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# PATHFINDER

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SERVING THE FRONT LINE

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## CHARTING THE SEA AND SKY

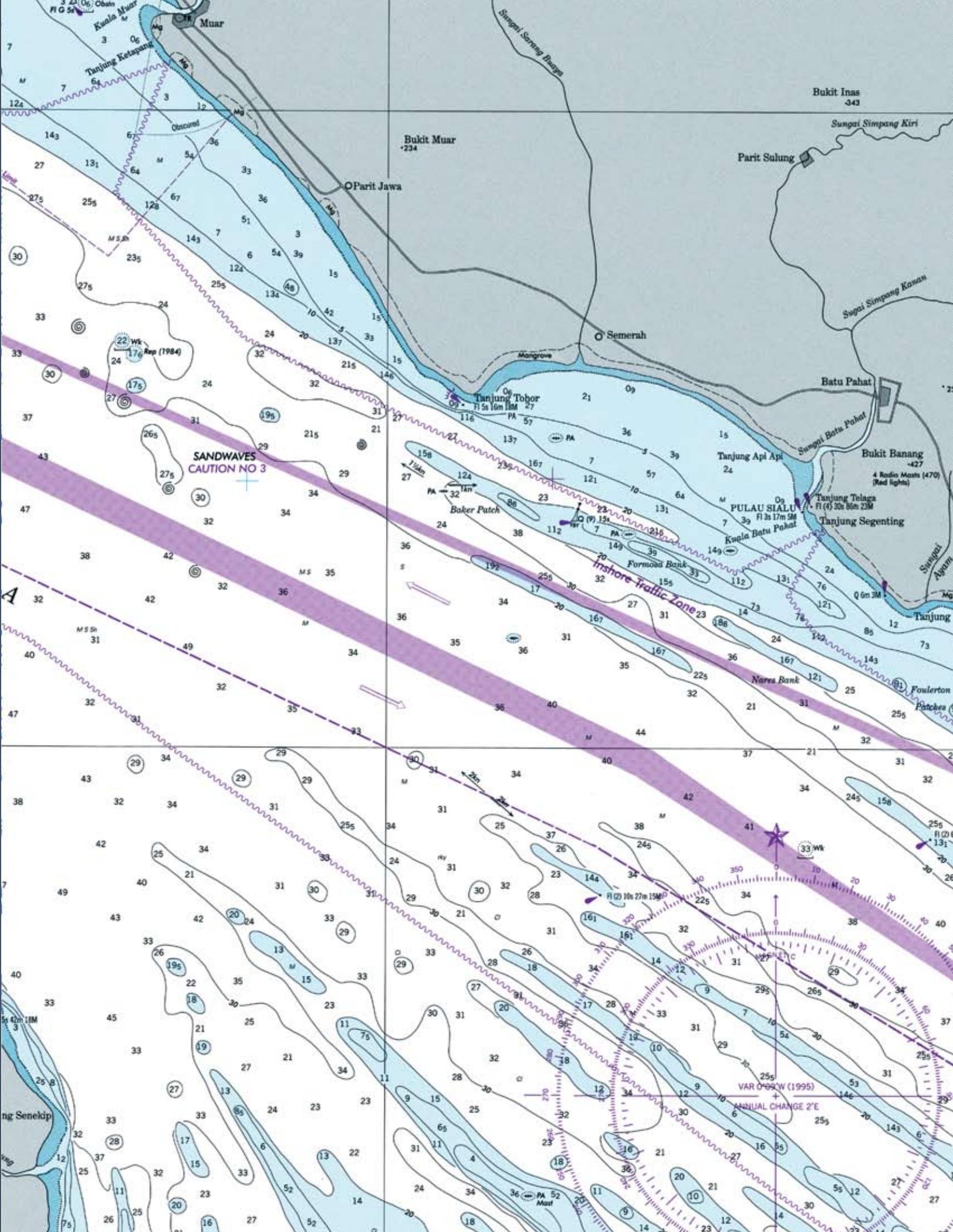
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## ON MY MIND

# Enabling the Aviator and the Mariner to Navigate Safely

NGA's marine analysts, aeronautical analysts, regional analysts, imagery analysts, geospatial analysts, visual information specialists and nautical cartographers have a vital mission: safety of navigation on the world's waterways and in its airspace. They protect mariners and aviators, and the people, equipment and cargo entrusted to them.

### Navigating the World's Waterways

The U.S. Navy and mariners around the world depend on our charts and hydrographic products. For example, NGA's Worldwide Navigational Warning Service, our 24/7 watch operation, monitors the world's maritime broadcasts and transmits urgent notifications to mariners, often within minutes of receipt. These critical, time-sensitive warnings alert mariners to such events as missile launches, tsunamis and military exercises.

Technology has also accelerated support for maritime missions: our Digital Nautical Chart (DNC®) is the only complete global digital chart set in the world. The DNC®, updated every 28 days, aggregates hydrographic and bathymetric data along with information about harbor and port facilities, imagery, surveys and user feedback. The DNC® is available via CD and the World Wide Web.

To support our mission partners in an even more timely manner, the Enterprise Product on Demand Service (EPODS) has accelerated the speed with which NGA delivers tailored navigational data. EPODS converts existing DNC® data into printable files that can be e-mailed to sailors where needed and then printed on location. Now hardcopy charts can be created and delivered in days instead of months.

During the crisis in Georgia in 2008, NGA used EPODS to expedite hardcopy charts to relief vessels delivering emergency supplies to desperate civilians. EPODS helped make history yet again when the aircraft carrier USS Dwight D. Eisenhower docked pierside at the Port of Mina Salman, Bahrain, in May 2009, the first time a carrier has done so in more than 60 years.

Previously, when operating in this area, U.S. Navy carriers had to anchor miles offshore. To address this problem, Bahrain built a new pier facility large enough to support a carrier. In February 2009, facing the scheduled visit of the USS Eisenhower, U.S. Naval Forces Central Command (NAVCENT) asked NGA for a new chart for navigation to the pier. NAVCENT needed the chart by April 1. Thanks to EPODS, NGA completed the new chart a week before it was needed, allowing the USS Eisenhower to moor safely alongside the new pier.

### Getting the Aviator There and Back

U.S. military aviators use NGA digital and hardcopy aeronautical charts and publications to move troops and supplies and to support humanitarian, combat and training operations anywhere in the world. In response to a short-turnaround request, NGA has created Instrument Approach Procedures that are used to support pilots providing close air support to ground troops in Afghanistan.

NGA's aeronautical charts, publications and digital navigation data are in such demand largely because of the people who create them. Many members of our aeronautical team bring a perspective informed by decades of experience as air traffic controllers, navigators, or civilian or military pilots. They, like their colleagues across NGA, bring a commitment and dedication to ensuring that we provide the highest quality geospatial intelligence (GEOINT) support to the mission.

### Getting the Job Done

Our mission partners, along with aviators and sailors everywhere, count on NGA analysts to provide them with the intelligence, data and information to navigate safely in the air and on the seas. The analysts and cartographers in NGA's Office of Global Navigation do their work day in, day out so that the people who fly the planes and sail the ships can do their work safely with the assurance that they have the best, most reliable, most up-to-date information and data to guide them during their missions.

NGA's global navigation mission offers yet one more example of how we collaborate—using our GEOINT expertise—to support the nation.

**ROBERT B. MURRETT**  
Vice Admiral, USN  
Director

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## ON THE COVER

A compass—the universal symbol of the navigator’s craft—guides mariners and aviators safely along an orderly course. For centuries, no serious pilot of sea or air has chosen to forego its direction. Similarly, modern sailors and airmen rely on NGA for quality geospatial intelligence to chart their courses accurately. From the poles to the skies to the deep sea, the agency plays a leading role developing charts, detecting hazards and increasing the safety of navigation for the global community. The agency’s aeronautical and maritime missions save lives and benefit all who fly or sail. Cover design by Anika McMillon.

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## More to the Story?

The online Classified Pathfinder, which is accessible by members of the Intelligence Community, may include additional information and expanded sections of some Pathfinder articles. The Classified Pathfinder provides a forum for reading and discussing topics at the level of “Unclassified//For Official Use Only” or higher. For information please contact the Classified Pathfinder editor, Heather Cox, at (301) 227-2290.



## LETTER TO OUR READERS

# Charting the Sea and Sky

NGA contributes enormously to the safety of navigation worldwide—military and civilian. The agency’s maritime and aeronautical roles encompass all facets of charting and related tradecrafts. Its international responsibilities place it among global leaders in these fields. No one travels by ship or plane who isn’t served by the navigational efforts of this agency.

The agency’s aeronautical and maritime missions range widely, as topics in this issue make clear. Operation Deep Freeze, which supplies Antarctic bases, receives its lifeblood from airlifts aided by NGA in an ongoing relationship with the scientific community.

Likewise, NGA’s partnership with the U.S. Air Force demonstrates its constant refinement of the Global Positioning System (GPS). The omnipresent GPS testifies to the reach of geospatial intelligence (GEOINT).

Always looking forward, the agency continues to improve the face of its aeronautical services, expanding its digital offerings in the wake of Sept. 11. Paralleling these advances, digital improvements in maritime navigation enable safer sailing.

NGA resources recently contributed to a notable milestone—the visit of the King of Bahrain to the aircraft carrier USS Dwight D. Eisenhower during a spring call to the Persian Gulf state. Whether transiting ocean or sky, reducing and eliminating hazards to navigation remain critical challenges that the agency meets around the world. Through NGA’s efforts, vertical obstructions and underwater “Red Dots” all pose fewer risks.

The aeronautical and maritime professionals who deliver these services and their associated products require specialized skills and experience. Two articles describe these careers. Building on the legacy of pioneers such as Mary Sears, these agency personnel drive the development of the GEOINT that sustains international navigation of both the water and the air.

Mariners and flight crews will continue to rely on NGA for the best resources available. NGA’s maritime and aeronautical commitments are truly global. NGA’s humanitarian efforts represent a similar international outreach. The November/December issue of Pathfinder will note NGA’s GEOINT response to disasters and crises.



**JENNIFER A.K. DANIEL**

Director, Office of Corporate Communications

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#### GETTING PUBLISHED

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UP FRONT

## NGA Director Addresses National Defense Intelligence College Graduates

BY MICHAEL R.

