also this country's primary mode of transportation for the import and export of goods.

Information security threats to the maritime industry are not much different than threats to the general world of computer and network technology. Viruses, worms, and other forms of malicious software, or malware, affect the industry even when shipping is not the direct target. Stuxnet, for example, the circa-2009 malware targeting centrifuges used in Iranian nuclear research facilities, was also found in control systems at Chevron.[1] NotPetya, the ransomware virus that spread across the planet in a matter of hours in May 2017, cost Maersk Line as much as $300 million in lost revenue, forcing them to rebuild nearly 50,000 servers and user computers—and Maersk wasn't even a target, merely vulnerable.[2]

This is not to say that the maritime industry has not been targeted. Advanced persistent threats (APT)—a class of attack first described in 2010—are cyberattacks targeting a specific victim using sophisticated, dynamic methods that adapt to the victim's defenses, and are often state-sponsored. Reports in 2018 showed that Chinese-linked APTs had been targeting the maritime industry since 2013, with particular escalation in 2017.[3]

Cyberattacks on maritime information technology (IT) systems have been ongoing for some time. Hackers broke into Australian Customs and Border Protection Service cargo management systems in 2012 to track illicit cargo, allowing them to alert criminals if their particular containers had been marked as suspicious by the customs service. From 2011–2013, hackers used a variety of methods to break into Port of Antwerp the computer systems controlling movement and location of shipping containers, allowing criminals to generate bogus bills of lading, allowing them to remove cargo containers before the legitimate owner arrived.[4] In 2016, hackers exploited one shipping company's content management system, allowing pirates to identify specific containers on specific vessels, enabling them to target desired cargo ships and get on and off the vessel in a matter of hours.[5]

Cyberfraud is also a serious concern in the industry due to the high volume of communications, orders, and financial transactions that occur online. In 2014, World Fuel Services was defrauded of $17.9 million by a bogus fuel order, and a Malaysian bunker company was defrauded of more than $1 million in a phishing scheme.[6] In 2015, a shipping company in Cyprus received a fuel bill for $644,000 with a request to send the payment to a

different bank account than usual. A criminal had sent a bogus bill for a legitimate order and misdirected the funds to their account.[7]

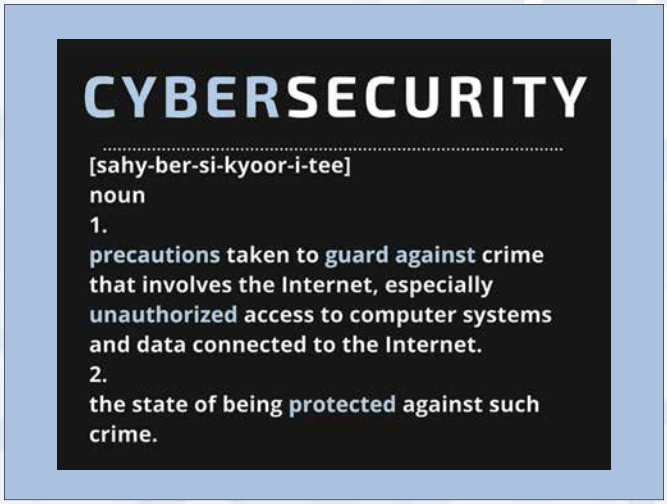
Presumably, every IT system manager in the industry has taken steps to protect their computers, servers, mobile devices, control systems, and other digital equipment from the threats associated with poor cybersecurity. Even so, cybersecurity policies and procedures specific to the maritime industry are still in the early stages, and there is only a very limited systematic response.

The Maritime IT System of Systems

There are myriad IT systems, components, vendors, jurisdictions, and manufacturers, as well as organizational policies, procedures, and requirements within the MTS. It is this diversity that makes protecting maritime IT assets from cyberthreats so difficult. Consider that the maritime system and industry comprises the following components and vulnerabilities:

- *Seaport operations,* including vessel control and traffic management, personnel management and screening, passenger management and passport control, WiFi and physical networks
- *Cargo and shipping,* including logistics, supply chain, routing, scheduling, loss management
- *Manufacturing,* including intellectual property theft, supply chain, payment systems, software and hardware flaws
- *Vessel traffic management,* including ship management, routing, communication, location management and communication
- *Shipping line operations,* including passenger information, reservation systems, communication, baggage and cargo handling, maintenance, catering, payment systems
- *Vessel operations,* including the ship's onboard network architecture providing interconnection between the bridge navigation, communication, mechanical, ship monitoring and security, cargo handling and other specialized systems, and communication with external networks with regards to vessel traffic management, ports, and shipping lines
- *Unmanned/autonomous vehicles,* including remote control or monitoring, GPS hacking and jamming, hardware and software flaws

At one level, these individual systems can be thought of as regular computers and networks. They are therefore susceptible to the same threats as any other computer or network, especially when it comes to human "weak links" in the system who will make errors or don't follow processes and procedures. Indeed, human error—clicking on a fateful web link, opening a malware attachment in an email, plugging a USB thumb drive of unknown origin into a computer, or not keeping up-to-date with anti-malware software—causes most cyber incidents. Even worse, intentional human attackers, including cybercriminals, cyberspies, and state-sponsored cyberterrorists, prey upon this lack of vigilance to force and/or exploit those human and system errors.



Air Force Special Operations Command

One result of the interconnectedness of networks within a system is that one network provides a path to other networks. For example, in late 2017 maritime cyber consulting company Naval Dome reported on multiple vulnerabilities in a shipboard network.[8] In one case, malware was inserted into the vessel's Electronic Chart Display and Information System (ECDIS) via a satellite link to the master's computer. Unbeknownst to the crew, the malware altered the ship's position during the night without changing the ECDIS display. A second piece of malware was uploaded to the radar system via the network switch that connected radar, ECDIS, bridge, and other ship communication systems. This malware altered the radar display by deleting targets on the display, essentially blinding the ship. The final malware was inserted into the machinery control systems network via an infected thumb drive.

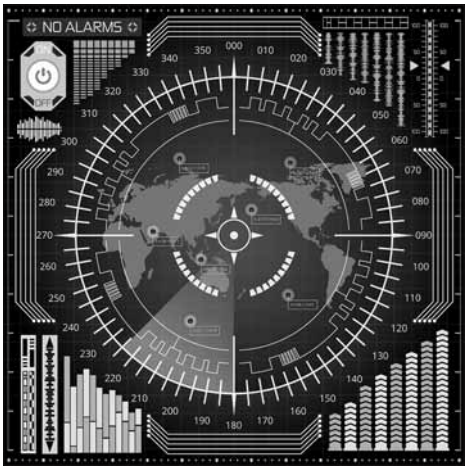
At another level, the issue lies not in protecting an individual system or network, but in the difficulty of protecting the broader system of systems and the inherent complexities therein. The networks throughout the MTS are ultimately interconnected, so the ripple effect of an attack on one part of the system might be felt in other parts. Even if every component within a single system or network was proven to be totally immune to attack, it would be impossible to ensure the security of all of those interconnected components. This is further complicated by the fact that no organization has any control over the other networks with which they interact. A common strategy of groups engaged in an APT is to probe and perform reconnaissance to find the weakest link in a set

of interconnected networks, or to attack a target's supply chain partners, in order to identify a pathway to the ultimate target.[9]

Cyber Threats to Navigation Systems

The global positioning system (GPS) and other global navigation satellite systems (GNSS) are essential elements to safety within the MTS. In addition to its obvious uses in navigation and ship positioning, GPS provides data for the placement of aids to navigation, chart surveys, ECDIS displays, and radar. GPS signals are transmitted from medium Earth orbit satellites at an altitude of 12,000–15,000 miles. Overpowering these relatively weak, unencrypted signals is not hard. In 2013, a University of Texas at Austin team demonstrated the ability to spoof GPS signals to cause a ship's crew to deviate course in a proof-of-concept experiment using off-the-shelf equipment.[10]

Deliberate GPS spoofing attacks have caused ships' equipment to misreport—or lose—their own position or that of other ships. In June 2017, a mass GPS spoofing incident in the Black Sea targeted ships off the Russian port of Novorossiysk, causing their GPS-based navigation systems to report their location up to 25 miles away at the Gelendzhik Airport. A secondary side effect involved the ships' automatic identification systems (AIS) broadcast alerts as they found themselves within 100 meters of at least a dozen other ships—all believing that they were at the same airport. This incident was thought to be the result of a Russian electronic warfare exercise.[11] These types of activities continue, with multiple GPS spoofing incidents reported in the eastern Mediterranean Sea during the first half of 2018.[12]



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The AIS is a GPS-based vessel tracking system providing a ship's unique identifier, position, course, speed, and other information. In a busy harbor or traffic lane, it broadcasts a ship's position and displays the location of other ships in the area. Cybersecurity solutions company TrendMicro has reported on several vulnerabilities in AIS, including the lack of message validity, integrity, authentication, and timing checks, and lack of encryption.[13] AIS also responds to abnormal events. For example, an attacker could cause a ship's crew to change course by spoofing the AIS' closest point of approach (CPA) warning, another ship's AIS distress beacon, or dynamic weather information. There are many reasons an attacker might want to divert a ship—from wanting to run it aground, to bringing it closer to pirates, to charging a ransom to *not* do these things.

Several public websites and smartphone apps allow anyone to find the current location of any vessel broadcasting its AIS information. The International Maritime Organization (IMO) Maritime Safety Committee warned against the dangers of AIS-based information leakage as far back as 2004. Even then, the IMO recognized that posting AIS on web pages and other public sites had the potential to undermine the safety of navigation and security in the international MTS.[14]

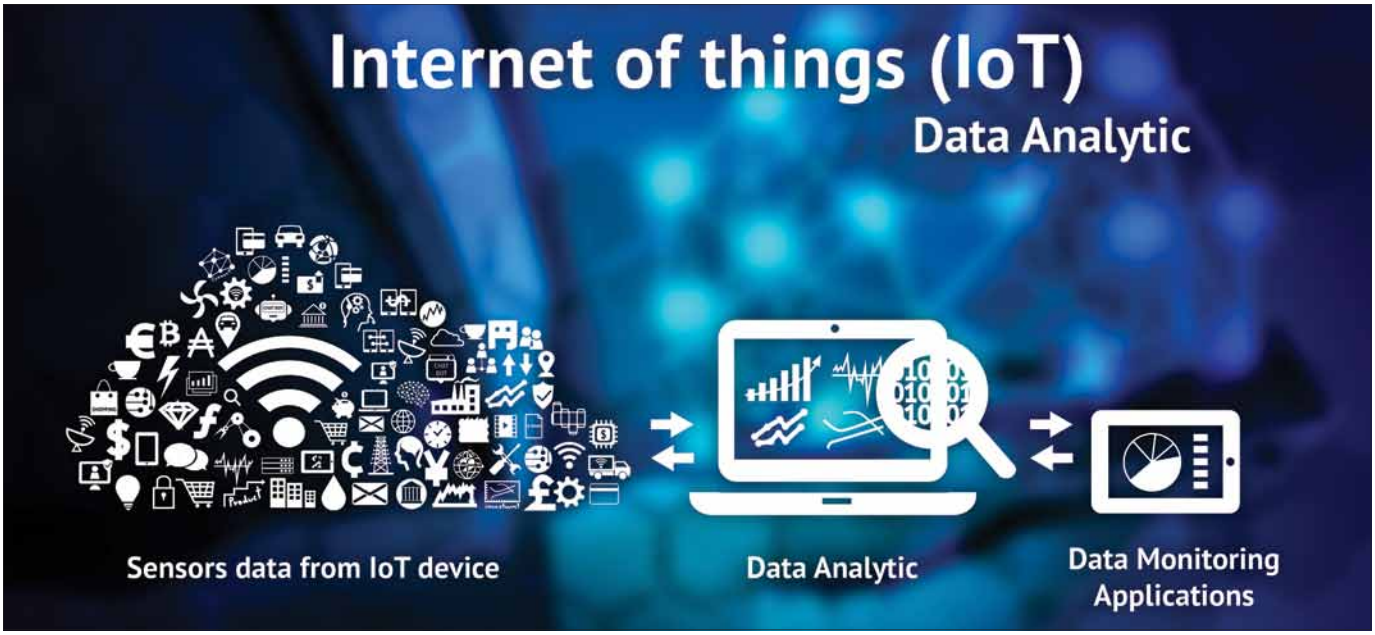
> Timing is critical to global positioning given that a one-nanosecond—one billionth of a second—error is equivalent to approximately one foot of positioning error.