NGA Director Vice Adm. Robert B. Murrett offered the commencement address at graduation ceremonies for the National Defense Intelligence College (NDIC) on Friday, July 24, at Bolling Air Force Base in Washington, D.C. The 2009 graduating class included seven NGA personnel. The college awarded 282 Master of Science of Strategic Intelligence degrees and another 21 Bachelor of Science in Intelligence degrees. More than 700 students and guests attended the event, including former NGA Director and Undersecretary of Defense for Intelligence retired Air Force Lt. Gen. James R. Clapper Jr.

Murrett addressed changes in the Intelligence Community (IC) to the new graduates. “A key lesson from reviewing these threats is that the IC and DOD [Department of Defense] need to improve our traditional ways of thinking and operating, maintain open minds, and be innovative in identifying possible threats to our national security,” he said. “We will be looking to you graduates to lead by example in collaboration, communication and cooperation.”

Murrett finished with a call to action saying, “I urge each of you to be Community players.” He continued, “Throughout this program you have built a network of colleagues from across the Community, folks you may not have otherwise had the opportunity to know. Use this network and reach out for different perspectives, for different viewpoints, for a more complete picture.”

Upon concluding his remarks, Murrett, a 1983 graduate of the college, received an honorary Doctorate in Strategic Intelligence from NDIC President A. Denis Clift, Provost Susan M. Studds and Defense Intelligence Agency Director Army Lt. Gen. Ronald Burgess.

NDIC is a dynamic learning community with a diverse student body of over 700, representing a mixture of experience in federal agencies and all branches of the U.S. armed services. All students must be employed in the federal government and hold security clearances. Chartered by DOD in 1962, the college has served as a leading institution for intelligence education and research. ■

Michael R. is a public affairs officer in the Office of Corporate Communications.

Photo by Getty Images

UP FRONT

## Empire Challenge 2009 Promotes Joint Military Operations

BY KAREN Y.

Now in its sixth year, the Empire Challenge intelligence, surveillance and reconnaissance (ISR) interoperability demonstration develops and integrates joint, interagency and multinational capabilities to meet the present and future operational needs of U.S. military forces and their partners. The exercise allows participants to evaluate technologies that support combined task forces in an operationally realistic, “live-fly” environment to provide solutions and ensure success in the field. NGA has been involved with Empire Challenge since it began.

Empire Challenge 2009 (EC09) achieved its goal of providing capabilities that meet warfighters’ challenges such as those identified by combatant commanders, national agencies and coalition partners. For EC09, NGA focused on setting up effective networks to ensure that analysts and warfighters receive data from full-

motion video sensors, in standard and high definition, to provide precision collection and intelligence at all levels—advantages that will allow more accurate analysis. In addition, NGA is working with others to experiment with new technologies such as third-generation cellular networks and a sensor web to ensure that all sensors in the field, whether air, water or ground, communicate with each other.

NGA’s contributions ensure that Empire Challenge will continue to advance the interoperability of military operations. The NGA lead for the exercise stated, “EC09 is an essential ISR event that improves interoperability of sensors, processors and weapons to ensure that they work together properly in theater. Doing this before the systems deploy allows the joint force to be better in our fight.” P

*Karen Y. is a public affairs officer in the Office of Corporate Communications.*

UP FRONT

## NGA Historian Addresses Piracy at Maritime Conference

Dr. Gary Weir, NGA chief historian, addressed the international Maritime Capacity Building Conference held June 16–17 at Mississippi State University. Organized by the university’s Radvanyi Center for International Security and Strategic Studies, the event highlighted the efforts of the United States, Japan, Australia and other major maritime nations. Additional sponsors included the Center for U.S.–Japan Studies and Cooperation at Vanderbilt University; the Okazaki Institute, based in Tokyo, Japan; the Institute of Southeast Asian Studies in Singapore; and the Australian National Centre for Ocean Resources and Security.

As part of its maritime mission, NGA produces nautical charts, issues U.S. Notice to Mariners, and coordinates the Worldwide Navigational Warning Service, which alerts mariners to navigational safety and piracy concerns. Weir, who documents NGA’s role within the context of world events, offered his perspective on addressing the complex problem of piracy.

On June 16, Weir discussed NGA and its geospatial mission and presented “The Dilemma of Piracy in the Horn of Africa, 2009.” Weir outlined the history of

piracy in Somalia, drawing on his work developing a recent exhibit on piracy for NGA’s museum in St. Louis. Weir concluded that the solution to piracy “would come from a blend of international influences, combined naval forces, and support from those engaging in regional commerce, but most of all from onshore local solutions and the restoration of a local economy in some degree of harmony with international interests.” He emphasized the need to restore the Somali fishing industry, so important to the poorest of that country, to lay the groundwork for the return of law, order and good governance to the Horn of Africa region.

In addition to Dr. Weir, featured speakers included retired Adm. Thomas B. Fargo, former commander of the U.S. Pacific Command; retired Japanese Rear Adm. Sumihiko Kawamura, vice president of the Okazaki Institute; and retired Filipino Vice Adm. Eduardo Ma R. Santos, president of the Maritime Academy of Asia and the Pacific, headquartered in Mariveles, Bataan, Philippines. Representatives from India, Indonesia, Malaysia, Singapore and South Korea also attended the conference. P



## AERONAUTICAL FEATURES

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## AERONAUTICAL

# GPS Reliability Depends on Air Force and NGA

BY DAVE C.

For drivers who dislike asking for directions, talking Global Positioning System (GPS) receivers in automobiles have become a welcome substitute for paper road maps. Today everything geospatially oriented relies on GPS. Originally designed almost 30 years ago as an all-weather, space-based navigation system with the primary purpose of enhancing the effectiveness of U.S. and allied military forces, GPS has revolutionized not only military navigation but commercial transportation, mapping and surveying. Nowadays GPS is even transforming international air traffic management, scientific research and precise timing for synchronization of financial institutions and cellular networks.

Because accurate positions are required for all geospatial intelligence (GEOINT), NGA has been a part of the GPS program since it was conceived, focusing on the system's accuracy and precise positioning. NGA's role in maintaining and improving GPS accuracy starts with providing the standard reference frame for GPS, the World Geodetic System 1984 (WGS 84), which was developed in partnership with the Department of Defense (DOD). A mathematical representation of the Earth's shape, WGS 84 provides a 3-D coordinate system and a gravity model that are essential for computing GPS satellite orbits and precise GPS-derived locations on, above or below the surface of the Earth.

As a GPS user, NGA uses sophisticated receivers to track GPS satellites and generate geographic positions for GEOINT products. From a constellation orbiting the Earth, the Air Force-operated GPS satellites broadcast signals that are sensed by users' GPS receivers. Locking onto several GPS satellite signals, the receivers multiply the signals' travel times by the speed of light to compute the distance from each satellite, resulting in accurate real-time positions. Therefore, precise time measurements are required for accuracy.

From the GPS Master Control Station (MCS) at Schriever Air Force Base, Colo., the Air Force exercises 24/7 command and control of the GPS satellite constellation, regulating the clocks and orbits of the satellites. Six Air

Force monitor stations keep watch over the satellites. NGA operates another 10 stations that also monitor the system. In NGA's GPS Division in St. Louis, orbit analysts operate the 24/7 GPS Monitor Station Network Control Center (MSNCC), monitoring station performance and real-time GPS data flow from NGA's globally dispersed network of GPS tracking stations. Additionally, orbit analysts provide around-the-clock integrity monitoring of the GPS satellites and are able to immediately report any anomalies to the Air Force GPS MCS.

Today the WGS 84 coordinate system is defined by the 3-D coordinates established by the combination of the Air Force and NGA satellite tracking stations. NGA periodically recomputes the positions of both the NGA and the Air Force tracking stations as part of efforts to maintain WGS 84 and improve the accuracy of the station positions. During the most recent update of the network, NGA computed station positions to approximately 1 centimeter accuracy. The more



Graphic by The University of Texas at Austin, Applied Research Laboratories.

accurately NGA knows the stations' positions, the more accurately NGA can determine the GPS satellite positions.

Many GPS accuracy enhancements can be traced to 1995, when the GPS Joint Program Office, which led the entire GPS program, formed a team of DOD representatives to identify potential GPS performance improvements. The team recommended adding data from NGA's GPS monitor stations to the data from the Air Force tracking network. The Air Force would use the NGA GPS tracking data for monitoring the radio signal used for GPS transmissions, as well as for monitoring and creating GPS orbit predictions to be uploaded to the satellites.

In 2005, real-time tracking data from the NGA monitor stations was added to similar data from the Air Force stations for processing in the MCS Kalman filter, a mathematical technique that provides estimated satellite clock and ephemeris (orbit) information for keeping satellites updated and broadcasting accurate signals.

Including the NGA tracking data has also resulted in the ability to monitor the quality of the GPS signal and the integrity of the constellation 100 percent of the time.

For more than 20 years, the GPS constellation operated with only the six Air Force monitor stations, which did not provide complete global coverage of the satellite constellation, leaving almost 4 percent of the GPS satellites' orbit paths completely unmonitored. Furthermore, almost a third of the orbit paths were monitored by only one station at a time, risking increased periods of unmonitored satellites if any one monitor station were lost. If a satellite were to become unhealthy during an unmonitored period, GPS users could be adversely affected. The addition of real-time tracking data from NGA's monitor stations has eliminated all unmonitored areas, and currently, on average, GPS satellites are seen by more than four monitor stations simultaneously. Furthermore, improved navigation uploads contain better prediction data as a result of the increased number of measurements entered into the MCS Kalman filter, resulting in more accurate GPS positioning.

GPS has been integrated into the very fabric of the modern world. More than 1 billion people have come to rely on the precise timing and navigation signal that is as responsible for dropping weapons with precision as it is for guiding civilians safely through their daily journeys. NGA continues to contribute to improving GPS performance while creating GEOINT that provides situational awareness for making national security decisions and supporting defense and homeland security operations. The growing demand for real-time positioning has generated a U.S. commercial GPS equipment and service industry that leads the world. As people develop new applications for GPS in the years ahead, NGA's continued partnership with the Air Force will ensure GPS accuracy, integrity and reliability. ▢

*Dave C. is an NGA liaison to the GPS Master Control Station at Schriever Air Force Base, Colo.*



## AERONAUTICAL

# Agency Aids Operation Deep Freeze Antarctic Airlifts

BY GREGORY G.

Just the name, Operation Deep Freeze, conjures up images of frigid conditions that, in this case, tend to match reality. This U.S. military mission provides operational and logistical support to the U.S. Antarctic Program and the National Science Foundation's (NSF's) research activities in Antarctica. In addition to its maritime and other support, since 2003, NGA has supported Operation Deep Freeze with aeronautical safety and navigational data products.

### Antarctic Airlifts

Beginning with the flight of Adm. Richard E. Byrd, who first flew over the South Pole in 1929, aircraft have provided vital assistance and support to scientific collection missions by making one of the least accessible spots on the globe easier to get to—at least when the weather is clear. Joint Task Force Support Forces Antarctica conducts Operation Deep Freeze, coordinating strategic airlifts, aeromedical evacuation support, search and rescue response, sealift access, bulk fuel supply, port cargo handling and transportation requirements.

The operation's reliance on airlifts has continued to grow so much that during the 2008–2009 flying season, the airborne movement of cargo and personnel provided the lifeblood for people on the ice. During

the six-month season, ski-equipped LC-130s, the polar version of the C-130 Hercules transport plane, flew more than 8.7 million pounds of material and 2,000 passengers on almost 300 missions throughout Antarctica. C-17 Globemaster III transport planes flew over 50 missions from Christchurch, New Zealand, to the McMurdo Station Antarctic research center and back, carrying over 3,800 passengers and 4.7 million pounds of cargo.

### Aeronautical Safety

NGA products increase safety of flight, navigational capabilities and aircrew situational awareness on the coldest, windiest and most inhospitable continent on the globe. Because NGA publishes all flight information publications for the Department of Defense, all of these critical supply missions, as well as the safety of aircrew and passengers, become, at some point, the responsibility of NGA.

NGA aeronautical analysts collaborate closely with the Space and Naval Warfare Systems Command (SPAWAR), Office of Polar Programs; the Federal Aviation Administration (FAA); the U.S. Air Force Flight Standards Agency, Pacific Air Forces (PACAF) command and 62nd Airlift Wing; and the 109th Airlift Wing of the New York Air National Guard to ensure the accuracy of all Antarctic instrument procedures.



Planning for the 2008–2009 season started in June 2008 when NGA aeronautical analysts met with partners from SPAWAR, the FAA, the Air Force and PACAF to determine which airfields would be used and the actual runway and skiway locations, and to update the locations of navigational aids and waypoints. Their goal was to define and create the instrument procedures used by U.S. aircraft operating into and out of the selected airfields, which present different landing conditions: Pegasus Field offers hard-packed ice used for wheel landings, while Williams Field and South Pole Station allow only ski-capable aircraft on their snow skiways.

The runways, skiways and navigational aids rest on constantly shifting ice, not on solid ground. Therefore, each runway, skiway and navigational aid is surveyed annually. The facilities are then replotted and changes are made to all waypoints used by aircraft to find each location and align for landing. While the flight instrument procedures remain similar at established airfields year to year, the exact details change, requiring updated published procedures that reflect the new information. After the preliminary revisions are completed, the FAA usually performs an in-flight check on the accuracy and usability of the procedures. Meanwhile, NGA aeronautical analysts receive frequent change requests from personnel in Antarctica, which they make and return as soon as possible.

This year, in response to a flight crew request, analysts also developed an Instrument Flight Rules chart to transition aircrews into the landing phase and assist with situational awareness and safety. Additionally, since all approaches in Antarctica occur in uncontrolled airspace—there are no ground controllers tracking aircraft and assisting with landings—NGA developed the publication *Airborne Radar Approaches* for radar-assisted landings at multiple Antarctic locations. NGA also publishes a procedure for when visibility is zero and an aircraft is almost out of fuel, allowing aircraft to land away from Pegasus Field in an area of relatively level ice and then either taxi to the airfield or wait for rescue personnel. Pilots followed this procedure five times during the 2008–2009 season, preventing loss of life and aircraft during some of the worst weather conditions they had reportedly ever experienced.

Even when a season ends, analysts get little respite from the operation’s demands. Planning for the 2009–2010 season began in June with the season scheduled to open in November. NGA will be there, supporting Operation Deep Freeze with specialized navigation products to help ensure in-flight safety in this extremely dangerous location. ▢

*Gregory G. is an aeronautical analyst within Aeronautical Services.*

*Operation Deep Freeze aircraft at Pegasus Field, McMurdo Station.*

U.S. Air Force photo by Tech. Sgt. Shane A. Cuomo





## AERONAUTICAL

# After Sept. 11: The Changing Face of Aeronautical Services

BY JIM C.

Few days have had more of an impact on NGA or the nation than Sept. 11, 2001. Ever since the U.S. Army Air Corps established its Map Unit in 1943, NGA and its predecessors have created aeronautical navigation information for the Department of Defense (DOD). However, since that tragic day eight years ago, the agency's Aeronautical Services has accelerated its transition from hardcopy to digital products to meet the growing demands for the aeronautical information upon which flight crews rely. Furthermore, the agency's aeronautical products and services have been increasingly in demand by the Intelligence Community (IC) and partners around the world.

Supporting the safety of navigation has always been part of NGA's mission. For decades, military and government air crews needing information about airports, flight routes and flight hazards have used Flight Information

Publications (FLIPs), which include Enroute Charts and Supplements, Planning Documents, and the Terminal Instrument Procedure books used for airport approaches—all currently produced by NGA. In addition to the U.S. military commands, other customers use NGA's products and its vast information databases. These customers include numerous federal agencies within the IC, the Joint Chiefs of Staff, DOD contractors, the Federal Aviation Administration (FAA), foreign military services, international partners, homeland security planners, search-and-rescue teams and crisis support offices.

### Moving to a Data-Centric Digital Environment

Harnessing the power of today's technology, NGA is moving from the present hardcopy product orientation to a next-generation, data-centric digital environment that will deliver ready access to aeronautical and geospatial



*Two U.S. Air Force captains enter data from an NGA Terminal Instrument Procedure book.*

U.S. Air Force photo

databases through an open architecture of interoperable, commercial systems and a dynamic communication infrastructure. Users will be able to customize and download specific data by using online dataset features through classified Web sites.

Key to automating aeronautical processes will be an international aeronautical data exchange standard known as the Aeronautical Information Exchange Model (AIXM). Eventually NGA will replace its current suite of aeronautical data and products with AIXM-based digital outputs via a Web-based service. This effort will provide DOD partners with a means to download flight safety data tailored to their specific needs.

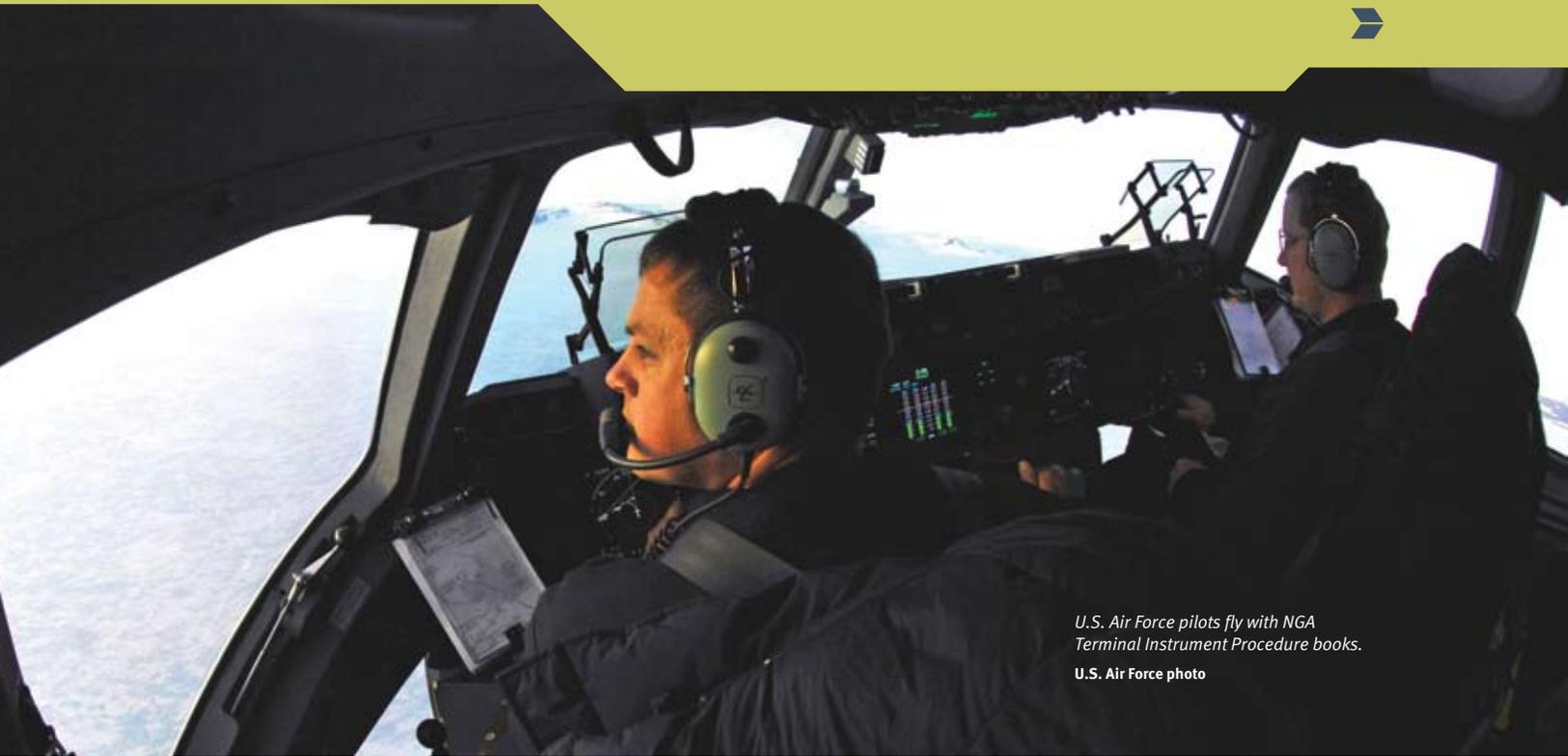
Several new initiatives will increase flexibility in responding to customers and improve quality by incorporating machine-to-machine automated data exchange into production processes. For example, NGA is streamlining the exchange of aeronautical data with select organizations and foreign countries. These partners will

eventually provide NGA with processed aeronautical data as part of the agency's coproduction agreements. NGA Aeronautical Services was certified in 2007 under the 9001 guidelines of the International Organization for Standardization in part to gain the ability to exchange data between multinational suppliers and customers.