Cyber Threats to Autonomous and Smart Systems

The introduction and growing use of automation in ships, ports, cargo, operations, and other maritime systems has added tremendous efficiencies and cost savings. It has also removed the possibility of human interference from many aspects of the redundancy and control loop.

A growing trend in the MTS is the development of so-called *smart ports*, largely using internet of things (IoT) technology. Smart ports use network-attached sensors to monitor tide, current, temperature, wind direction/speed, water depths, visibility, berth availability, and other data, feeding a centralized information dashboard to connected vessels. This type of system can streamline port operations to reduce wait times; optimize dock, load, and unload times; and maximize the number of vessels that can be managed efficiently, allowing the port and shippers to save significant amounts of money. Security, however, is not built into the design and development of these low-cost IoT devices, making them notoriously subject to network-based attacks. The massive distributed denial-of-service in 2016 against domain name and email service provider Dyn, for example, was due to a botnet—an automated attack network—comprising more than 100,000 such devices.[15]

Autonomous and remote-controlled vessels and port vehicles are another growing trend in the maritime industry, as witnessed by the Maritime Unmanned



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Navigation through Intelligence in Networks initiative and projects being led by organizations like Massterly, Rolls-Royce, the Port of Long Beach, and the Maritime Port Authority of Singapore. The technology that would support this level of automation is definitely in place, but what is missing is enough trust that these systems cannot be compromised via network attacks.[16]

Cyberphysical Threats

Cyberattacks are generally thought of as events that use a cybervector towards a cybertarget. Cyberphysical threats specifically address the case where the cyber vector is targeting a physical asset. Indeed, cyberphysical systems, defined as those that integrate computers and physical components, are increasingly common in all aspects of our lives as we develop more sophisticated sensors, instruments, networks, and embedded computers.[17] In the MTS environment, consider the situation if cyberterrorists were to gain control of autonomous vehicles at a port and use them to "attack" people or damage equipment at the port.

More worrisome is the case of gaining access to a ship's navigation, propulsion, or ballast system. If a ship could be deliberately grounded in any number of critical locations, the increase in shipping costs caused by delays or rerouting would be enormous, not to mention the cost to repair damaged facilities. If an attacker could alter sensors, gauges, or containment systems on a vessel carrying potentially hazardous materials, it might be possible to create a spill, explosion, or other adverse action.

Ultimately, all cyberattacks have a physical target, whether directly or indirectly. What has not been addressed yet is this scenario: If we would not allow a vessel of people with infections to a public dock, why would we not quarantine a vessel with a network virus, prevent them from connecting to a port's network? We need to take seriously cyberthreats to vessels, ports, and other parts of the MTS, and isolate "sick" entities from the "healthy" ones.[18]

Conclusion

The maritime industry is constantly evolving to become more advanced, compared to its ancient roots. Unfortunately, many old technologies, processes, and procedures in place today haven't kept up, causing some executives in the industry to observe that the maritime industry is 30 to 500 years behind in terms of technology.[19] This makes it difficult to keep up with the rapid acceleration of change—not only the adoption of new technology, but of understanding the vulnerabilities, exploits, and risks of emerging technologies.

A number of maritime industry organizations are responding to cyberthreats via suggested policies and procedures. The Baltic and International Maritime Council guidelines for vessel cybersecurity, for example, take a risk management approach to vessel cybersecurity.[20] The American Bureau of Shipping guidelines apply best practice cybersecurity principles to ships and other maritime platforms, as well as the landside systems that support them.[21] The National Institute of Standards and Technology, in conjunction with the U.S. Coast Guard, has added maritime-specific profiles to its widely used cybersecurity framework documents.[22] Indeed, the USCG Academy started a cyber systems major in fall 2018, their first new major in 20 years.[23] In addition, a private company specializing in testing,


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inspection, and certification, has released cybersecurity guidelines addressing software management and secure ship-to-shore communication.[24]

Despite all of these measures, a 2017 industry survey about maritime cybersecurity revealed a disparity between management and crewmembers. While two-thirds of executives and managers think their organization provides cybersecurity awareness for crew and staff, less than half of the crew and staff respondents still think they receive adequate training. And, while only a third of executives identified insiders as the biggest cybersecurity threat, half the managers and two-thirds of the crew and staff disagreed.[25]

None of the observations made here are a surprise to most cybersecurity professionals. The marriage of the maritime industry and technology is as important as it is inevitable. Facilitation of open discussions will help the industry better prepare for and address information risks inherent with cybersecurity attacks.

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Historical Snapshot

The Long Blue Line

Jackson's battle with the rogue waves of '44

by William H. Thiesen, Ph.D.
Historian, Atlantic Area
U.S. Coast Guard

Ships encounter waves that exceed their stress rating. In the dry terminology of naval architecture, these are called "non-negotiable waves." Mariners call them "rogue waves" or "freak seas." Typically they are very steep and have an equally steep trough in front of them—a "hole in the ocean" as some witnesses have described it. —The Perfect Storm, 1997

Written more than 20 years ago, the above text from Sebastian Junger's book, *The Perfect Storm,* describes rogue waves—at one time known only to unfortunate mariners who witnessed them firsthand and died as a result. Today, rogue waves are better known by scientists, researchers, and fortunate mariners who have survived them. During the Great Atlantic Hurricane of 1944 there were a few lucky survivors of the Coast Guard Cutter *Jackson* that experienced rogue waves.

In the pre-dawn hours of Thursday, September 14, 1944, the Great Atlantic Hurricane was making its presence known off the North Carolina coast. The hurricane had spawned several days earlier in the Atlantic sweeping up the East Coast and reaching its peak strength just south of North Carolina. Steaming off the Outer Banks, Coast Guard Cutters *Jackson* and *Bedloe* had received several storm warnings while screening the Liberty ship *George Ade,* disabled by a torpedo attack, and her tow, a

The Coast Guard Cutter *Jackson* in the grips of the Great Atlantic Hurricane with sister cutter *Bedloe* and damaged Liberty Ship *George Ade* in the background. Painting by Louis Barber from the Coast Guard Collection

Navy oceangoing tug. The 125-foot cutters were sister ships built in the 1920s to interdict illegal liquor smugglers during Prohibition. At the start of World War II, larger guns, depth charges, and heavy deck gear added to their top heaviness.

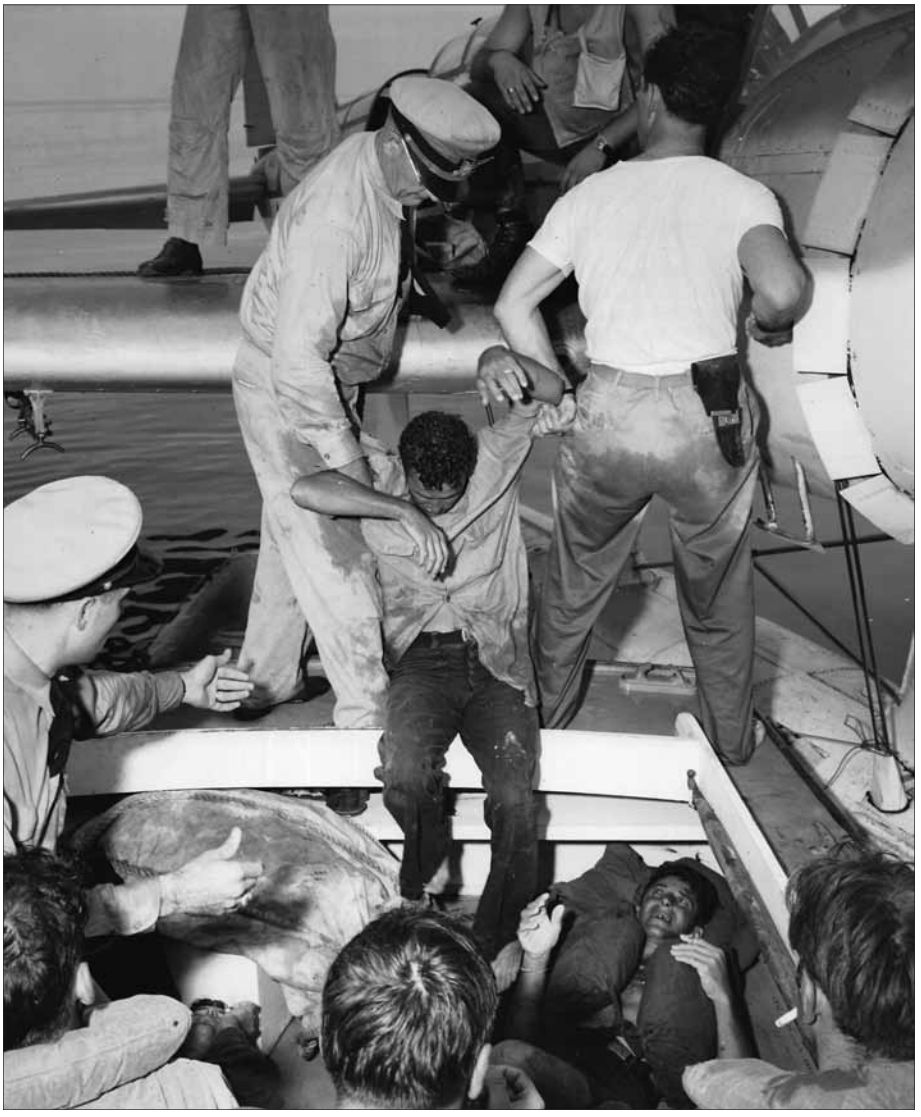
At dawn that day, seas had reached as high as 50 feet and winds topped 50 miles per hour. *Jackson's* crew began preparing for even heavier weather, battening down hatches and disarming depth charges on the stern racks. By 9 a.m., conditions became frightening with driving rains and seas so high the cutter's radar failed to locate contacts hidden behind towering waves. The larger Liberty ship sent out an S.O.S. signal, but it was all *Jackson* and the other vessels could do to keep themselves afloat.

Later, with wave heights increasing to between 50 and 100 feet, rudders alone failed to keep *Jackson* headed into the seas so the bridge crew used the cutter's twin screws to help steer her. Green water cascading onto the cutter began ripping loose *Jackson's* deck gear, including her depth charges, luckily disarmed hours before. Riding the cutter resembled an amusement park ride with the sea lifting the cutter onto the crest of a wave and then plunging her into the void on the other side.

By 10 a.m., winds were clocked at well over 100 miles per hour. The huge waves that eyewitnesses believed to be 100 feet high forced *Jackson* on a wild ride down their faces only to slam her into a wall of water at the base of the next monster wave. Meanwhile, equipment throughout the cutter, including galley gear and radios broke out of their lockers and crashed onto the interior decks. Earlier in the day, the crew had complete confidence in the cutter's seaworthiness, but the worsening conditions made many wonder if they would survive.

Left: Coast Guard Petty Officer 1st Class W.W. McCreedy, upper left, renders aid to Coast Guard Cutter *Jackson's* cook, Frank Ebbert, whose face is seen contorted with pain after being stung multiple times by Portuguese man-o-wars while awaiting his rescue from shark-infested waters. He was adrift off the North Carolina coast for 58 hours following the wreck of the *Jackson* during the Great Atlantic Hurricane of 1944.