A next-generation production system will also be used to create and maintain over 6,000 digitally drawn military terminal instrument procedure charts directly from aeronautical databases. Projected to be active within 12 to 24 months, the system will eliminate manual production of the charts, increase production capabilities, improve quality, and ingest and efficiently process large amounts of data, offer global chart updating and provide greater flexibility to interface with other NGA data.

Another technical program that will help replace the current hardcopy environment encompasses a completely integrated next-generation aeronautical database production system. A separate program involving NGA,





U.S. Air Force pilots fly with NGA Terminal Instrument Procedure books.  
U.S. Air Force photo

the FAA, and DOD Terminal Procedures offices will compile and exchange information machine-to-machine and have the ability to ingest AIXM data in an .XML format for the Web.

Work is also under way to create a one-stop aeronautical shop. A new query tool to access NGA's FLIPs will move the customer from product-centered use to data-centric use by enabling contractors and customers to access online data on a custom-tailored basis.

### **Increasing Intelligence Support and Collaboration**

Another challenging front for NGA is the increasing demand for aeronautical types of geospatial intelligence (GEOINT), such as precise airfield and heliport locations, in every format and from all available sources. As the air-based component of GEOINT, aeronautical data enables users to quickly orient and visualize their 3-D mission space, an advantage that improves their airborne precision, agility and effectiveness. When integrated with multiple sources of GEOINT, aeronautical safety of navigation data ensures that decision makers have the information required for planning and possible action to meet national security objectives.

Aeronautical analysts at NGA collaborate with intelligence agencies on a variety of complex global airspace issues, including analyses of navigational aids, airfield activity and infrastructure, airport safety, flight-following

studies, surge operations and force protection. Analysts also routinely analyze unique data in Aeronautical Information Reports for IC mission partners. Within NGA, aeronautical analysts often contribute to the work of other GEOINT analysts.

On occasion, requests come into NGA to analyze airports, create airfield graphics and perform airspace assessments for special events such as the 2002 Winter Olympics in Salt Lake City, Utah, the 2004 Summer Olympics in Athens, Greece, and the 2006 Winter Olympics in Torino, Italy. Other requests for similar assistance often involve response to disasters and humanitarian crises such as the devastating 1997 Indonesian wildfires, the 2004 Asian Tsunami, Hurricanes Katrina and Flossie, and the Darfur crisis.

NGA's aeronautical products and services have proven to be essential to flight crews in conducting safe and effective global air operations. Analytical aeronautical products also provide valuable background information to government officials who make critical decisions to protect the nation. By working now to create a data-centric digital environment and increasing collaboration within the IC, NGA's Aeronautical Services is well prepared to meet whatever challenges may arise. ▢

*Jim C. is an aeronautical analyst within Aeronautical Services.*

## AERONAUTICAL

# Aeronautical Analysts Soar to New Heights

BY DENNIS L.

When people first took to the skies in hot air balloons and biplanes, they not only created an exciting new way to travel, but also foreshadowed a new geospatial intelligence (GEOINT) challenge: providing charts and services for the safety of aeronautical navigation. The aeronautical safety mission supporting the U.S. military dates back to 1943, when the Army Air Corps established the Aeronautical Chart Plant in St. Louis, Mo, which would become a key part of NGA. Today's aeronautical analysts remain leaders in their tradecraft as they serve the Department of Defense, the Intelligence Community (IC) and other agency partners in not only safety of navigation but also intelligence and national security.

NGA's highly specialized aeronautical analysis workforce comprises GEOINT professionals who possess an aeronautical, military or computer science degree or

background, many years of aviation experience, and technical and geographic information system (GIS) skills. Together, the agency's aeronautical analysts have nearly 1,900 years of military and civilian work experience gained as pilots, navigators, flight engineers, air traffic controllers, airport managers and military air intelligence officers. With this firsthand knowledge, they produce sophisticated aeronautical products, collaborate with NGA partners, and analyze aeronautical intelligence issues in depth.

NGA recruits aeronautical analysts through university and military career and job fairs. The hiring criteria provide the agency with the flexibility to hire applicants with extensive aeronautical background or recent graduates from an aeronautical university, military flight training program or military academy. Future hiring

*NGA aeronautical products can now be exploited in GIS applications and Google Earth™.*

NGA graphic



requirements will include an elevated level of education and experience in GIS, database and other technical skills that are rapidly growing in importance and use within the tradecraft.

A typical day in the life of an aeronautical analyst depends on the analyst's functional or production area. Those focused on geographic areas collect and analyze source data for producing digital Flight Information Publication maps and charts, collaborate with IC analysts on air intelligence issues, and maintain a highly detailed and accurate database on airfields and airspace around the globe. Others performing stereo airfield collection analyze imagery to collect and specify airfield features and obstructions in the shapefile format used in GIS applications. Analysts working on vertical obstructions research data from worldwide sources, which they compile and include in products to ensure safe navigation of flight crews during take-off and landing phases and at low altitudes. Those who specialize in airport terminal area operations work closely with NGA's military partners to build and maintain safe and reliable arrival and departure procedures for flight crews and ensure that the Digital Aeronautical Flight Information File data used in military aircraft is accurate and reliable. Finally, aeronautical analysts who collaborate closely with foreign governments guarantee the seamless exchange of aeronautical navigation data and information while others ensure the accuracy and reliability of analyzed data provided to NGA's production partners for printing and dissemination.

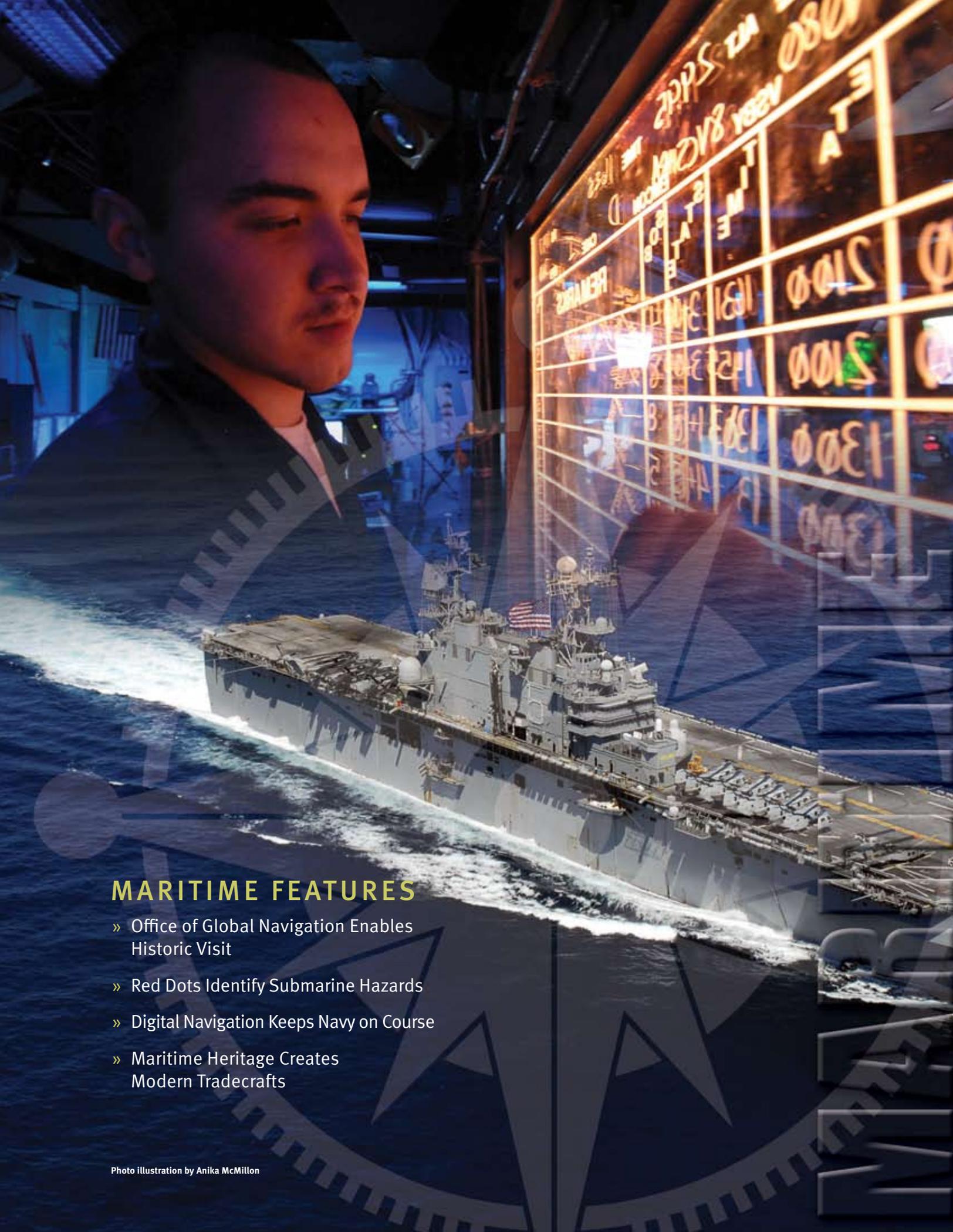
Because NGA's aeronautical data, products and services are vital to the lives and success of warfighters and

many of NGA's other partners and customers, outreach and collaboration are part of each aeronautical analyst's daily work. Analysts maintain frequent contact with partners and customers, who provide direct feedback regarding quality, data and production. They often travel to collaborate directly on U.S. and international air navigation requirements and issues.