Below: Survivors of the Coast Guard Cutter *Jackson* are transferred from the wing of a Coast Guard rescue plane onto a Coast Guard vessel, which rushed them ashore for hospitalization. Coast Guard photos



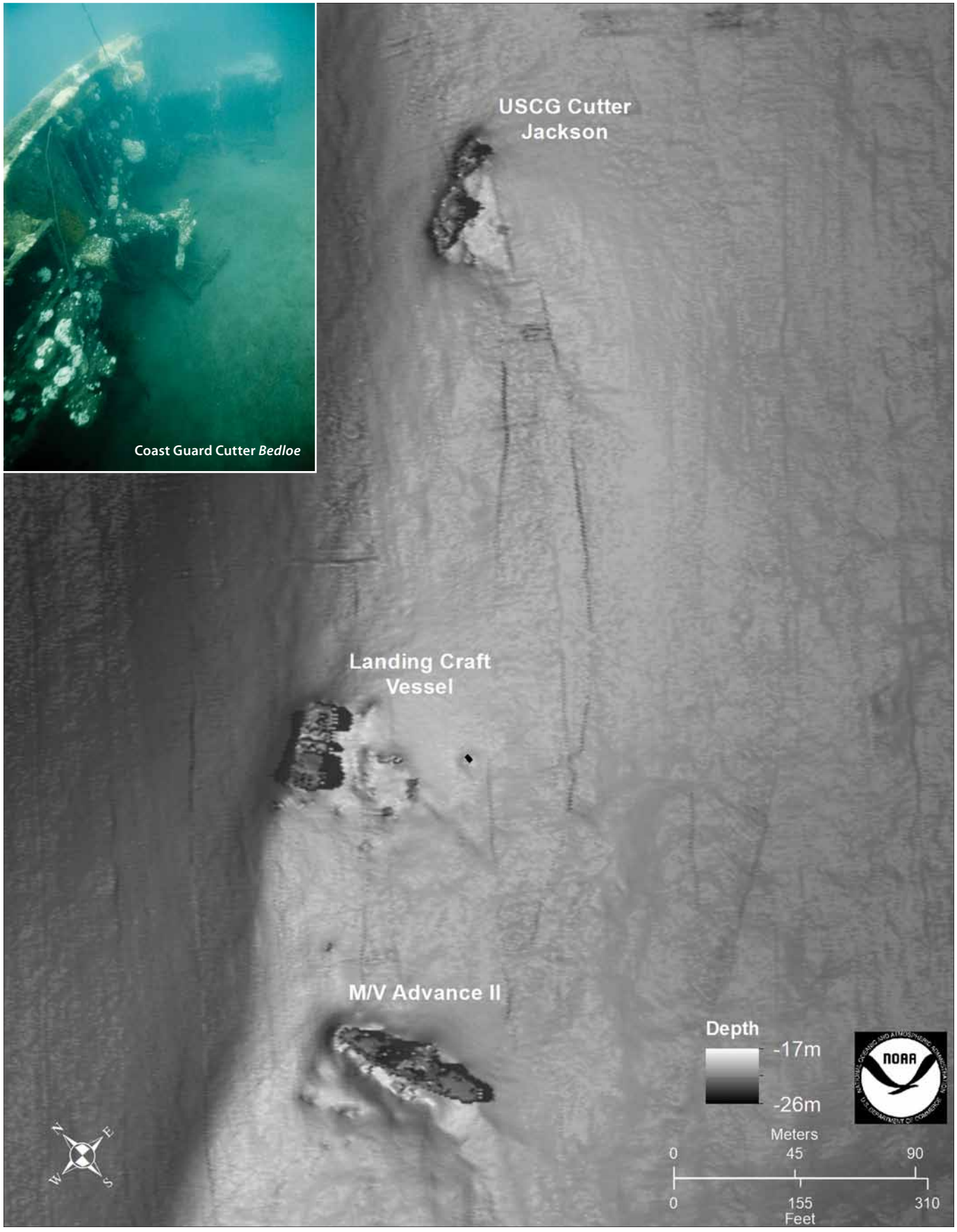
Above: The Coast Guard Cutter *Bedloe* in 1930, when it was known as *Antietam*. It was renamed *Bedloe* in 1943. Opposite page: The remains of the *Jackson* lie near the wreckage of two additional vessels, an unidentified landing craft and the M/V *Advance II*. The inset shows the wreckage of the *Jacskon*'s sister ship, *Bedloe*. Coast Guard photos

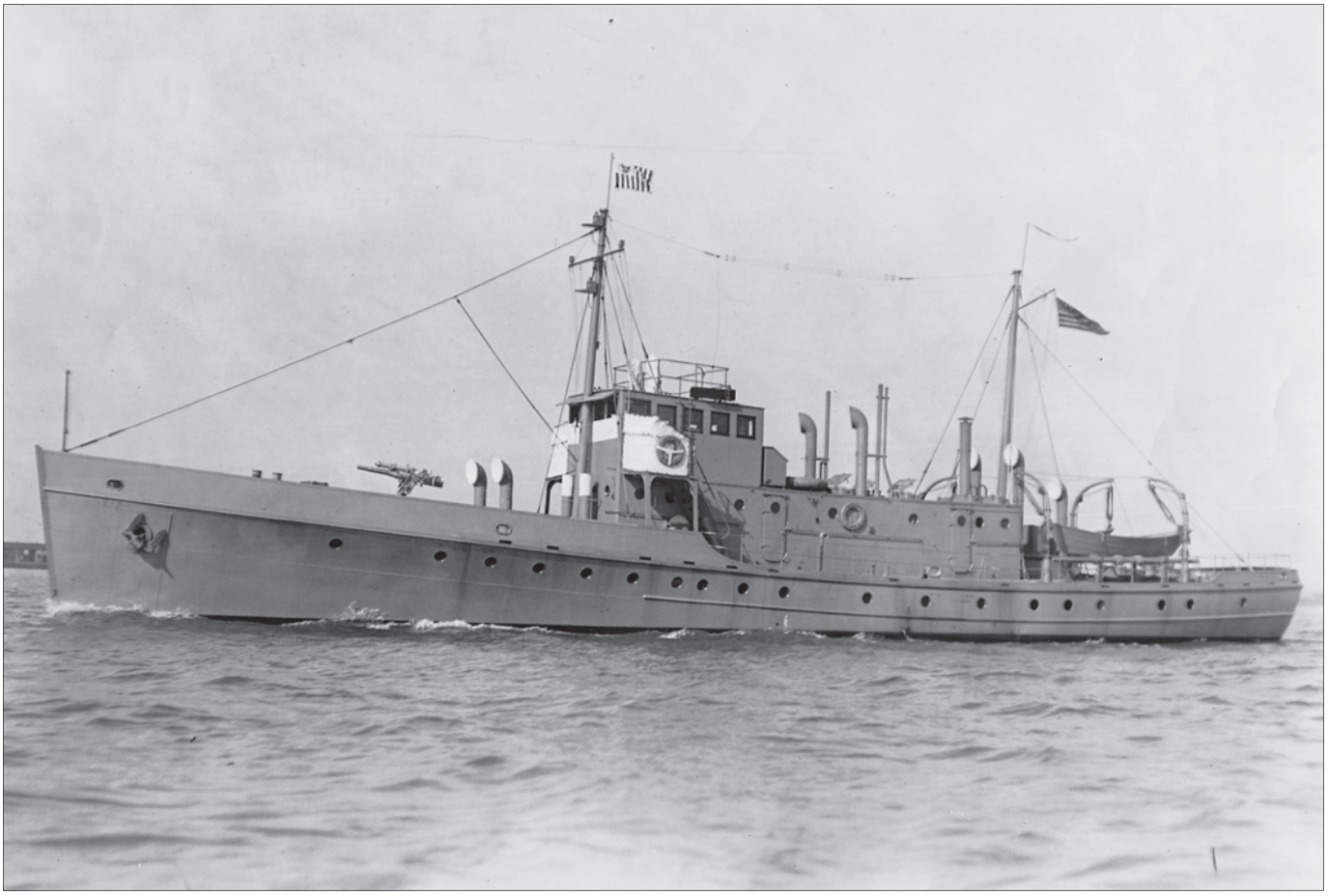
It was a series of larger waves—likely mountains of water referred to as rogue waves—that hit *Jackson* late in the morning. The first wave carried *Jackson* to its crest from which she managed to recover, but then a second towering wave rolled her on her port side forcing her mast into the sea. A third wave, described by a crew member as "a pyramid with a huge curl on top" and estimated as high as 125 feet, bore *Jackson* on its crest where survivors said she hung in mid-air for seconds. There, the hurricane's blasting winds blew the cutter on her side and she plummeted from the wave top to the bottom of the trough 100 feet below. This time, *Jackson* failed to right herself, filled with water and disappeared into the hole between the behemoth waves.

> Riding the cutter resembled an amusement park ride with the sea lifting the cutter onto the crest of a wave and then plunging her into the void on the other side.

In the aftermath of the sinking, most but not all of the crew escaped the capsized cutter. Only a few were trapped in her darkened compartments or fell into the

Survivors of Coast Guard Cutter *Jackson's* crew are rescued after floating for more than 50 hours off the coast of North Carolina after surviving the sinking of their cutter in the Great Atlantic Hurricane of 1944. Navy photo courtesy of William Ruhl


Coast Guard Cutter *Bedloe*
USCG Cutter Jackson
Landing Craft Vessel
M/V Advance II
Depth
-17m
-26m
NOAA
Meters
0
45
90
0
155
310
Feet
N
E
S
W



The 125-foot Coast Guard Cutter *Jackson* in her pre-World War II configuration. Coast Guard photo

roiling water. However, several who made their way outside had no life preservers in a maelstrom of behemoth waves and 125 mile-an-hour winds. Of those who managed to get to a raft, the seas ripped them from the floatation device every time it flipped over. Every time the raft toppled over, fewer men climbed back aboard, while others died of hypothermia and exposure.

Sistercutter *Bedloe* suffered a fate similar to the *Jackson*, when a succession of rogue waves knocked her over and capsized her. While *Jackson* capsized at about 10:30 a.m., *Bedloe* lost the fight at about 1 p.m. Likely, *Jackson* succumbed to waves pushed ahead of the storm's eyewall, while *Bedloe* was sunk by rogue waves formed on the backside of the eyewall. It is possible that both cutters were victims of a phenomenon called the "three sisters," a series of rogue waves that travel in threes and are large enough to be tracked by radar.

Exhaustion took its toll on the men in the rafts. Of the 38 officers and men who made it into *Bedloe's* rafts, only 12 survived the storm and subsequent hours of exposure. Of the 37 men who got into *Jackson's* rafts, only 20 survived. These cuttermen were not old timers—they were youngsters in their physical prime. Most of the officers and enlisted men were in their late teens and 20s, including *Jackson's* skipper who was barely 23.

When new recruits enlist during wartime, they fail to realize they will fight two enemies—humankind and Mother Nature. Just ask veterans of the Marine Corps 1st Division about the green hell of Guadalcanal, veterans of the 101st Airborne Division about the frozen hell of Bastogne, or the Coast Guardsmen of the cutter *Jackson* about the watery hell of the Great Atlantic Hurricane. This wartime cutter fought the good fight and lost against the most formidable and deadly waves in the world's oceans. *Jackson* and her brave crew and the men of the *Bedloe* will be remembered as part of the service's long blue line.

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U.S. COAST GUARD AUXILIARY
U.S. COAST GUARD
80TH
1939-2019
ANNIVERSARY
AUXILIARY

80th Anniversary of the Coast Guard Auxiliary

USCG Auxiliary's Proud Heritage and Continuing Mission

80 years of service to the Coast Guard and the boating public

by C. Douglas Kroll, Ph.D.
U. S. Coast Guard Auxiliary

The birth of the Coast Guard Auxiliary can be traced back to the summer of 1934, when LT Francis Pollard, commanding officer of the 165-foot *Aurora*, accompanied Malcom Boylan, on his boat, the Chula, from Los Angeles to Catalina Island.

Boylan, a Hollywood screenwriter, was the commodore of the Pacific Writers Yacht Club of Hollywood which made regular cruises to Catalina Island. During the cruise, Pollard and Boylan had several lengthy conversations, in which Pollard discussed the Coast Guard's history, traditions, and missions and apparently the fact that the Coast Guard had no organized reserve. The Naval Reserve was founded in 1915 and had almost 300,000 members by the end of World War I. By the 1930s it boasted 6,500 officers and 17,000 enlisted men. Boylan subsequently addressed a letter to Pollard on August 23, 1934, outlining the gist of their discussions with additional observations of his own. His letter has come to be known, in Coast Guard Auxiliary lore, as "The Founder's Letter." It suggested the Coast Guard form a volunteer, civilian reserve of private boat owners and their vessels. Pollard forwarded Boylan's letter through official channels to the office of the Coast Guard commandant in Washington, where it came to the attention of Commander R.R. Waesche, then aide to the commandant.

Coast Guard Auxiliarist Bill Bowen assists in unfurling an Auxiliary flag prior to the start of the Veterans Day Parade in Hartford, Connecticut, on November 11, 2013. Coast Guard Auxiliary photo by Robert Carlson

In 1936, Waesche was promoted to rear admiral and appointed commandant. With his support and urging, Congress passed H.R. 5966, entitled "An Act to establish a Coast Guard Reserve to be composed of owners of motorboats and yachts." It passed the Senate and President Franklin Roosevelt signed it into law on June 23, 1939.

That legislation—the original Coast Guard Reserve Act—started the five missions of the future Coast Guard Auxiliary:

- assist the Coast Guard
- promote efficiency in the operation of motorboats and yachts
- foster a wider knowledge of and better compliance with the laws, rules, and regulations governing the operation of motorboats
- promote safety and effect rescues on and over the high seas and navigable waters
- facilitate other operations of the Coast Guard.

This civilian Coast Guard Reserve laid the foundation for what became the Coast Guard Auxiliary. Today, this uniformed service organization with a membership open to U.S. citizens 17 or older has members in all 56 states, territories, and the District of Columbia. A vital member of Team Coast Guard for 80 years, the Auxiliary assists the Coast Guard in its missions except where prohibited by statute, such as direct law enforcement and military actions.

WWII, a Turning Point for the Auxiliary

World War II was well underway by the time the Coast Guard Auxiliary was created. While the Coast Guard needed the Auxiliary's support, the terms of the 1939

The Coast Guard Auxiliary in World War II

The United States Coast Guard Auxiliary was, and still is, comprised of volunteers. They contribute not only time and expertise to the mission, but personal assets, like the docked boats in the 1944 photo below, as well as aircraft. This has been the case for 80 years.

In 1943, Bill Welch (left), a Boston lawyer, member of the Marblehead unit of the Coast Guard Auxiliary, and junior commander of the flotilla, contributed 12 hours a week to patrol duty. During World War II, Coast Guard Auxiliary members were authorized to serve as temporary reservists and manned vessels like those below.

U.S. Farm Security Administration/Office of War Information Collection, LC-USW3-055521-C

Designated by the initials of the Coast Guard Reserves, these cabin cruisers were made available to the government for the duration of WWII by their owners. A temporary reservist serves as helmsman for each of the boats while regular Coast Guardsmen man the gun during practice firing. U.S. Office of War Information photo by Alfred T.Palmer, February 1943

U.S. Office of War Information photo by Alfred T. Palmer, February 1943

and 1941 legislation posed challenges, including that the Auxiliary was strictly a civilian organization. Under international law a nonuniformed yachtsman serving as an auxiliarist and captured by the enemy might not be entitled to the protections afforded to a prisoner of war under the Third Geneva Convention and so might be charged with espionage. In addition, the Coast Guard needed more than just boat owners, it needed reinforcements.

On June 6, 1942, Congress acted and amended the Coast Guard Auxiliary and Reserve Act of 1941, authorizing auxiliarists to serve as temporary reservists in the Coast Guard, a move many auxiliarists made. Others remained in the civilian Reserve or the Auxiliary. It is conservatively estimated that six temporary reservists performed the duties of one full-time service member. That's about 8,250 regular Coast Guardsmen freed for sea duty.[1]

These Temporary Reserve auxiliarists painted the hulls of their "cockleshell boats" battleship gray and went to sea, some with a handgun or two, or a rifle. Some braved their duties with no weapons at all. For two years they served, leaving a legacy one publication declared, "will rank in history with that of the brave men of Concord and Lexington."[2]

Auxiliary membership provide immunity from the draft, and many were inducted into one of the other four services. Nevertheless, the Auxiliary continued growing and, by 1943, reached 25,039 members. The following year, private aircraft owners stepped up to form the aviation arm of the Coast Guard Auxiliary.

Men weren't the only ones volunteering during WWII. Women had been members of the Auxiliary since the early days of the war, including some who were active in boat patrol operations. They were also authorized to serve as temporary reservists. With the cultural changes of the 1970s women auxiliarists played an increasingly public role and, by 1979, Bolling Douglas was sworn in as the first female district commodore.

But between 1939 and 1979, the Auxiliary would take on broader roles with increasing responsibility and shift with the cultural changes. For instance, before the war began, inspections of members' boats and issuance of certificates to those that met regulations, had been one of the Auxiliary's key functions. By 1946, and with the full approval of Coast Guard headquarters, the Auxiliary in the Seventh District (Miami) began offering to inspect—with somewhat less stringent standards—motorboats belonging to the general public. The idea caught on, and a year later, the Auxiliary established the Courtesy Boat Inspection program on a national level. Throughout the next quarter century, the program was renamed the Courtesy Marine Examination (CME) and expanded to include sailboats.

The Coast Guard suspended its "boat check" inspection and decal program in 1974, leaving all responsibility to the Auxiliary's CME program. It wasn't until 1991, however, that the Auxiliary began issuing "safety check" decals to personal watercraft and the program was renamed the Vessel Safety Check program, known today as the Courtesy Vessel Examination.

Richard Weiss, a member of Coast Guard Auxiliary Flotilla 8-2 located in Cape May, New Jersey, inspects a life jacket during a vessel safety check at Bree-Zee-Lee Yacht Basin in Cape May in 2010. Members of the Coast Guard Auxiliary, with help from members of Coast Guard Station Cape May, conduct vessel safety checks at marinas throughout the area during National Safe Boating Week to inform boaters on the importance of boating safety. Coast Guard photo by Petty Officer 3rd Class Jonathan Lindberg

The Auxiliary also created the Marine Dealer Visitation Program in 1970s with the goal of forming a cordial relationship with the businesses selling boats and boating equipment to the public. The hope was that these dealers would allow the Auxiliary to provide free boating safety literature through each dealer to further safe boating practices. This program became the Recreational Boating Safety Visitation Program and expanded to include non-traditional marine businesses like large retail stores and sporting goods stores. This included businesses recreational boaters may frequent—hardware stores, doctor's and dentist's offices, insurance agencies, libraries, county boat/care license agencies, bait and tackle vendors, or any chain store

Coast Guard boat crews along with a Coast Guard Auxiliary boat crew help a boater after his 15-foot catamaran capsized near Bolivar Galveston Jetty on March 13, 2016. Coast Guard photo by Petty Officer 3rd Class Brandon Gonzalez

with sport/boat equipment departments.

Post-World War II

Recreational boating enjoyed a resurgence after World War II and the Auxiliary took on the responsibility of educating the public on boating safety. Education became one of the four cornerstones of the Auxiliary in 1947 and the Public Education (PE) program got under way the following January, when auxiliarists offered a series of free public instruction courses at the annual New York City Motorboat Show. In January 1950, the Auxiliary introduced an eight-lesson course in basic seamanship. With an enthusiastic reception, it evolved into today's Boating Safety and Seamanship course. Over the years classes have been added for sailors, children, navigation, and a standard boating course—About Boating Safely."

A Coast Guard crew from Sector Houston-Galveston and a Coast Guard Auxiliary crew prepare to escort an overloaded boat back to the shores of Texas' Lake Texoma in 2009. Coast Guard photo/Petty Officer Renee C. Aiello

While interest in recreational boating picked up after the war, the Coast Guard Academy suffered a decline in popularity and funding. As early as 1946, Coast Guard headquarters asked the Auxiliary to help identify prospective cadets. Headquarters' concern was justified. By the mid-1950s almost three times as many Coast Guard officers were coming from the service's enlisted ranks by way of Officer Candidate School.

In 1955, VADM Alfred Richmond, then commandant of the Coast Guard, presented the idea of an Academy Activity Week to the Auxiliary Spring National Conference. In response, Commodore Paul Richardson of the Seventh District, began a letter-writing campaign, encouraging Auxiliary units to sponsor promising high school seniors by paying their expenses for a visit to the New London, Connecticut, campus. That summer, 77 high school juniors participated in the first Academy Activity Week, which became an annual event, with increasing participation each year. Four years after it began, the Auxiliary National Board appropriated $2,000 to cover half of the travel cost for two young men from each district to take part. Academy Activity Week was

officially renamed Academy Introductory Mission (AIM) in 1966.

In 2004, the director of admissions at the Academy began selecting AIMsters. Today, the program is primarily run by the Academy Admissions Office, though auxiliarists continue to play an important part in the academy recruiting program and are still a part of publicizing and staffing AIM. They would later assist Coast Guard Recruiters.

The recruiting experience auxiliarists gained in the early days of AIM, proved valuable as involvement in Vietnam wound down and the draft ended. Coast Guard recruiters began experiencing trouble in meeting their quotas, and in 1974 the Auxiliary responded by initiating Project RAP, or Recruiting Assistance Program, as a way to interest qualified young people in serving in the Coast Guard, and connecting them with the nearest recruiting office. With a very small number of Coast Guard recruiters spread across the nation, auxiliarists could reach out into their communities and encourage the best prospective Coast Guard members to join, rather than simply being content with, or relying upon, only those individuals who sought out a recruiter.

Part of Team Coast Guard

Becoming part of Team Coast Guard started with a uniform change. During the early years, auxiliarists were not required to wear uniforms, but when they did, they were nearly identical to active-duty Coast Guard chief petty officers' uniforms—khakis and blues—but without rank insignia. When wearing working khaki, auxiliarists wore the Auxiliary emblem on their left collar and their elected or appointed office insignia on their right collar. In the 1970s, when the Coast Guard switched to "Bender Blues," the Auxiliary also changed its uniform. In a break with earlier practice, however, the new uniforms would be identical to Coast Guard Officer uniforms with two exceptions—silver stripes on sleeves and shoulder boards instead of gold and a change in the cap devices. This move offered a more cohesive appearance across the different versions of the Coast Guard—active duty and Auxiliary. However, the new Coast Guard cap devices for paygrades E-6 and below were too similar to the former Auxiliary cap devices—spurring a change to the Auxiliary device. It resembles that of Coast Guard commissioned officers—an eagle with spread wings in silver instead of gold.

A Force Multiplier

Auxiliarists work in Coast Guard recruiting offices, as physicians assisting in Coast Guard clinics, as clergy assisting chaplains, as food service personnel—ashore and afloat—as ombudsmen, and as communication watch standers. Still, others work with Aids to Navigation Teams building day-shapes, or as interpreters on cutters making foreign port calls. The Auxiliary has truly become a force multiplier within Team Coast Guard.

On October 19, 1996, Congress doubled down on this aspect of the auxiliary when it passed the Coast Guard Authorization Act of 1996—the first major revision to the 57-year-old statute authorizing the Auxiliary. It expanded the service's missions to include all but military operations and direct law enforcement, and gave the commandant authority to provide Auxiliary assistance to federal, state, and local agencies.

The 9/11 attacks tested the Auxiliary's role under the 1996 act. For the first time since World War II, the Coast Guard Auxiliary lent major operational support to the Coast Guard to protect U.S. cities, coastlines, ports, and citizens against foreign attacks

It also was "something of a coming out party" for the Coast Guard Auxiliary, P.J. Capoletti wrote in *Rogue Wave: The U.S. Coast Guard on and after 9/11.* It dramatically elevated the profile of the Auxiliary, as civilian volunteer Auxiliary boats and aircraft conducted surface

Coast Guard and Coast Guard Auxiliary vessels jointly patrol the Gasparilla boat parade in Tampa Bay, Florida, in January 2014. The joint effort symbolizes the four components of the Coast Guard—active duty, Reserve, Auxiliary, and Coast Guard civilian employees. Coast Guard Photo by George Papabeis

and air patrols and assumed search and rescue standby postures at many small boat stations. This allowed the active duty small boat force the latitude to redirect its resources to port security and homeland defense.

As they did during WWII, auxiliarists did the jobs that allowed their active-duty counterparts to focus on the bigger picture—distributing face masks and gloves, along with food and water to rescue personnel at ground zero immediately after the attacks. On the water, Auxiliary boats from Westchester County, New York, ran security patrols around the George Washington Bridge. Those from Sandy Hook, New Jersey, did the same around the Verrazano Narrows Bridge. Auxiliary boat crews backfilled for Coast Guard search and rescue crews at Stations New York, Sandy Hook, and New London, Connecticut, also taking over as communications watch standers in New London. At Tarrytown, New York, legally blind Auxiliary radio operator Mike Coffey worked continuously, monitoring patrols, for which he earned the Award of Operational Merit. Another Auxiliarist, and licensed psychologist, Dr. Janice Jackson, served as backup to the critical incident stress management team throughout the day on September 13.

A Coast Guard auxiliarist helps to right a capsized catamaran. Coast Guard photo

In the six months after the attacks, the Auxiliary contributed nearly 250,000 hours to the Coast Guard's post-9/11 surge operations. Auxiliary surface and air patrols alone amounted to 10,139 people conducting 7,454 sorties over 53,910 hours.

The total number of Auxiliary volunteers after 9/11 exceeded 35,000, or more 80 percent of the total Auxiliary force.

Envrionmental Responders

The Coast Guard Auxiliary also assists in the wake of natural disasters like the record-breaking 2005 hurricane season when three major hurricanes pummeled the South in as many months, Auxiliary search and rescue operations alone saved 24,135 lives. Efforts also included Coast Guard Auxiliary District 8 (Central Region), which sent several divisions to support the Coast Guard with personnel and facilities—surface, air, and communications.

In 2010, Deepwater Horizon became a household name as the news reported the loss of 11 lives in the explosion aboard the Deepwater Horizon drilling rig in the Gulf of Mexico that resulted in the largest off-shore oil spill in U.S. history. Again, the Auxiliary responded sending examiners to participate in safety exams for vessels of opportunity, conduct overflights of the Gulf for observation of oil flow, serve in joint information centers, and backfill Coast Guard positions in public affairs units at the Unified Area Command Center in New Orleans.