The depth of knowledge that aeronautical analysts possess has also made them a valuable resource for other IC analysts on aeronautical intelligence issues and products. In addition, many IC analysts call upon NGA analysts for help deciphering unique terminology or acronyms and to assist with other barriers to analysis that require an understanding of aeronautical navigation, operations and airspace. Also, many aeronautical analysts serve alongside NGA partners and within the agency's Time-Dominant Operations Center.

The aeronautical analysis tradecraft and workforce have come far since 1943 and the Aeronautical Chart Plant, and these professionals still care deeply about their mission. Many have placed their lives in the hands of NGA's aeronautical products and understand firsthand how warfighters' lives and missions rely upon an analyst's attention to detail and accuracy. Furthermore, the use of commercial aircraft as weapons during the terrorist attacks on Sept. 11, 2001, sparked a new and urgent sense of responsibility to the intelligence mission that analysts now consider equal to their safety of navigation mission. Everyone who travels by air can be confident that aeronautical analysts are on the job supporting the GEOINT mission and national security. ▣

*Dennis L. is NGA's Professional Advisory Board manager for the aeronautical analysis occupation.*



## MARITIME FEATURES

- » Office of Global Navigation Enables Historic Visit
- » Red Dots Identify Submarine Hazards
- » Digital Navigation Keeps Navy on Course
- » Maritime Heritage Creates Modern Tradecrafts



## MARITIME

# Office of Global Navigation Enables Historic Visit

By JIM R.

NGA's Office of Global Navigation, Maritime Services, created a new nautical navigation chart of the Port of Mina Salman, Bahrain, and delivered it to the U.S. Navy in just 33 days to help make possible a May 17 visit by the King of Bahrain to the aircraft carrier USS Dwight D. Eisenhower. The carrier was only the second to pull into Bahrain pierside and the first to do so in more than 60 years.

Previously, when operating in this area, U.S. Navy carriers would anchor miles offshore, making logistics of resupply and refueling challenging. However, a new dock recently dredged and constructed at the Port of Mina Salman, Bahrain, can accommodate carriers. The U.S. Naval Forces Central Command (NAVCENT) and the U.S. 5th Fleet, to which the Eisenhower is deployed, contacted NGA in February requesting an updated chart with the newly dredged port by April 1 so the ship's crew could safely navigate to the new pier. Using new software, the Enterprise Product on Demand System-Maritime, an NGA team took port hydrographic survey data from the U.S. Naval Oceanographic

Office and the Bahrainis to create the new chart by March 25, a process that normally would have taken months. Moreover, the team saved the chart as a PDF file so it could be easily e-mailed and printed in theater for faster distribution to the fleet.

The USS Eisenhower used the new chart to dock at the port on May 16. The next day, the Eisenhower received a visit from Shaikh Hamad bin Isa Al Khalifa, the King of Bahrain; J. Adam Ereli, the U.S. Ambassador; and Vice Adm. William E. Gortney, NAVCENT commander. "This is a phenomenal feat," remarked the NGA briefer who addressed NGA Director Vice Adm. Robert B. Murrett following the king's visit. Murrett concurred, saying, "To have accomplished this in the [brief] period of time ... this is very important work." ▢

*Jim R. is a branch chief within Maritime Services.*

*The King of Bahrain (left) visits the USS Eisenhower.*

**U.S. Navy photo by Mass Communication Specialist Seaman Bradley Evans**



MARITIME

## Red Dots Identify Submarine Hazards

BY MARY S.

On Jan. 8, 2005, the USS San Francisco, a Los Angeles-class attack submarine, collided with an unknown and uncharted seamount in the vicinity of the Caroline Islands, causing significant damage to the submarine, numerous injuries and one fatality. The Red Dot program, an NGA partnership formed in response to the collision, is identifying unknown submarine hazards to prevent future tragedies.

The incident brought to light the larger issue of safely navigating all the oceans, not just the western Pacific.

Due to the modest number of bathymetric surveying tools available to the world's hydrographic authorities, detailed surveys of water depth have yet to be conducted over much of the world's open oceans. About 40 percent of the oceans have never been systematically surveyed, and about

95 percent have yet to be surveyed to the required GPS accuracy. The danger to submarines looms well beyond the Caroline Islands.

Shortly after the accident, representatives from NGA, the National Oceanic and Atmospheric Administration (NOAA) and the U.S. Naval Oceanographic Office (NAVOCEANO) met to determine if it was possible to identify potential hazards to submarine transits through the Caroline Islands region and elsewhere. A predicted bathymetry map, which depicts estimated ocean depths, had been developed a decade before the grounding. Additional data sources and continued development of the algorithms used to compute the depths have improved to the point that a new worldwide depiction of predicted bathymetry could help identify potential navigation hazards to submarines and surface ships. Lacking a full ocean survey, the partnership concluded that the use of predicted bathymetry to identify potential hazards was the most timely and realistic approach to reducing the probability of a recurrence.

NGA contributed available bathymetry and gravity data to the effort. NOAA provided its latest algorithms and altimetry data depicting the height of the ocean floors. The Scripps Institution of Oceanography,



A Naval Oceanographic Office ship surveys a predicted Red Dot hazard.

Photo by Mary S.



working closely with NOAA, joined in to analyze the various datasets and perform the initial compilation of data for the new predicted bathymetry layer. NAVOCEANO agreed to help compute the new predicted bathymetry data layer and assist with error analysis.

Subsequent discussions involving NGA and several Navy components that share responsibility or interest in safety of navigation led to the creation of the multiagency Submarine Navigation Improvement Program (SNIP), to focus on solving geospatial challenges that pose a risk to submarine navigation. The SNIP group promptly began to develop a prioritized list of predicted hazards to navigation derived from the predicted bathymetry layer. The group started referring to the effort as the Red Dot program following a NAVOCEANO briefing that symbolized potential uncharted hazards with the unassuming icon.

Through this collaborative effort, the list of predicted Red Dot hazards quickly rose to almost 700 worldwide. In the fall of 2006, NGA began publishing a special Red

Dot U.S. Notice to Mariners to warn of these potential navigation hazards. Red Dot hazards represent not only potential dangers to submerged navigation, but also to surface navigation—hazards close to the surface could ground fishing vessels or rip out the hull of even very large craft.

To verify or invalidate the Red Dot hazards, NGA analysts thoroughly review all data holdings and charts. They also analyze commercial imagery, seeking to corroborate hazards that are relatively near the ocean surface (approximately 50 meters deep or less), by using imagery at various wavelengths and algorithms to extract the faintest imagery features. About 25 new pinnacles have been detected using this technique.

Red Dots are assigned to one of the NAVOCEANO survey ships that conduct military surveys around the world, though the ships conduct surveys of these predicted hazards only when already assigned to survey or transit near a Red Dot location. Additionally, the U.K. Royal

*NGA analysts prepare a conductivity, temperature and density probe for a Red Dot survey.*

*Photo by Mary S.*



Navy, a partner in the Red Dot program, also surveys these predicted hazards through the U.K. Hydrographic Office as opportunities allow.

Through the joint NGA–NAVOCEANO Shiprider Program, NGA analysts collaborate with NAVOCEANO scientists aboard the survey ships conducting Red Dot bathymetric surveys. Two maritime analysts aboard the USNS Sumner helped confirm several predicted Red Dot hazards as navigation hazards. The operation surveyed one of the Red Dot hazards at just 21 meters deep, confirming the feature as a navigation hazard for both surface ships and submarines.

Once a Red Dot hazard has been surveyed and confirmed, the survey ship sends a message to the Worldwide Navigational Warning Service, which NGA coordinates. The service issues an appropriate safety warning, usually through a Notice to Mariners, to add the correct depth to the appropriate charts. After the

survey data are reviewed and edited and the feature is represented on updated charts, the Red Dot hazard is removed from the list.

NGA analysts continually track each predicted hazard on the Red Dot list in an effort to protect all mariners, civil or military, from these potential dangers. The SNIP meets regularly, and Red Dot status, briefed by both NGA and NAVOCEANO, is always at the top of the agenda. Through continued collaboration, close to 100 predicted Red Dot hazards have been detected. Of the over 80 surveyed to date, all have turned out to be actual features, and 50 percent have proven to be hazards to submarine operations. The Red Dot team still has a long way to go to resolve each Red Dot hazard, but the navigation risk to Navy and commercial ships has been significantly reduced by identifying and publishing Red Dot locations and resolving many of the potential hazards themselves. ▢

*Mary S. is a nautical cartographer within Maritime Services.*



*Analysts rely on carefully calibrated survey equipment to help detect Red Dot hazards.*

Photo by Mary S.

## MARITIME

# Digital Navigation Keeps Navy on Course

BY CHRIS ANDREASEN

Centuries ago, maritime explorers relied on stars, planets, compasses, clocks, voyage logs and sketchy charts to guide themselves across Earth's vast oceans and seas, trusting their instincts and faith in rudimentary methods to tell them where they were. In contrast, today's navigators can always know their precise locations, improving not only their safety but their combat situational awareness. U.S. Navy warfighters are just beginning to experience the power of fingertip access to digital data, following NGA's journey into the digital world.

### Going Digital

NGA's maritime roots come from the Defense Mapping Agency (DMA), one of its predecessors. As DMA began its transition to digital geospatial products, it developed a standard format that would apply to nautical, aeronautical and topographic products. This standard, the military Vector Product Format (VPF), became the framework for the NGA Digital Nautical Chart (DNC®).

From the mid-1990s through 2004, the agency digitized its collection of 5,000 hardcopy nautical charts, organizing data such as navigational aids, depths, and obstructions into thematic layers within DNC®. Since then, the DNC® has been continually maintained using

the VPF Digital Update (VDU)© process, which provides a patch of updates to the base nautical chart. The Canadian Department of National Defence assisted with the chart digitization and today helps maintain DNC® for all Canadian waters. VDU updates are issued on a 28-day cycle on CD-ROM, whereas paper chart Notices to Mariners are posted online weekly.

When NGA completed DNC® in 2004, this was the only worldwide vector chart coverage. Recently, the Navy implemented polar navigation using NGA charts and is now capable of true worldwide digital navigation. Over 50 ships operate with DNC® primary navigation, and the entire Navy is projected to transition by about 2013.