For 80 years, The United States Coast Guard Auxiliary has been a vital part of Team Coast Guard, a role it will continue to fill into the foreseeable future while continuing to live up to its motto, *"A Proud Tradition, A Worthy Mission."*

About the author:
C. Douglas Kroll, is a former Coast Guard officer with a Ph.D. in history. He currently teaches at the College of the Desert, in Palm Desert, California, and has written three books, all focused on the Coast Guard.

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The History of Coast Guard Auxiliary Aviation

More than 70 years of service

by Joseph Giannattasio
District Staff Officer Aviation
Coast Guard Auxiliary District 5NR

In 2016, Coast Guard Aviators—men and women, officers and enlisted—commemorated a century of Coast Guard Aviation in service to the American public. Included in this prominent history is the Coast Guard Auxiliary and its members.

Comprising over 23,000 men and women, the Auxiliary is the Coast Guard's uniformed volunteer component that works with the Coast Guard in carrying out its noncombatant and non-law enforcement missions. Auxiliary Aviation (AUXAIR) is an Auxiliary operational program. These aviators have varied backgrounds, including many with prior military experience, and many who volunteer their aircraft for use just as surface operators volunteer their boats. All Auxiliary aircraft meet strict Coast Guard and Federal Aviation Administration requirements and annual inspections.

Aircraft Commander Judy Redlawsk and aircrew member David Crownover perform preflight checks in Redlawsk's Robinson R44 helicopter before takeoff from USCG Air Station Atlantic City, New Jersey. Auxiliary aviators volunteer their aircraft for use as facilities, just as surface operators volunteer their boats. Coast Guard Auxiliary photo by Joseph Giannattasio

"A fact sporadically publicized is that some 50,000 United States Coast Guard Auxiliary members served during World War II where they engaged in coastal defense, port security, anti-submarine patrols, and search and rescue duties," said John A. Tilley in his history of the Auxiliary. "Thousands of Coast Guard personnel were freed up for service overseas as Auxiliary membership increased. General aviation aircraft and civilian pilots assisted the Coast Guard Auxiliary 'informally' during World War II. Public Law 451 passed by Congress in September 1945 allowed owners of aircraft and radio stations eligibility for membership in the Auxiliary."

The postwar period brought cutbacks in funding for the Coast Guard and reductions in the number of active duty personnel, vessels, and aircraft available for search and rescue. Simultaneously, the need was expanding due to the increasing popularity of recreational boating. The Auxiliary, supplementing active duty forces, proved to be a practical solution for the Coast Guard, which thereafter would rely on the Auxiliary to fill the gaps. Aircraft use increased and several Auxiliary districts formed aviation units. Auxiliary pilots from District 11 operated out of Los Angeles' Vail Field and District 14 formed two air divisions in Hawaii where Coast Guard aviation assets were limited.

In November 1947, Coast Guard Commander David H. Bartlett was assigned to reactivate the Coast Guard Auxiliary and establish an Auxiliary Air Wing in Hawaii. With no precedence to build on, he called upon Commodore Lloyd T. Nicholls, then an Air Force Reserve major, to assist in the effort due to his experience in the Air Force Association and Civil Air Patrol. By March 1948, after establishing administrative and organizational protocols and acquiring necessary equipment,

the Auxiliary Air Division had more than 40 aircraft certified for Search and Rescue while the Coast Guard had just two. It was Commodore Nicholls who made the first set of Auxiliary Wings in his apartment by soldering a miniature Auxiliary emblem onto a set of Coast Guard pilot wings over his kitchen gas stove. The wings were approved by CDR Bartlett and are the same design worn by Auxiliary pilots today, though the color changed from gold to silver.

In 1952, the Coast Guard Commandant Admiral Merlin O'Neill authorized the creation of Auxiliary Operational Units. These specially trained groups consisting of five boats, two aircraft, two radio stations, and 50 auxiliarists were organized to assist the Coast Guard in emergencies. The program was later converted to "Operational Auxiliarist" curriculum—a specialized, rigorous training curriculum for individual auxiliarists.

Nationally, the number of documented Auxiliary aircraft had been diminishing since the early 1950s. In 1953, the national roster indicated 461 aircraft; by 1960 the number dropped to 139, and in 1965 there were only 57 Auxiliary aircraft registered. As a result of the Federal Boat Safety Act of 1971 that expanded boating safety awareness, Auxiliary flotillas were established on state and inland waterways. This muted the growth of the Auxiliary Aviation program since use of aviation tended to be location specific. Aircraft were effective in search missions because they could cover more area in less time. They were also effectively used in checking and verifying the location and operation of aids to navigation, for winter ice patrols in the northern areas, and occasionally to provide rapid transportation to and from Coast Guard stations not served by commercial air transport. In the 1990s, auxiliarists flew as observers on Coast Guard HC-130 aircraft.

The 1996 Coast Guard Authorization Act significantly expanded the Auxiliary's missions. AUXAIR rapidly broadened and was tasked to assist the Coast Guard in missions and operations authorized by law and the commandant. In January of 1997, Coast Guard Auxiliary Aviation was upgraded to establish a standard command and control network. Unlike surface operations, AUXAIR has its own structure and is organized solely on a district basis. This alignment of district AUXAIR units with Coast Guard Air Stations is known as the "squadron concept," meaning the air station is the order-issuing authority and provides oversight.

The increased and expanding role of the Coast Guard prompted the "Team Coast Guard" concept, uniting

An Auxiliary aircraft from District Five Northern Region flies over USCG Training Center Cape May, New Jersey, during a coastal patrol. Coast Guard Auxiliary photo by Joseph Giannattasio

Auxiliary and Coast Guard aviators from the District Five Northern Region aviation program prepare for a joint training exercise using Auxiliary surface and air assets working in coordination. Coast Guard Auxiliary photo by Joseph Giannattasio

Active Duty Forces, the Coast Guard Reserve, and the Coast Guard Auxiliary. Coast Guard Auxiliary Aviation became a force multiplier.

In the aftermath of 9/11, Coast Guard helicopter units were tasked with conducting the Coast Guard's National Capital Region air defense mission and performing Rotary Wing Air Intercept (RWAI) missions over the nation's capital and other critical areas throughout the country. In RWAI training flights AUXAIR aircraft and aviators are used to help improve the helicopter pilots' response times and to provide moving targets to hone flight interception techniques. Today, Auxiliary Aviation participates in many Coast Guard missions including search and rescue, waterways security, marine safety, pollution response, and aids to navigation.

While assigned by a Coast Guard unit commander to duty under orders, qualified and current Auxiliary pilots are considered Coast Guard pilots and approved aircraft are considered Coast Guard aircraft. Maintaining this relationship and joint training is essential for maximum effectiveness of Coast Guard and Auxiliary Aviation.

As part of Team Coast Guard, auxiliarists enjoy supporting Coast Guard Aviation and take pride in being part of America's heritage.

About the author

Joseph Giannattasio has served in the Coast Guard Auxiliary for 15 years. He serves in many capacities, most notably as a pilot and coxswain. He has received two Operational Merit Awards, two Auxiliary Commendation Awards, and was selected as the Coast Guard's Auxiliarist of the Year for 2017.

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The Longest Serving Coast Guard Auxiliary Pilot

Ray Bejarano is the Auxiliary's 'Ancient Albatross'

The Coast Guard Auxiliary aviators do not have their own version of the Ancient Albatross—the honor bestowed on the active Coast Guard aviator with the longest tenure. If it did, Raymond Bejarano of District 5SR, Flotilla 24-04, in Gaithersburg, Maryland, would hold that honor—a fact confirmed by the assistant national commodore for Information Technology.

Raymond Bejarano.

Bejarano joined the Auxiliary in May 1979, qualified as a pilot and flew patrols in his Mooney M20F Executive out of Slidell, Louisiana, where he resided. Supporting Air Station New Orleans, he patrolled between Destin, Florida, and the Texas-Mexico border. Missions included maritime observation, transporting, logistics, and search and rescue sorties.

"We would always start our missions from the air station, and we alternated flying either east of New Orleans to Florida, or west of New Orleans to Texas." he said. "This was before the advent of cell phones, so we had a lot of overdue fishermen that we needed to track down in the marshes."

In 1980, Bejarano traded his Mooney for a Piper Twin Comanche in order to safely conduct patrols over the Gulf of Mexico. He flew this aircraft for Auxiliary flights over the next 34 years. He moved to Gaithersburg, Maryland, in 1983, and has been flying the gamut of Auxiliary air missions under air stations Elizabeth City and Atlantic City ever since.

Comanche Flyer Magazine featured Bejarano in 2008, extolling the Coast Guard Auxiliary's air program, its missions, and his aircraft. "For the past 28 years, [the *Comanche*] has been an incredible machine," he told the publication. "It has been able to carry out all of its missions whether they were family or Coast Guard-oriented, with little or no problems."

When Bejarano fully retired from the business world, he began spending winters near Miami. Naturally, he took his airplane and Auxiliary flight suit.

"In 2010, I started taking my airplane down with me and began flying on behalf of Air Station Miami." he explained. "Because of the capabilities of my Twin, we would conduct offshore patrols over the Bahamas and the north coast of Cuba that were over 100 miles from Florida. I still fly for Air Station Miami, but only as crew in somebody else's aircraft."

In 2014, Bejarano sold his Twin Comanche and bought a single-engine Cessna 177RG Cardinal. "It is the ideal aircraft for MOMs (maritime observation missions) and rotary wing air intercept exercise flights."

As the Auxiliary's longest serving pilot, Raymond Bejarano would know best.

—by Joseph Giannattasio

From left, Andrew Diffley, Raymond Bejarano, and Charles Browning review an electronic flight bag program on a tablet. Coast Guard Auxiliary photos by Joseph Giannattasio

Hunting for *Bear*

The search for the Coast Guard's most iconic vessel

by Mark A. Snell, Ph.D.
U.S. Coast Guard Auxiliary

A Coast Guard plane out of Salem dropped rescue equipment Tuesday to enable two men to abandon the former Coast Guard cutter Bear, *battered by gale-force winds and 12-foot seas and sinking off Greenwood, Nova Scotia.* —*The Boston Globe,* March 20, 1963

Some old salts swear USCGC *Bear* caused its own demise, opting for an honorable burial at sea rather than suffering the prolonged agony and ignominy of incarceration on a Philadelphia dock as a floating restaurant—not a fitting end for such a noble, iconic, and historic ship. And what a history it had. Originally a vessel for seal hunting, *Bear* was built in 1874 by Alexander Stephen and Sons, Ltd., in their shipyard in the Linthouse (Govan) District on the River Clyde in Glasgow, Scotland. The three-mast ship served this original purpose off the coast of Nova Scotia for a decade before being purchased by the U.S. Navy on January 28, 1884. Commissioned seven weeks later, the vessel's first commanding officer was Lieutenant William H. Emory, an 1866 graduate of the Naval Academy and the son of General William Emory, a West Point graduate, topographical engineer, explorer, and Union general in the Civil War.[1]

The Navy procured the *Bear* for the specific purpose of finding and rescuing the Greely Expedition. The 25-man Arctic exploration party was led by Lieutenant Adolphus Greely of the 5th U.S. Cavalry, who had volunteered to lead a detachment of Signal Corps soldiers to Lady Franklin Bay, Greenland, to collect meteorological data. The *Bear* was exceptionally well-suited for a transit through ice-clogged seas, with its six-inch planking that had been steamed and bent to fit over the ribs, and fastened down with high-grade iron imported from Sweden. It was, according to historian, and Coast Guard auxiliarist, C. Douglas Kroll, "a sailing battering-ram." The Greely exploration had begun in the summer of 1881 but ended in near-disaster three years later. After several unsuccessful attempts to resupply Greely's command, which had been decimated by hunger and sickness, a three-ship U.S. Navy rescue operation led by the *Bear* rescued only six survivors, including Greely.[2]

Captain Michael A. Healy on the quarterdeck of his most famous command, Revenue Cutter *Bear,* with his pet parrot, circa 1895. Coast Guard photo