NGA has not been alone during this migration to digital standards and formats. Since its DMA days, NGA has been the U.S. Department of Defense representative to the International Hydrographic Organization (IHO), an intergovernmental organization supporting navigation safety and protection of the marine environment. NGA's Office of Global Navigation works within the IHO to build international uniformity among nautical charts and establish standards for worldwide navigation. For as long as NGA has been developing DNC®, the IHO has been developing its digital vector chart, the Electronic Navigational Chart (ENC).

The IHO plans to complete initial worldwide coverage in 2010, but without the extensive port coverage of DNC®. In the United States, the National Oceanic and Atmospheric Administration produces ENCs for civilian navigation; other IHO member countries produce ENCs for their regions of the world. NGA uses ENC data to supplement DNC® maintenance.

*An NGA agreement provides improvements to the Voyage Management System used by Navy ships.*

U. S. Navy photo



## Enhancing the Systems

NGA has a Cooperative Research and Development Agreement with Sperry Corporation, which manufactures the Voyage Management System (VMS) navigation software being installed on Navy ships, to implement improvements. For example, applying VMS updates now requires fewer manual steps. Also, the number of navigational warning alarms has been reduced, and some alarms have been changed from an audible alarm to a visual indication on the navigation display. To streamline chart maintenance, rather than updating a particular feature on multiple chart products, NGA is exploring transitioning to updating features one time in a database that would feed multiple products. Initially this effort is focused on developing a feature database derived from ENC digital source data to directly support compilation of DNC®. The features would be maintained only at their most accurate scales, eliminating discrepancies when different scale product layers are combined.

## Improving Maintenance

The DNC® VDU patches, which contain cumulative chart changes for a given period, are often too large to download through available communications bandwidth. To solve this problem, the Navy and NGA are working to create a system that would track the last time each ship updated using VDU and then transmit only the new VDU updates. This solution could reduce update transmissions to about 10 percent of their current size. Also, the Navy would transmit only the updates needed for the area of operations.

Once the system is successfully tested, the results will support the Navy's decision to adopt this netcentric service-oriented architecture. This technology could significantly reduce CD-ROM distribution of VDU updates and the Publication Digital Updates for digital NGA maritime publications. The Navy and NGA are also working towards fully automated updating to ease the burden on fleet quartermasters and navigators.

## From the Vector Product Format to S-100

VPF is now over a decade old. The IHO has been developing a new suite of formats, S-100, that will implement new capabilities. Rather than develop a new military format, NGA plans to transition to the S-100 format. After the IHO adopts this new format in 2012, nations can start building S-100 format data. NGA will build entire regions in the S-100 format in parallel with current DNC® maintenance to effect the transition without impacting fleet operations. Realigning some bathymetric products to the S-100 format will require many years.

Despite the difficulties of transition, digital navigation products will be significantly improved by this migration. The new S-100 format includes improvements for the next-generation ENC involving many kinds of maritime data, formats, publications and Web services. NGA's transition to S-100 will make it possible to better integrate U.S. and coalition warfighters because products will be interchangeable. NGA can benefit through coproduction with allied nations, particularly from compilation of Additional Military Layers data (military data used in conjunction with ENCs), which requires significantly denser data and more types of sources beyond those used in the past.

## Cruising Into the Future

The IHO has recently agreed to integrate data on tides into the DNC® display. In parallel, the system format used to digitally exchange information among ships is being reworked to include broadcasting real-time tides data from ports so that ship systems will automatically adjust the chart display for the actual tides. Integrating these new time-variable capabilities as well as data from future sources will provide true NGA maritime geospatial intelligence to the naval warfighter as well as Intelligence Community maritime operations and analyses. P

*Retired National Oceanic and Atmospheric Administration Rear Adm. Chris Andreasen is the NGA chief hydrographer.*





## MARITIME

# Maritime Heritage Creates Modern Tradecrafts

BY HOWARD C.

NGA's maritime tradecrafts date from Dec. 6, 1830, when the U.S. Navy established the Depot of Charts and Instruments in a rented house in Washington, D.C., near the White House to collect navigational charts, publications and instruments. This was the government's first attempt to assume responsibility for hydrographic surveying and charting. By the early 1850s, the depot had gained global recognition as an observatory and a hydrographic office through the dedicated work of experts such as Louis M. Goldsborough, Charles Wilkes, James M. Gilliss and Matthew Fontaine Maury, for whom one of the buildings at NGA's Bethesda headquarters is named. Their contributions in the sciences of navigation, hydrography, astronomy and oceanography formed the foundation of maritime charting tradecrafts.

As the military's nautical charts evolved through organizations preceding NGA, the maritime tradecrafts developed into today's professions in maritime analysis and bathymetry. Seventy percent of the Earth is water, and NGA's maritime analysts and bathymetrists cover the wet worlds, both on the surface as well as subsurface, serving a user community consisting of vessels that navigate in these environments. This workforce contributes to the geospatial base on the nautical side for military, commercial and special operations.

Maritime analysts acquire, analyze, compile and disseminate maritime safety information to populate and update nautical databases that support the Digital Nautical Chart (a database of worldwide navigation charts), hardcopy charts, digital publications and Electronic Chart Display and Information Systems used to navigate vessels. They generate mission-specific data, issue worldwide navigational warnings and respond to queries from foreign hydrographic offices and the users of NGA's products and services.

Typically, maritime analysts have graduated from one of the six state maritime academies (Massachusetts, Maine, New York, Texas, California and the Great Lakes), or from one of the federal service academies (U.S. Merchant Marine, Naval and Coast Guard), with a degree in marine sciences, marine transportation, environmental science, oceanography or navigation. Earning the U.S. Coast Guard

third mate's license is a requirement too, which qualifies them to navigate and serve as a deck officer in the Merchant Marine. Alternatively, Navy and Coast Guard quartermasters with three years of experience qualify to be analysts. Maritime analysts' skills and practical navigation experience allow them to view NGA maritime products from a true user's perspective.

Bathymetry is the science of determining ocean depths and the configuration of the Earth underneath bodies of water. Bathymetrists have an intimate understanding of environmental sciences, particularly oceanography and the study of tides and currents; remote sensing, such as sonar (sound detection and ranging), lidar (light detection and ranging) and other techniques; geodesy, the science of measuring the Earth; geomatics, the science of acquiring and managing geographic information; and hydrographic surveys. They assess the accuracy and currency of sounding (depth) data; validate, populate and maintain a worldwide bathymetric internal agency database; and are experts on sea-floor information.

Bathymetrists may have college degrees in areas such as geodesy, geography, geology, hydrography, hydrology, marine sciences, oceanography, physical science and remote sensing. They might also have career experience in hydrography, bathymetry and geographic information systems tools.

The agency's maritime experts work cooperatively with their counterparts in the National Ocean Service, the Naval Oceanographic Office and the U.S. Coast Guard, as well as with contractor partners and nearly all foreign hydrographic offices worldwide. Their work fulfills NGA's marine navigation obligations under federal and international laws and regulations in support of national security goals, concerns and strategies.

When Commodore Matthew C. Perry negotiated an 1854 treaty that established the United States' presence in Asia, Sailing Directions were constructed for the new ports that led the way for future trade. Now 37 volumes of this publication provide expanded foreign coastal and port information that cannot be portrayed on a chart. Knowing about pilot channel frequencies, currents, local weather,

port regulations and descriptive views of the area is vital when entering a port. Planning Guides, based on ocean basins, came into existence in 1971 to assist the mariner in planning a transoceanic voyage. Five volumes provide worldwide coverage of information about countries, governments, buoyage systems, military exercise areas and mined areas to be avoided, among other topics.

The most noted publication for safety of navigation is the U.S. Notice to Mariners, which has maintained a continuous weekly production cycle since 1869. First published under the authority of the Bureau of Navigation, it is the oldest continuous running U.S. government publication. Until it transitioned to being only online in January 2005, it retained a government publication's printing priority second only to the Congressional Record. This weekly publication, jointly produced by NGA, the National Ocean Service of the National Oceanic and Atmospheric Administration and the U.S. Coast Guard, is used by U.S. military forces and civilian mariners worldwide to obtain vital corrections to U.S. charts and navigation publications. Notifying the military and civilian maritime community

about corrective information regarding hydrographic discoveries, changes in channels, navigational aids and other important data, the U.S. Notice to Mariners is the only publication officially authorized and recognized to update and maintain the U.S. portfolio of nautical products.

From a rich heritage now in its third century, the maritime tradecrafts at NGA have changed from their origins at the Depot of Charts and Instruments. Forefathers Goldsborough, Wilkes, Gilliss and Maury would be astounded to see those who have followed in their footsteps analyzing worldwide hydrographic and bathymetric data, staffing 24/7 operations, responding to environmental crises such as hurricanes or the 2004 Asian Tsunami, and working with the Intelligence Community to carry out national security objectives. And they would certainly be pleased that their true legacy—dedication to the safety of navigation, from clipper ships to nuclear submarines—is alive and well at NGA.

*NGA maritime products and services may be found at [www.nga.mil/maritime](http://www.nga.mil/maritime).* ▢

*Howard C. recently served as NGA's Professional Advisory Board manager for the marine analysis occupation.*

Photo illustration by Anika McMillon



21ST CENTURY

# Innovation Promises to Moderate Vertical Obstruction Risk

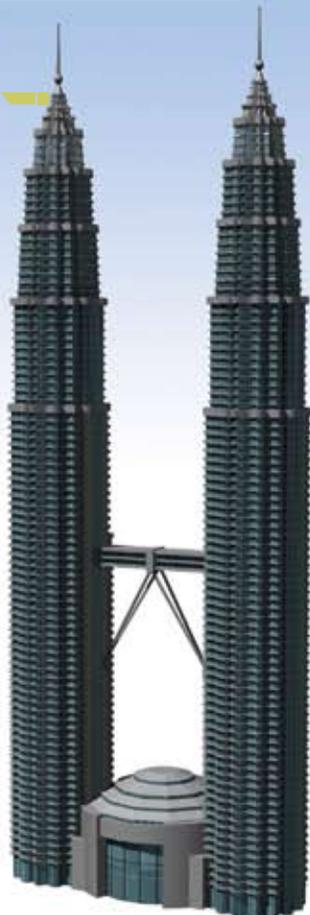
BY RICK M.