After two more years of Navy service, the *Bear* was decommissioned, struck from the Naval Register in April 1885, and transferred to the U.S. Revenue Cutter Service (RCS) operating under the control of the Treasury Department. The vessel was refitted as a revenue cutter at the Fundy and Murphy Shipyard in New York. Now known as USRC *Bear,* it initially was commanded by Captain Alvin A. Fengar.[3] The Revenue Cutter Service designated the *Bear* as the flagship of the Bering Sea Force, where it also would operate as an Arctic Ocean cruiser. In 1886, Captain Michael A. "Hell Roaring Mike" Healey took command of the ship.[4] Because of his mixed-race ancestry—his father was an Irish-born Georgia planter and his mother was biracial—Healy has been called the first African-American commander in the history of the RCS—and USCG. Healey, however, would have

shunned that classification, as he chose instead to pass as a white man, thus allowing him the social mobility he would have been denied as a mixed-race man at that time in American history.[5] Regardless of how Healy chose to identify himself, his exploits in Alaskan waters made his name legendary. During his stint as the *Bear's* skipper, he initiated policies still associated with the Coast Guard's myriad missions:

- search and rescue
- environmental protection
- law enforcement—especially cracking down on seal poachers
- the suppression of illicit trade

He also resupplied distant outposts while sometimes serving as the lone federal authority in the more remote regions of the Alaska Territory. One of Healy's most amazing endeavors was the intercontinental transport of reindeer—a source of food for the Aleut and Inuit people—from Siberia to Alaska, made necessary by the rapid decline of the Alaskan seal population from overhunting and poaching. Although the plan was only moderately successful, it breathed new life into the native population, who had gone through a very difficult time, made worse when they were introduced to alcohol by traders from the United States and Canada.[6]

Healy commanded the *Bear* from 1886–1896, but he was followed by a "who's who" list of skippers and ship's officers destined for everlasting Coast Guard fame. All told, some 15 future admirals served on the *Bear,* including two who would become commandant and four who would become Coast Guard Academy superintendents.[7]

In late 1897 the *Bear,* now commanded by Captain Francis Tuttle, was forced to venture out to sea during the perilous winter season to rescue the crews of eight whalers—about 250 men—stranded in ice off of Point Barrow, Alaska. The cutter itself became ice bound off Cape Nome, some 1,600 miles from the marooned sailors. But the *Bear's* 1st Lt, David Jarvis, 2nd Lt. Ellsworth Bertholf, and U.S. Public Health Service surgeon Dr. Samuel Call set out with dog teams in the dead of an Arctic winter, in what became known as the "Overland Relief Expedition." Driving a reindeer herd ahead of them to supply much-needed food to the trapped whalers, they began their overland trek on March 29, 1898, reaching the survivors four months later, on July 28, 1898. It remains the longest rescue mission ever attempted in the history of the Coast Guard or its predecessor. In recognition of their heroism, Congress authorized special gold medals to be struck and awarded to the three officers. Today, both Jarvis and Bertholf have cutters that bear their name, and the medical clinic at USCG Training Center Cape May is named for Dr. Call. Additionally, Jarvis was further honored in 1971 when the Navy League named its annual "Inspirational Leadership Award" in David Jarvis's memory.[8]

While Jarvis, Bertholf, and Call were performing their heroic feat, the United States declared war on Spain, the first of three wars in which the *Bear* participated. In this short, victorious conflict that lasted less than four

The USRC *Bear,* front, and SS *Corwin* in the roadstead, Nome, Alaska, shortly after their arrival, June 1, 1914. Photo courtesy of the Library of Congress, by Lomex Brothers

Among the *Bear*'s Elite Crew

- Ellsworth P. Bertholf, first commandant of the Coast Guard
- Harry G. Hamlet, superintendent of the Coast Guard Academy and seventh commandant of the Coast Guard
- Francis S. Van Boskerck, composer and lyricist of the official Coast Guard song, *Semper Paratus*

months, the vessel remained on patrol in Alaskan waters. But the war's outcome brought new territories and colonies into the American fold—especially the Philippines, Puerto Rico, and Guam—thus increasing the territorial area of the United States and expanding the geographic responsibility of the Revenue Cutter Service.[9]

In 1915 President Woodrow Wilson signed legislation that merged the RCS and the U.S. Life-Saving Service to create the United States Coast Guard. Two years later the *Bear* came under U.S. Navy control, along with the rest of the Coast Guard, when the United States entered the First World War. As in the Spanish-American War, the *Bear* remained on Alaskan patrol, performing the same missions she had accomplished in peacetime. When the war ended with the November 11, 1918, armistice, the ship and the Coast Guard soon were transferred back to the Treasury Department. After another decade of Arctic maritime duties USCGC *Bear* was decommissioned May 3, 1929, but its story did not end there.[10] Docked in Oakland, California, where it remained until 1932, the *Bear* became a floating maritime museum. It gained another lease on life when U.S. Navy Admiral Richard Byrd, who knew of the *Bear's* Arctic exploits, purchased her for little more than $1,000, however.

Commander Richard E. Byrd in 1905. Photo courtesy of Library of Congress, by Harris & Ewing Collection

With an extensive overhaul complete and a crew of eager volunteers, Byrd got underway for his Second Antarctic Expedition in late 1933 and reached the continent the following January. The party remained there through August 1935. Between 1939 and 1941, Byrd undertook a third Antarctic expedition, though the *Bear* had been repurchased by the U.S. Navy on September 11, 1939, and commissioned USS *Bear* (AG-29). When the United States was thrust into the Second World War, the vessel again was crewed by the Coast Guard and became part of the Greenland Patrol.[11]

In early September 1941, before the United States officially entered the war, the *Bear* joined the cutters *Northland* and *Northstar* on their mission to patrol the waters off the coast of Greenland in anticipation of Nazis establishing weather stations there. All three cutters were under the leadership of Coast Guard Commander Edward G. Smith. Earlier that year, the Danish Ambassador to the United States had authorized America's defense of Greenland—a protectorate of Denmark—even though Denmark already had been conquered by the Nazis.

When the Norwegian sealer *Buskoe* was stopped by the *Northland* on September 12, a boarding officer found the vessel loaded with radio equipment. Interrogation of the crew revealed that a landing party already had been put ashore. While the crew of the *Bear* kept the *Buskoe* and its crew under guard, the landing party was found and captured. Because the United States still was technically a neutral country, the *Bear* escorted the Norwegian crew and its German radio operator to Boston where they were charged as illegal immigrants. After war was declared against the Axis powers in December, the *Bear* remained a part of the Greenland Patrol until November 15, 1943. The antiquated vessel was decommissioned on May 17, 1944, and transferred to the Maritime Commission in 1948, which sold it to a Canadian firm that same year. The firm had intended to convert the vessel back to a sealing ship, but the work was never completed.[12]

Not only did the Canadian company abandon its plans, it also abandoned the *Bear* on a rocky Nova Scotia beach. There, the old, rugged vessel was found by Alfred M. Johnston, a Philadelphia builder, restaurateur, and entrepreneur, who bought the old relic with plans to convert it to a floating museum and restaurant. Ultimately, the ship would be docked on the City of Brotherly Love's waterfront, at Pier 4 South near Chestnut Street. After spending $50,000 for repairs at a shipyard in Dartmouth, Nova Scotia, Johnson contracted the tug *Irving Birch* to tow the historic vessel to its new Delaware River berth.[13] That's when, tragedy—or perhaps serendipity—struck.

On what proved to be its final voyage, the *Bear* and its tugboat were caught in a North Atlantic gale only 90 miles out of Cape Sable, Nova Scotia, and some 260 miles east of Boston. According to a news report in the March 20 edition of the *Philadelphia Daily News,* the historic vessel, though "battered and listing, its foremast snapped like a matchstick, the *Bear* had managed to survive more than 24 hours of fierce buffeting by the stormy Atlantic. It got into trouble Monday night [March 18, 1963] when two [towing] cables snapped …" The next morning, crew men on the two vessels attempted to reattach the towing lines, but to no avail. "But the last sun had risen on the *Bear,*" waxed the news writer. "By gray dawn, the 198-foot vessel had gone down." Fittingly, the last photograph ever taken of the foundering vessel was captured by a crew member of a Coast Guard reconnaissance plane minutes before the *Bear* disappeared beneath the waves.[14] Mike Healy's and Richard Byrd's rugged,

iconic ship was gone at last, its final resting place only vaguely determined by the relatively primitive navigational instruments aboard the *Irving Birch.* Though lost, it would not be forgotten.

Nearly five decades later, researchers at the University of Connecticut showed interest in finding the exact location of the *Bear,* and drafted a preliminary proposal to the National Oceanographic and Atmospheric Administration's (NOAA) Office of Ocean Exploration and Research to conduct a search for the sunken vessel, but the project was not funded.[15] In late spring of 2018, Coast Guard and Coast Guard Auxiliary historians learned the NOAA Research Vessel *Okeanos Explorer* was conducting a mapping expedition and would pass near the site of the *Bear's* watery grave. Auxiliarist Bruce Buckley, spearheading the historians' efforts, reached out to the expedition's research team. The team participated in several conference calls and webinars ahead of the expedition, scheduled to depart Bermuda in August 2018.

"As part of this collaboration, work continues on refining potential search areas using existing data, as well as potentially employing the *Okeanos Explorer* to visit these identified high-probability targets on a 'ship of opportunity' basis, which will certainly advance this knowledge even further," Dr. Brad Barr, director of the NOAA's Maritime Heritage Program, noted in a proposed ASPIRE white paper "Search for the USS *BEAR*." Dr. Barr is with NOAA's Office of National Marine Sanctuaries, Maritime Heritage Program.

On June 22, 2018, during preliminary discussions, Dr. Frank Cantelas, a maritime archaeologist with NOAA's Office of Ocean Exploration and Research in Silver Spring, Maryland, explained the technical procedures to find the *Bear:*

> *I've been working with the expedition team to determine the best survey strategy based on the USCG probability model developed … [which] crosses the continental shelf from shallow to deep water. Since we have a wide range of water depth we have to plan knowing the best depth for finding a target the size of the* Bear *using the ship's sonar.* Okeanos *generally works in water more than 250 meters deep. We can find targets down to several hundred meters, but as water depth increases, sonar resolution decreases. At a certain point, depending on the size of the wreck, we are unable to distinguish it from the background. Based on these factors we are figuring out the best depth range to survey … We will base our surveys on filling data gaps in the probability area and mapping essential habitat important to our Canadian partners. That's where things stand at the moment.*[16]

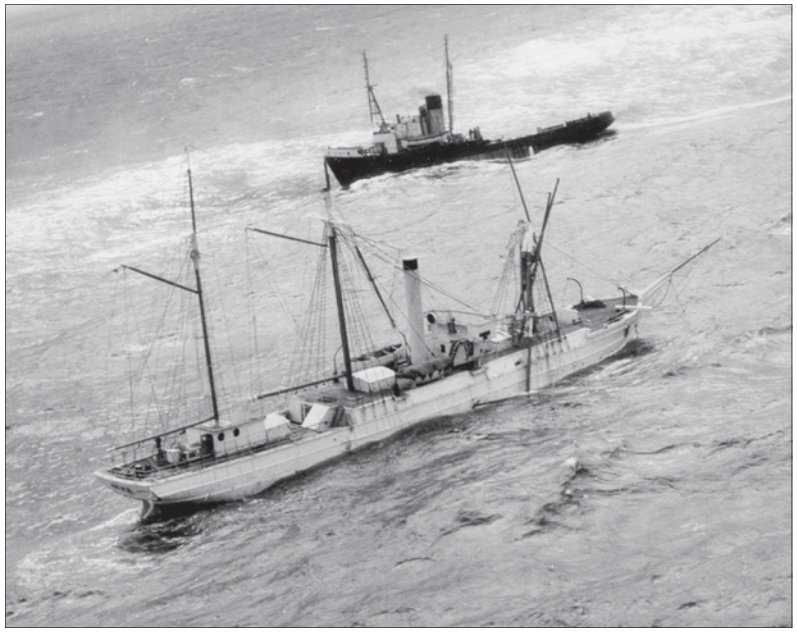
Then, at the last moment, the crew of the *Explorer* learned that the ship's dry dock repairs would take longer than expected, and the expedition would not get underway in 2018.[17] Nevertheless, the quest to find the final resting place of the *Bear* will continue.

After all, the *Bear* is considered the most important ship in the Coast Guard's long history, more so than the famed *Eagle,* or the doomed cutters *Tampa,* lost with all hands during World War I, or *Escanaba,* sunk by enemy action during the Second World War with only two crew members surviving. As homage to the *Bear's* fighting spirit, in 1926 the Coast Guard Academy Corps of Cadets voted unanimously to adopt a symbolic bear as its athletic teams' "fitting mascot, representative of the tenacity and timely aggressiveness of the service."[18]

Recently, Dr. Barr verified both the historical and inspirational significance of locating this important artifact of Coast Guard legend and lore.