You command a helicopter unit tasked to fly soldiers into a battle zone. Your mission is risky, but essential. You determine the best route, following the terrain and flying low to avoid detection. But this will take you near several villages and towns—built-up areas with communication towers, high-tension power lines and other potential obstructions of varying heights. Your aircrews and their precious cargo of warfighters have put their lives in your hands as you develop the final flight plan. How high do you fly? High enough to avoid every vertical obstruction and you risk detection and hostile fire. Low enough to avoid surface-to-air missiles and you risk hitting obstacles before reaching the landing zone. Deciding is your responsibility as commander. You know

that every flight and mission entails risk, but you need information to weigh that risk wisely.

NGA bears responsibility for safety of navigation for the Department of Defense and U.S. military forces. To help fulfill this charge, the agency actively collects data on vertical obstructions through imagery analysis and by acquiring existing databases of obstructions from commercial and foreign partners. Within the last decade, the agency has increased its data on known vertical obstructions twenty-fold. But, despite that impressive record, collecting every possible vertical obstruction hazard everywhere on the globe through current means would require resources beyond comprehension.

The agency is leading a major initiative to address this very complex problem. Technological advances in the use of lidar (light detection and ranging) within the last few years make rapid collection of features over



Petronas Twin Towers  
1,482 ft



Empire State Building  
1,454 ft



Eiffel Tower  
1,063 ft



Telecommunications Tower  
up to 984 ft

large areas a possibility. Using this laser radar system, NGA will be able to accurately and quickly collect feature locations and vertical heights. Although the system's ability to identify additional attributes remains limited, lidar-collected data will increasingly alert aircrews to obstructions, identifying where they are and how high they stand.

However, how can a chart possibly display such a huge amount of data without obscuring other critical information? Could a commander correctly assess the risk of flying one route over another with tens of thousands of points of varying heights plotted on a potential route? In addition to a great increase in feature collection, NGA is also working to improve how features are displayed digitally and on charts to aid commanders making risk assessments.

The agency will explore new ideas, such as a color-coded, digital, vertical obstruction elevation model, which could be draped over a proposed flight route to illustrate risk. For example, choosing a 50-foot altitude for a flight segment might show red, signifying a high risk of hitting an obstruction. Raise the flight altitude to 90 feet and the risk may become moderate or yellow. Raise it again to 150 feet and the display becomes green, indicating no obstruction risk. Flying a training mission in Alabama, the 150-foot altitude might suffice, whereas a mission in hostile territory might dictate a lower, more dangerous altitude. In either case, the commander and crew would know the risk. This elevation model is just one possibility among many ideas that the agency will pursue.



Photo illustration by Kipling W.

In addition to improving collection and how obstructions are displayed, NGA will examine ways to increase data storage and Web dissemination. Whichever ideas prove best, two things are certain: five years from now, aircrews will enjoy a tremendous increase in their knowledge of the obstructions that endanger airmen's lives, and NGA will offer solutions for a commander's need to understand the risks and a crew's need to avoid them. P

*Rick M. is the aeronautical issues manager in the Office of Global Navigation.*



Seattle Space Needle  
605 ft



Washington Monument  
555 ft



Big Ben  
320 ft



Statue of Liberty  
305 ft



Leaning Tower of Pisa  
186 ft



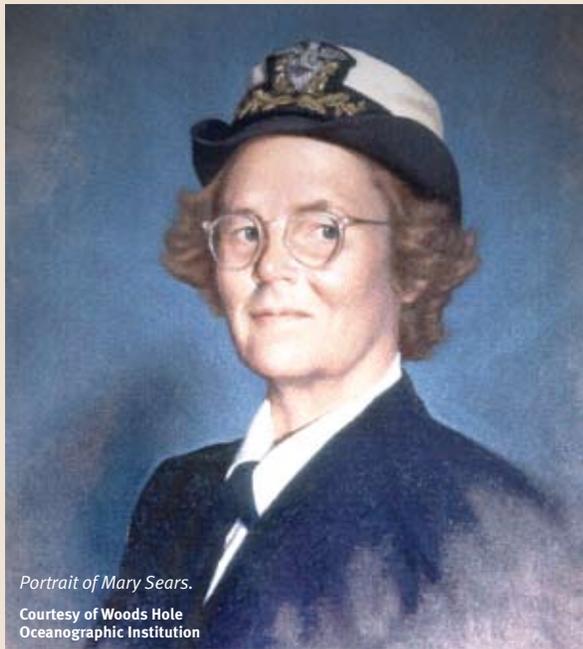
High Tension  
Electrical Tower  
180 ft



## OUR HERITAGE

# Oceanographer Mary Sears Advanced Marine Science

BY HOWARD C.



Portrait of Mary Sears.  
Courtesy of Woods Hole  
Oceanographic Institution

On Oct. 19, 2000, scuttling a longtime U.S. Navy tradition, then-Secretary of the Navy Richard Danzig named the Navy's newest oceanographic survey vessel for Mary Sears, honoring one of this country's earliest women pioneers in oceanography. It was the first Navy oceanographic ship named for a woman. Like all ships in its class, the Mary Sears is a multimission vessel capable of surveying in coastal waters or the deep ocean.

The USNS Mary Sears employs products, services and data from NGA's Office of Global Navigation, Maritime Services, to accomplish its various oceanographic survey missions. Crewed by civilian mariners, it is one of seven oceanographic survey ships in the U.S. Navy's inventory and is operated by the Military Sealift Command for the Oceanographer of the Navy, Rear Adm. David W. Titley.

In a partnership with the U.S. Naval Oceanographic Office, these survey vessels also play an integral role hosting NGA maritime analysts as part of the joint-agency Shiprider Program. About these opportunities, the program manager said, "It's a great opportunity to see our products used first hand and participate in data collection that we use to populate and maintain our hydrographic databases."

But who was Mary Sears? Born July 18, 1905, Mary Sears was raised in Wayland, Mass. She graduated from Radcliffe College with a bachelor's degree in 1927, a master's degree in 1929 and a doctorate in zoology in 1933. While still at Radcliffe, Sears worked with the first and founding director of the Woods Hole Oceanographic Institution, Dr. Henry Bigelow, at Harvard University. She began at Woods Hole as a planktonologist in 1932, working summers at first, becoming one of 10 research assistants first appointed to the staff.

During World War II, Sears left Woods Hole to answer her country's call to duty. As a Navy lieutenant in the Women Accepted for Volunteer Emergency Service (WAVES), she and Navy Reserve Lt. Roger Revelle, for whom the Scripps Institution of Oceanography research vessel RV Roger Revelle is named, were appointed to head the Navy Hydrographic Office's new Oceanographic Unit, which she directed very often in Revelle's absence. The unit, created in 1943 after the oceanographic unit of the Army Air Forces was transferred to the Navy Hydrographic Office, marked the beginning of military efforts to consolidate oceanographic programs.

Sears' contributions to the U.S. Navy and the research community are legendary, as exemplified by her post-analysis of the Battle of Tarawa in the South Pacific, where the familiar adage "time and tide wait for no man," had proved literally true.

The Second Marine Division's invasion of Betio—the Tarawa atoll's only island of consequence because it had an airfield—was set for Nov. 20, 1943, when the tide was expected to be favorable. The bombardment would begin in the early morning at low tide. As the tide rose and water levels in the lagoon reached 5 feet, landing craft would head ashore. By noon, at high tide, heavier craft could come ashore bringing tanks and supplies.

It seemed like a sound military plan; however, the British advised against the invasion timing because of an unusually low and narrow tidal range time that would prevent the invasion craft from moving close to the beach. U.S. Navy planners believed differently, and their calculations proved grossly in error.

The landing craft needed 4 feet of water to cross the reef. At landing time, the reef was covered by only 3 feet

of water. As a result, no landing craft was able to float over the reef, and the Second Marine Division troops had to wade for 400 to 500 yards under heavy fire, in water waist-deep, which meant death by drowning from a wound or a stumble into an underwater shell hole.

Three days and 3,407 casualties later, the division secured the three-mile-long, 800-yard-wide Betio Island. Sears went to Tarawa soon after. Her in-depth tidal analysis showed that forecasts predicting that a high tide would carry landing craft over the reef had been in error. With a delay in the planned invasion time, this error had led to terrible losses for the Marines.

Sears soon after applied her observational tidal data to build a much-improved method for tidal forecasting—amazingly, without the benefit of modern-day computers. Her model helped future beach assaults in the Pacific succeed, saving the lives of many U.S. soldiers, sailors and Marines.

Sears' research while in the WAVES also proved critical to the survivability of U.S. submarines during the war. Her intelligence reports, "Submarine Supplements to the Sailing Directions," predicted the presence of thermoclines—areas of rapid water temperature change—under which a submarine could hide to escape enemy detection by surface sonar.

Following the war, the Navy Hydrographic Office formally established a Division of Oceanography. On Jan. 29, 1946, Sears was appointed the first officer-in-charge of the division with Dr. Richard H. Fleming as the civilian director.

In 1947, Sears transferred to the Navy Reserve and returned to Woods Hole. Sears secured her reputation in marine science as an editor of journals and books that reported the results of oceanographic research. A found-

ing editor of *Deep-Sea Research*, she also helped establish *Progress in Oceanography*, another journal. She also edited several well-regarded books on the history of marine science. In 1963, Sears retired from the U.S. Naval Reserve as a commander. Woods Hole designated her a senior scientist in its biology department, from which she retired in 1970.

To honor Sears, *Deep-Sea Research* dedicated an issue to her for her 80th birthday. Affirming her contributions, the journal stated that she "has probably played a greater role in the advancement of oceanographic studies than any other woman." The Women's Committee of Woods Hole recognized her during its inaugural "Woman Pioneers in Oceanography" seminar in 1994.

After a brief illness, Mary Sears passed away Sept. 2, 1997, at age 92 in her home at Woods Hole.