"The history of the *Bear* is compelling, and such an exploration would not only offer the opportunity to tell

Appearing very different from its last Greenland visit in 1884, the USS *Bear* returned in 1944. Unlike in 1884, the *Bear* relied on a Coast Guard crew during World War II. As part of the Greenland Patrol, it cruised Greenland's waters and, in October 1941, brought home the German trawler *Buskoe,* the first enemy vessel captured by the U.S. in WWII. Coast Guard photo



The SS *Arctic Bear* with her towline parted and foremast collapsed, begins her final journey down into the sea as the tug *Irving Birch* stands by, helpless to save her. The *Bear* sank at 8:15 p.m., March 19, 1963. Coast Guard photo

these significant stories of the ship's heritage to a wider audience, but the discovery of the final resting place of the *Bear* would empower relevant agencies … to insure the wreck is appropriately protected, preserved, and commemorated," he wrote in the ASPIRE white paper. "With such a meritorious and notable history of service to the United States and the world, the *Bear* deserves no less."[19]

And so, the hunt for the *Bear* continues. A few years ago, an aspiring author posted an ode about the loss of the *Bear* on a website known as "Ghost Stories for Lovers." Her thoughts on the final moments of the iconic ship are an apt denouement both for the sinking of the *Bear* and the conclusion of this article:

> *I imagine her exhaustion. I imagine the familiar rush of waves lapping against her parched skin, reawakening every memory of every youthful adventure with such a flood of overwhelming intensity that the strength of the wind and the salt and the biting northern air that she once drank now aches. Her arthritic timbers swell and throb as they move through the rough ocean. The towline grows taut, too taut, as she struggles to keep pace with the smaller boat. Did she welcome the final gale that snapped it, I wonder, that final push of force that plunged her mast deep into her hull, into her heart, releasing nearly a century's worth of man's insatiable hope from her shattered bones and back into the sea from which he crawled?*
>
> *She didn't take anyone down with her. The two sailors who were with her when it happened shivered and gaped from the rails of the tugboat that rescued them as she slipped further into the black water. Slowly. Silently. As if she were never there….*[20]

About the author:

Mark A. Snell, Ph.D. retired from the Army in 1993 after more than two decades of service. Upon retiring, he became the founding director of the George Tyler Moore Center for the Study of the Civil War at Shepherd University in West Virginia. He was a professor in the history department before retiring in 2013. He has authored or edited 10 books, three pending release. Dr. Snell joined the Coast Guard Auxiliary in 2017 and currently is a member of Flotilla 22-02 of District 5-Southern Region. In March 2018, he was appointed to the Auxiliary National Staff as the Auxiliary History-Liaison Officer to the Coast Guard Historian's Office, Washington, D.C.

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The Coast Guard Auxiliary Interpreter Corps

A valuable asset

by Keith Fawcett
Marine Casualty Investigator
U.S. Coast Guard Investigations National Center of Expertise

With the exceptional capability to translate 48 foreign languages, the Coast Guard Auxiliary Interpreter Corps can be a critical asset during marine casualty investigations.

In October 2015, the U.S. flagged cargo vessel SS *El Faro* sank in Hurricane Joaquin just east of the Bahamas in the Atlantic Ocean with all hands aboard. In this tragedy, five Polish nationals on the *El Faro* perished. As the preliminary investigation unfolded, the commandant's Marine Board of Investigation decided to formally interview one of the Polish crewmembers who had previously served on the ship, but left the day it departed on the accident voyage. The Polish workers, called "ship riders," had been working on the *El Faro* to complete a conversion project to return the ship to a previous cargo configuration. This work required the installation of piping and associated internal equipment.

One of the investigation's goals was to determine the English language skills of the Polish contractors along with the level and detail of the shipboard safety briefings and safety related information that these non-crew members received aboard the *El Faro.* Based on the circumstances of the formal public hearings, the Marine Board made the decision to conduct an interview with the critical Polish witness over the telephone with a video interview during the third formal hearing in February 2017. The hearing took place in a large hearing room in a conference center in Jacksonville, Florida, the homeport for the *El Faro* and a large number of the vessel's crew.

Coast Guard Auxiliarist Ewa Benavides, at the podium, translates questions and answers from Polish to English during a witness testimony in Jacksonville, Florida, on February 15, 2017. The witness, Marek Pupp, a Polish man, worked aboard the SS *El Faro* and provided testimony to the SS *El Faro* Marine Board of Investigation panel. Coast Guard photo by Petty Officer 2nd Class Anthony L. Soto

Prior to the hearing session, the Marine Board investigators worked with the Polish Maritime Administration to arrange for the appearance of the witness. At the same time, the investigators reached out to the Coast Guard Office of Auxiliary and Boating Safety at U.S. Coast Guard Headquarters to locate an Auxiliary interpreter with Polish language skills—written and spoken. On top of these obvious skills, the auxiliarist would need the poise and professionalism to work precisely and effectively in a high profile, media-intense public hearing setting. Auxiliarist Ewa Benavides gladly accepted the mission.

To call this a unique challenge for Ms. Benavides was an understatement. She played a prominent role in the web-streamed public testimony of a critical, transatlantic, non-English speaking witness. Initially, Ms. Benavides was to serve as a contingency backup in case the hearings had technical issues with the video link or communications equipment. Nonetheless, as soon as she accepted the mission, she took it upon herself to prepare for the challenge, preparing a comprehensive briefing book replete with relevant nautical terminology for the ship's cargo operations. She also familiarized herself with the details of this complex investigation digesting dates, people, charts, ship characteristics, and a thousand other details that might come up should she be called upon.

The original plan was to have a member of the Polish Maritime Authority sitting with the witness in Gdansk, Poland translate the video and audio testimony. However, things do

not always work out as planned, validating the need for contingency plans.

On February 15, 2017, after the unique witness interview procedures were explained, the interview began. Shortly after the first question, one of the attorneys—representing the steamship company—objected to the translation provided by the government representative in Poland. The objection was sustained.

In this moment, the capabilities and dedication of the Coast Guard Auxiliary Interpreter Corps became the most critical asset in the room. The Marine Board looked to Ms. Benavides who translated every word of the complex, technical questions and responses clearly, and without bias. To ensure the attorneys representing the parties to the investigation were satisfied, a Polish-speaking attorney representing the SS *El Faro's* operating company validated the testimony and answers, ensuring all parties were satisfied with the translation of this important testimony.

Ms. Benavides' service allowed for a thorough examination of this critical witness' safety-related testimony which, was a key component of certain safety related facts, conclusions and critical safety recommendations contained in the Marine Board's Report of Investigation. Standing there at the podium in a well-attended hearing with the witness on the video screen while interpreting "on the fly" is not an easy task. At the conclusion of this transatlantic video testimony, a recess was called before the next witness was called. As her participation concluded, Ms. Benavides was pleased to have completed this highly technical translation in support of the marine casualty investigation, which was especially tragic for the Polish riding crew that did not have full command of the English language.

Captain Jason Neubauer, chairman of the Marine Board, met with Ms. Benavides to thank her for the critical assistance she provided the *El Faro* investigation team. With a fleeting handshake, he passed a token of his esteem for her unique contribution to the investigation—a challenge coin from the Coast Guard's Office of Investigations and Analysis.

Ms. Benavides' willingness to assist this crucial investigation is one of many examples of the Coast Guard Auxiliary assisting in the Coast Guard's marine safety mission.

About the author:
Keith Fawcett is the winner of the Coast Guard's 2015 Sener Award for excellence in marine casualty investigations. A Coast Guard civilian investigator, he is a licensed merchant mariner and worked in the marine industry for more than 20 years, primarily in Gulf of Mexico operations. He has conducted high profile, complex marine casualty investigations for the Coast Guard, specifically focusing on human factors, bridge resource management, and marine operations. He is a member of the staff at the USCG Investigations National Center of Expertise.

In spring 2015, halfway around the world from the shores of Florida, a Taiwanese-registered 125-foot line fishing vessel—Commercial Fishing Vessel *Sea Hawk 68*—grounded on a reef offshore of the International airport in Pago Pago, American Samoa. The 22 members of the crew abandoned the ship into the breaking surf, eventually making it to shore safety.

The Coast Guard determined there would be a marine casualty investigation while the National Transportation Safety Board conducted an independent investigation. The Coast Guard Marine Safety Detachment in Pago Pago is a small unit, thus the lead investigator from the Investigations National Center of Expertise in New Orleans was assigned to support the investigation. When the Coast Guard's investigation team assembled in American Samoa, it discovered a major issue—20 of the crew on the *Sea Hawk 68* were Indonesian and the captain and chief engineer Taiwanese. Each only spoke their native languages.

Even before the investigation team assembled in American Samoa, the director of Auxiliary in Coast Guard District 14 reached out to identify Coast Guard Auxiliary language specialists to assist the investigation. They were identified before the lead investigators departure for the accident site.

After an in-person assessment of the grounding off the shore of Pago Pago, the *Sea Hawk 68's* captain, chief engineer, and six key Indonesian witnesses from the crew were interviewed. These interviews were not as simple as one would think. Beside the need to connect witnesses in Pago Pago telephonically with the interpreters in San Francisco and coastal Alabama, there were unique cultural issues the investigation team faced. Looking at the critical interviews with the *Sea Hawk* captain and chief engineer, auxiliarist Jimmin Chang prepared the team with a briefing on issues associated with understanding social context. Mr. Chang provided "on the fly" translation while examining and translating Chinese language documents from the stranded vessel. This allowed the investigators to gather the facts needed to analyze the incident from the standpoint of the vessel's decision makers, the captain and the chief engineer.

What about the Indonesian crew who stood the watches alone the night before the accident while the captain slept? Did the Indonesian crew members understand their duties? Could they communicate with the Chinese-speaking captain? Were the 20 members of the Indonesian crew briefed on their life jackets, life rafts, and

Auxiliary Translators Assist with Pago Pago Grounding Investigation

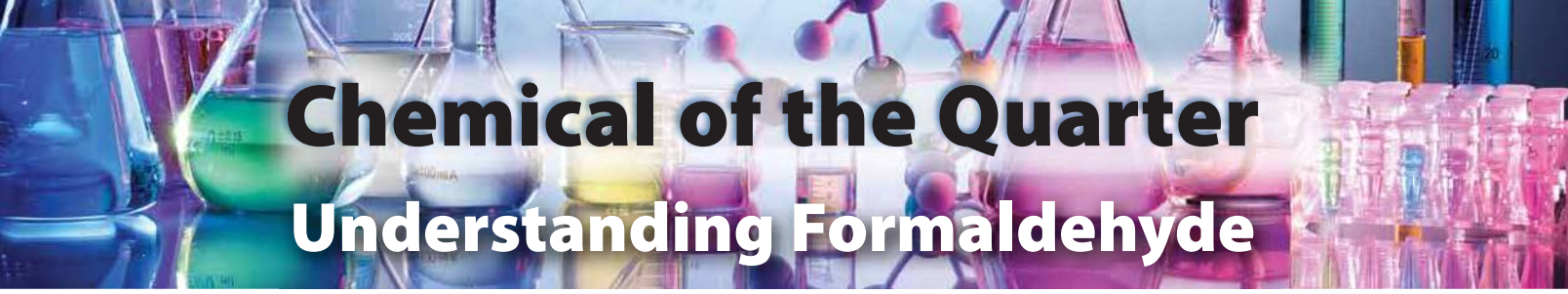
other critical operational and safety considerations aboard the *Sea Hawk 68*?

To answer these questions, Morley and Rebecca Mason, both Coast Guard Auxiliary Interpreters, stepped up to assist. Having spent time in Indonesia as a missionary couple, they were well-versed in Indonesia's customs and traditions. Halfway around the world, six interviews were scheduled and the Masons patiently and precisely carried out their translation for identified witnesses. With their unique immersion in the Indonesian culture they were able to assist the investigators in these critical interviews that validated and explained what happened on the fateful pre-dawn grounding. These critical interviews were recorded and annotated with notes. This evidence would become the foundation for the written English transcripts used to support the investigation. The Masons' exceptional translation services supported both the Coast Guard and the National Transportation Safety Board investigation reports that contributed to prevention strategies to reduce the likelihood of a similar accident occurring.

— Keith Fawcett

Left: Coast Guard Auxiliarist Jimmin Chang provides translation for the Coast Guard investigation of the grounding of F/V *Seahawk 68* off the shore of Pago Pago, American Samoa in 2015. Coast Guard photo

Below: F/V *Seahawk 68* grounded on the reef just outside of American Samoa on May 22, 2015. Coast Guard photo



Chemical of the Quarter

Understanding Formaldehyde

by Ms. Hillary Sadoff
Hazardous Materials Division
U.S. Coast Guard Office of Design and Engineering Standards

What is it?

Formaldehyde (CH_2O or H_2CO) is commonly thought of as a preserving solution like that used in high school biology lab. However, formaldehyde is found in a wide range of items including common household products, building materials, or even tobacco smoke. Shampoos, soaps, cleaning supplies, spackle, caulk, and even products like hair dye and make-up contain formaldehyde. The most common use in the United States is in manufacturing resins, which are used in particleboard production. Outside of manufacturing or common products, formaldehyde is also formed naturally when there is incomplete combustion of hydrocarbons or during methanol oxidation. Formaldehyde solutions, also known as formalin, are colorless, pungent compounds that are readily soluble in water and can be stabilized with methanol. The Occupational Safety and Health Administration (OSHA) regulates exposure to formaldehyde.

How is it shipped?

Formaldehyde is shipped under two different United Nation (UN) numbers: 1) UN1198 Formaldehyde Solution, Flammable and 2) UN2209 Formaldehyde Solution with not less than 25 percent formaldehyde. UN1198 is a class 3 flammable liquid with a subsidiary corrosive hazard and UN2209 is only a class 3 corrosive. Neither version is considered a marine pollutant and can be shipped in limited quantities. Formaldehyde can be transported by truck, train, plane, barge, or ship provided it is transported according to the applicable regulations. Formaldehyde solution—45 percent or less—can also be shipped in bulk in chemical carriers by following requirements set out in the International Code for the Construction and Equipment of Ships Carrying Dangerous Chemicals in Bulk, or IBC Code.

Why should I care?

➤ *Health Concerns:*

Formaldehyde's strong smelling, colorless vapors are heavier than air. It is a sensitizing agent and OSHA considers it a potential cancer hazard. The major routes of exposure to formaldehyde include inhalation and dermal exposure risk. Upon initial exposure, it can cause an immune system response such as coughing and wheezing. It is irritating to the eyes, nose, and throat. Long-term low level exposure causes respiratory problems and skin irritation. Formaldehyde is fatal if ingested. The immediate danger to life and health exposure level is 100 ppm (OSHA) or 20 ppm (National Institute for Occupational Safety and Health). Implementation of feasible engineering and work practice controls to reduce and maintain worker exposure to formaldehyde is the most used personal protection, however, when that is not feasible, respirators should be worn. Other personal protective equipment includes impervious clothing, gloves, aprons, and chemical splash goggles. Because of the health risks, formaldehyde is stored away from living quarters on vessels.

➤ *Fire or explosion concerns?*

This material is stable at room temperature and atmospheric pressure but shipping containers can explode if the material is heated. The toxic vapors from an explosion include carbon dioxide and carbon monoxide.

What is the Coast Guard doing about it?

The Coast Guard enforces maritime transportation requirements for hazardous materials such as formaldehyde. Regulations found in 49 CFR Subchapter C are in place to minimize the risk associated with transporting packaged hazardous materials. These regulations set requirements for marking, labeling, and transporting of the material in packaged form. The regulations found in 46 CFR Subchapter O include safety requirements for transporting this chemical in bulk by barge or ship.

Additionally, the Coast Guard operates the National Response Center, the sole federal point of contact for reporting chemical spills. In the event of a spill or emergency with formaldehyde, call (800)424-8802.

About the author:
Ms. Hillary Sadoff is a chemical engineer in the Hazardous Materials Division in the Office of Design and Engineering Standards with the United States Coast Guard. Her primary responsibilities are in the areas of packaged hazardous materials shipments by water. She serves as the Coast Guard subject matter expert for rulemaking projects harmonizing international and domestic packaged hazardous materials regulations. She earned her B.S. and M.Eng. in Chemical Engineering at University of Maryland, College Park and a Graduate Certificate in Project Management from Boston University.

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Nautical Engineering Queries

Questions

Prepared by NMC Engineering Examination Team

1. Beside voltage regulation, what is a function of the voltage regulators used with AC generators?

A. To cut out generators when they are no longer required.
B. To cut in additional generators automatically as required.
C. To divide the kW load equally between generators operating in parallel.
D. To divide the kVAR load equally between generators operating in parallel.

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2. Some fluid filters used in hydraulic systems are designed to cope with increasing pressure differentials by _____.

A. diverting the flow automatically to the stand-by filter of the duplex unit.
B. automatically bypassing the fluid via an internal valve arrangement.
C. automatically securing the system.
D. diverting the pump discharge directly back to the suction.

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3. The degree of fuel atomization in a diesel engine cylinder depends primarily on _____.

A. the size of the holes in the fuel nozzle.
B. timing of the pump.
C. supply pressure to the pump.
D. shape of the combustion chamber.

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4. The flammable limits of kerosene are 0.7% to 6.0% by volume in air. The combustible gas indicator reading is 50% of the lower explosive level. The flammable vapor concentration at the sample point is _____.

A. too rich to burn
B. 0.35%
C. 2.65%
D. in the flammable range

Engineering Answers

1. *Note: When an AC generator is connected to the bus for single-generator operation, the voltage regulator functions solely to control the generator output voltage. When operating generators in parallel, the voltage regulators also function to divide and transfer reactive power between the parallel-connected generators.*

A. To cut out generators when they are no longer required.	Incorrect.
B. To cut in additional generators automatically as required.	Incorrect.
C. To divide the kW load equally between generators operating in parallel.	Incorrect.
D. To divide the kVAR load equally between generators operating in parallel.	**Correct answer.** To establish equal generator power factors, the kVAR load is equally divided by the action of the generator voltage regulator voltage settings. Reference: *Modern Marine Engineer's Manual-Volume II,* Hunt.

2.

A. diverting the flow automatically to the stand-by filter of the duplex unit.	Incorrect.
B. automatically bypassing the fluid via an internal valve arrangement.	**Correct answer.** In hydraulic system applications, coping with increasing pressure differentials across a filter is commonly dealt with by the action of an internal bypass relief valve, which senses the pressure differential across the filter element and opens when the differential reaches a certain value, thereby maintaining critical rated fluid flow at rated pressure to the hydraulic actuator.
C. automatically securing the system.	Incorrect.
D. diverting the pump discharge directly back to the suction.	Incorrect.

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3. *Note: The degree of atomization of fuel entering a diesel engine cylinder is a function of the diameter and shape of the nozzle orifices, injection pressure, and the density of the air charge in the combustion chamber.*

A. the size of the holes in the fuel nozzle.	**Correct answer.** The diameter of the fuel injector nozzle orifices is a critical factor influencing the degree of fuel atomization. With all other factors remaining unchanged, the smaller the diameter of the orifices, the greater the degree of fuel atomization.
B. timing of the pump.	Incorrect.
C. supply pressure to the pump.	Incorrect.
D. shape of the combustion chamber.	Incorrect.

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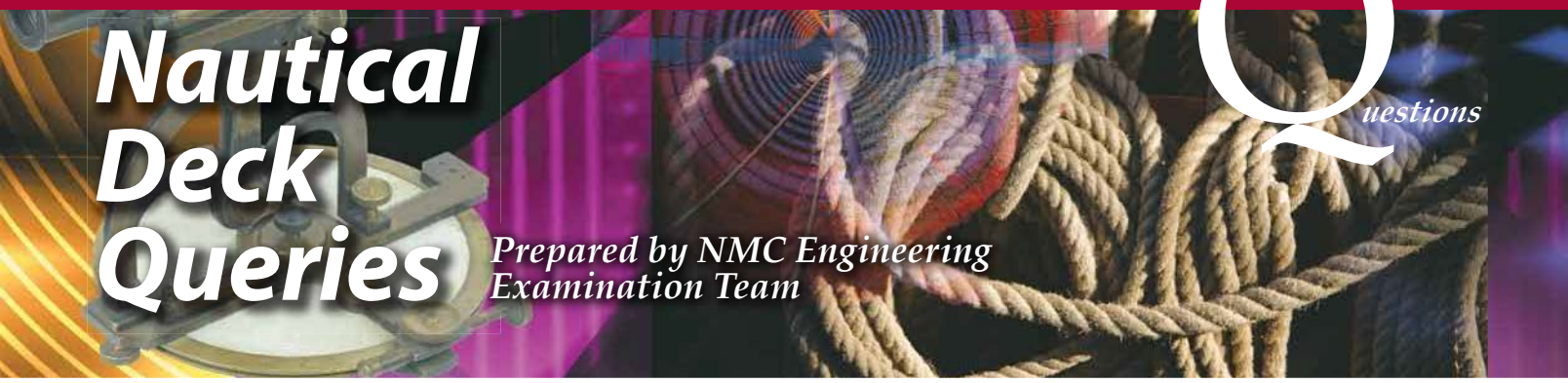
4. *Note: If the flammable limits of kerosene are 0.7% to 6.0% by volume in air, this means that the lower explosive limit (LEL) for kerosene is 0.7% and the upper explosive limit (UEL) is 6.0%. The combustible gas indicator (CGI) reading is given as a percentage of the LEL.*

A. too rich to burn	Incorrect.
B. 0.35%	**Correct answer.** See *Note* on previous page. LEL x CGI = 0.7 x 0.5 = 0.35%
C. 2.65%	Incorrect.
D. in the flammable range	Incorrect.



Nautical Deck Queries

Questions

Prepared by NMC Engineering Examination Team

1. Both international and inland: A fog signal of one short, one prolonged, and one short blast may be sounded by which vessel?

A. A vessel at anchor
B. A vessel not under command
C. A vessel towing
D. All of the above

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2. Galvanizing would be suitable for protecting wire rope. Which wire would normally be galvanized?

A. Cargo runners
B. Mast stays
C. Topping lifts
D. All of the above

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3. What shall be conducted during a fire and boat drill?

A. All watertight doors in the vicinity of the drill shall be operated.
B. All lifeboat equipment shall be examined.
C. Fire pumps shall be started and all exterior outlets opened.
D. All of the above.

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4. According to Buys Ballot's law, when an observer in the Northern Hemisphere experiences a northwest wind, where is the center of low pressure located?

A. Northeast of the observer
B. West-southwest of the observer
C. Northwest of the observer
D. South-southeast of the observer

1. A. A vessel at anchor — **Correct answer.** In accordance with 33 CFR 83.35(g), *"A vessel at anchor shall at intervals of not more than one minute ring the bell rapidly for about 5 seconds. In a vessel of 100 meters or more in length the bell shall be sounded in the forepart of the vessel and immediately after the ringing of the bell the gong shall be sounded rapidly for about 5 seconds in the after part of the vessel. A vessel at anchor may in addition sound three blasts in succession, namely one short, one prolonged and one short blast, to give warning of her position and of the possibility of collision to an approaching vessel."*

B. A vessel not under command — Incorrect.

C. A vessel towing — Incorrect.

D. All of the above — Incorrect.

References: Navigation Rules and Regulations Handbook-August 2014.
33 CFR 83.35 (Rule 35) (g)

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2. A. Cargo runners — Incorrect.

B. Mast stays — **Correct answer.** Galvanized wire is generally used for standing rigging or towing hawsers because it will lose its zinc coating if constantly run through blocks.

C. Topping lifts — Incorrect.

D. All of the above — Incorrect.

Reference: *American Merchant Seaman's Manual, 7th Edition*, Hayler.

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3. A. All watertight doors in the vicinity of the drill shall be operated. — **Correct answer.** In accordance with 46 CFR 199.180(f)(2)(v), *"Each fire drill must include—Checking the operation of watertight doors, fire doors, fire dampers, and main inlets and outlets of ventilation systems in the drill area."*

B. All lifeboat equipment shall be examined. — Incorrect.

C. Fire pumps shall be started and all exterior outlets opened. — Incorrect.

D. All of the above. — Incorrect.

Reference: 46 CFR 199.180(f)(2)(v)

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4. A. Northeast of the observer — **Correct answer.** In the northern hemisphere an observer whose back is to the wind has the low pressure system on the left varying from 90 to 135 degrees from straight ahead.

B. West-southwest of the observer — Incorrect.

C. Northwest of the observer — Incorrect.

D. South-southeast of the observer — Incorrect.

Reference: *The American Practical Navigator, 2002 Edition*

In the News: Coast Guard Rescues Ice Fisherman

Coast Guard Station Sturgeon Bay SPC-AIR responds to seven fishermen stranded on the ice in a fishing shanty near Sturgeon Bay, Wisconsin, on January 29, 2019. The fishermen were unable to make it back to shore due to inclement weather and difficulties with their vehicle. Coast Guard photo by Petty Officer 2nd Class Garrit Speckhard

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