NGA continues legendary oceanographer Mary Sears' pioneering endeavors. The agency's bathymetrists evaluate and extract hydrographic and bathymetric data to support safety in maritime navigation and create geospatial displays and textual reports of intelligence information to meet customer requirements. NGA Bathymetric Contour Charts play a vital role in underwater navigation and enable Navy submarines to support the nation's interests around the world. These and other maritime safety efforts build on the foundation Mary Sears helped establish. ▢

*Howard C. is chief of the Bathymetry Branch within Maritime Services.*

*USNS Mary Sears*

U. S. Navy photo

## NEW CAMPUS EAST

# NGA Takes Charge of First Two Buildings

By Jay K.

On July 10, 2009, the men and women of NGA converged at the agency's New Campus East (NCE), under construction in Springfield, Va., to take the reins of two key facilities during a ribbon-cutting ceremony. The two buildings, the Technology Center and the Central Utilities Plant, are foundations in the development of NCE, which will open its doors to the NGA workforce beginning in 2010. Among the ceremony's participants were the newest member of the NGA workforce, who joined NGA on June 22, and an employee who was recently honored for 40 years of service to NGA and its predecessor agencies.

Under the direction of the U.S. Army Corps of Engineers, the structures were built to meet NGA's power and computing needs as it prepares to consolidate multiple offices in the Washington, D.C. area into NCE. With NGA in command of these buildings, the agency can begin developing NCE's internal infrastructure.

The Technology Center will support an integrated NGA information technology architecture that will enable analysts to develop geospatial intelligence (GEOINT) products for NGA partners more efficiently. The Central Utilities Plant—a 105,000 square foot building with seven chillers and eight cooling towers—will provide power and cooling for NCE's 2.4 million square foot campus. At peak capacity the plant will be able to produce 31,500 gallons of chilled water per minute—enough to fill three Olympic-size swimming pools every hour.

During the ribbon-cutting ceremony, NGA Director Vice Adm. Robert B. Murrett noted the historic significance of the handover. "The ongoing challenges to the nation have ushered in a new era for the agency and accelerated the integration and relevance of our diverse but unified agency," said Murrett. "Today, as we accept the first two buildings, we continue that forward momentum and pass an important milestone of mission deployment," he added.

CIA Associate Deputy Director Scott White, the keynote speaker at the ceremony, joined Murrett in praising the completion of the two buildings. "This is more than the new headquarters; it's the promised land," said White, adding, "It's great to see it become a reality. When the campus opens in two years, it will be the crowning achievement" in bringing GEOINT to the warfighter and NGA mission partners. ▢

Jay K. is a public affairs officer in the Office of Corporate Communications.

*During a ribbon-cutting ceremony, NGA took the reins of the New Campus East Technology Center (pictured) and Central Utilities Plant.*

Photo by Larry F.

# PIRATES!



U.S. Navy Photo

*“... the problem of piracy is and continues to be a problem that begins ashore and is an international problem that requires an international solution.”*

**Vice Admiral William E. Gortney  
Commander, U.S. Fifth Fleet**

Twenty-first century piracy in the Horn of Africa and the Gulf of Aden is both a symptom and a disease. It is a symptom of economic deprivation, lost fishing rights, political instability, governmental collapse, lack of international action, and failure to meet the basic needs of desperate people.

As a disease, it has developed into high seas crime, destructive to normal commerce and human life.

NGA provides eyes and analytic insight to those who fight piracy at sea and those who craft diplomatic and political solutions.



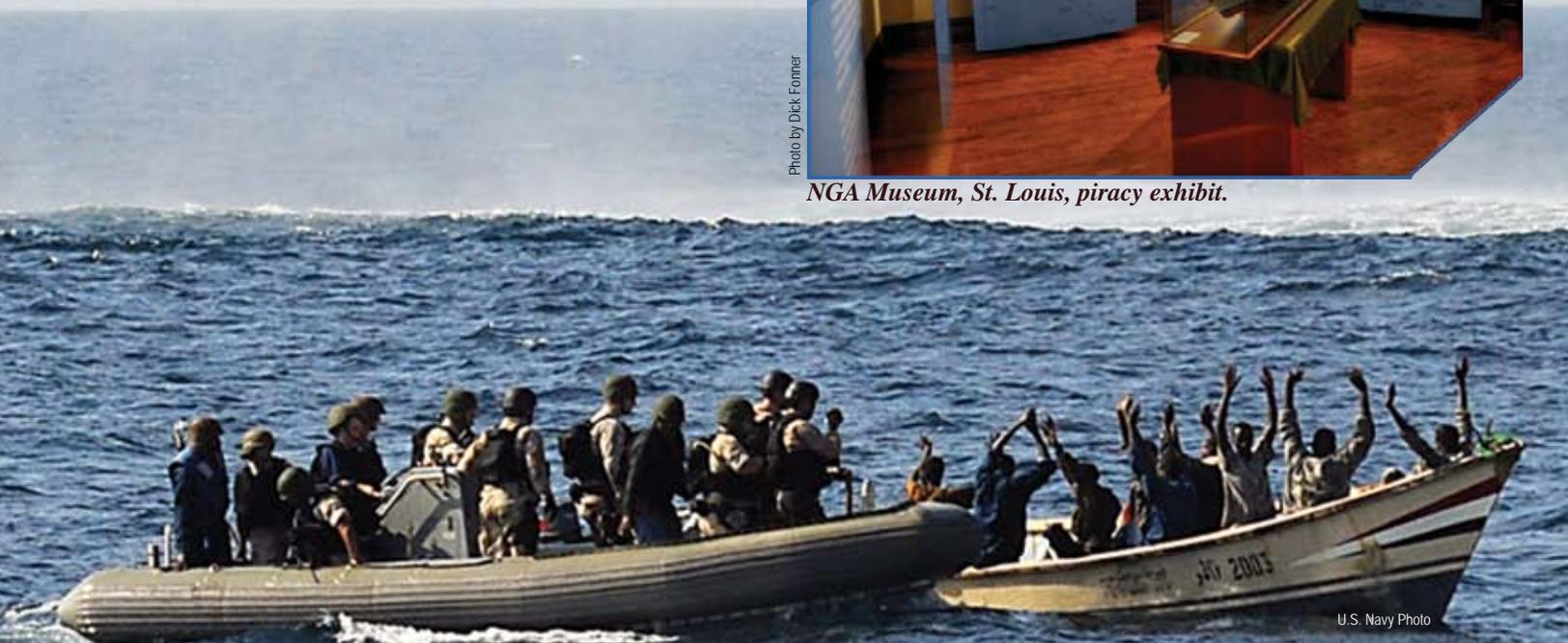
U.S. Navy Photo by Ensign Elizabeth Tree

**Crew members from the merchant vessel Al Marjan meet with a boarding team from the U.S. Navy dock landing ship USS Whidbey Island. Al Marjan was released from pirates off the Somali coast December 2, 2008.**



Photo by Dick Forner

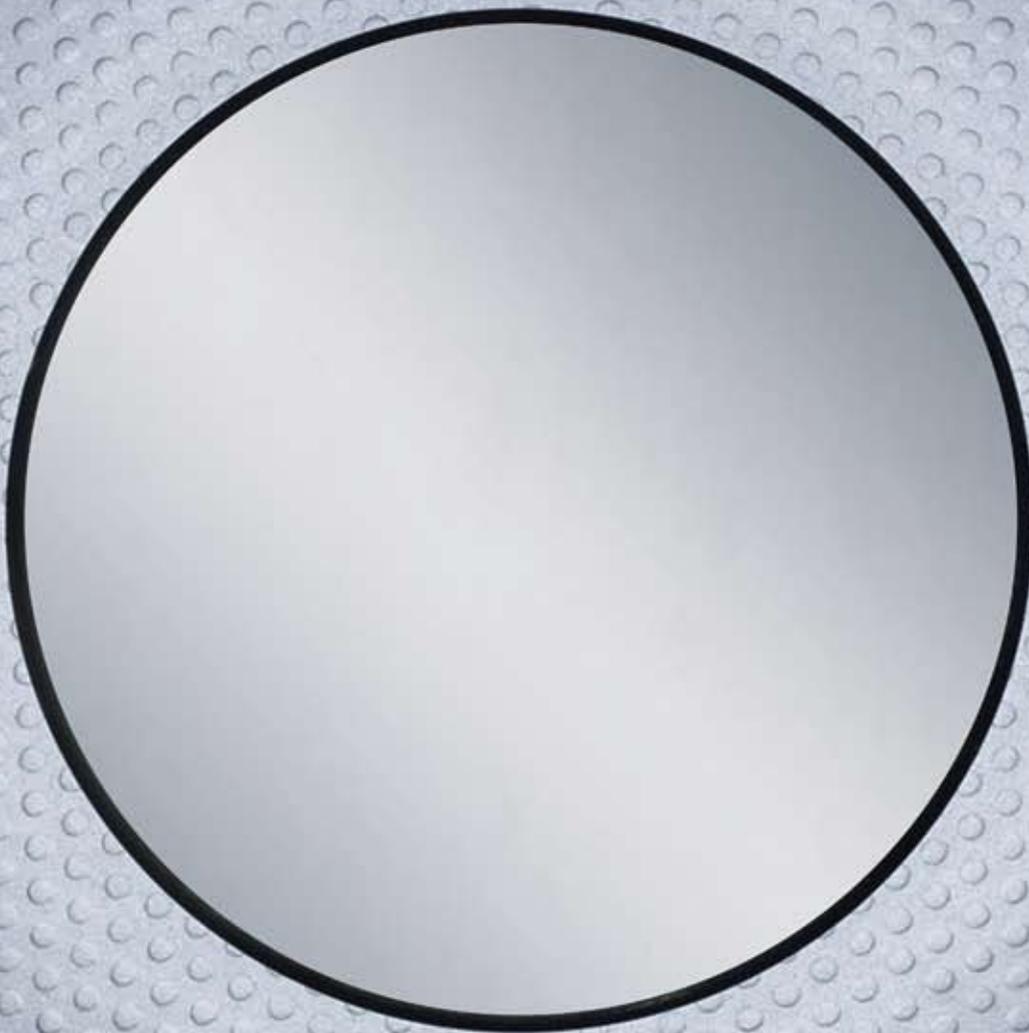
**NGA Museum, St. Louis, piracy exhibit.**



U.S. Navy Photo







[www.nga.mil](http://www.nga.mil)