

THE NAVY'S ENERGY & ENVIRONMENTAL MAGAZINE

Currents

fall 2014

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& Other Innovations Continue
Dahlgren's Tradition

Cutting Edge Ordnance Testing Evolves
with Environmental Commitment

Navy Explores the Future of 3D Printing

NAVAIR Finding Alternatives to Hexavalent Chromium & Cadmium

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of Unexploded Ordnance



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cover

Naval Surface Warfare Center Dahlgren offers proof that advanced ammunition testing, innovation, and development can co-exist with sound environmental management.

John F. Williams

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Moving Out on Energy Action Month, New App & Marine Mammal Research

WELCOME TO THE fall 2014 issue of *Currents*. October is Energy Action Month, so I'm hopeful that you're reading this issue during or shortly after the many activities we had planned across the Navy to promote the importance of energy and conservation both afloat and ashore. The Navy (and overall Department of Defense) Energy Action Month theme for this year is "Energy Action = Mission Success," and it's certainly appropriate. Beyond the themed posters, senior leadership panel discussions, social media posts, and Navy energy projects and initiatives we spotlight during the month of October, we're taking action year round to reduce our energy consumption and increase our operational capability, reach, and resiliency.

A large component of our program is behavioral change, which starts at the deck plate level and extends to our most senior leaders, which is why increasing energy awareness across the Navy continues to be a focus area. With that in mind we launched our new "Energy Warrior" digital publication (app) in mid-September, targeting our younger Sailors. The app, which can be downloaded for free for use on Mac iPads and Android devices, demonstrates the efforts of Sailors and other personnel who are taking innovative steps to conserve energy, lead behavioral change, and get the maximum warfighting punch out of every gallon of fuel or kilowatt of electrical power. We also have a new Energy Warrior playlist on the Navy's YouTube channel with videos and personnel profiles.

I'm excited about the app as a tool to help us reach out and connect with Sailors around the Fleet on a personal level. Energy Warrior can help our Sailors and civilians understand how truly critical energy is, both for our daily jobs and for enabling combat capability for the long term. Plans are already underway for additional video profile interviews for a future version of the app. Commands with innovative energy projects, people, and ideas can contact the Navy's energy team at energywarrior@navy.mil. For additional information, visit <http://greenfleet.dodlive.mil/energy/energywarrior>.



The Navy Secretariat, our office, and the Fleets are also in the planning stages for a second set of Fleet Energy Training events at Fleet concentration areas. Similar to the events in San Diego and Norfolk held earlier this year, these are envisioned as one-day workshops

that focus on understanding why energy is viewed as both a combat enabler and a vulnerability, energy saving practices that extend time between refuelings, and the need for culture change and innovative ideas.

In the technology realm, we are accelerating the installation of light emitting diode (LED) bulbs on ships. While the Naval Sea Systems Command (NAVSEA) and the Fleets have completed installation of LEDs on many of our ships over the past few years, this year we've funded the installation of LEDs for critical/key areas on all remaining surface combatants within the Fleet that have not been outfitted and the conversion of shipboard



battle lanterns to LED. The switch to LED lighting reduces the maintenance burden for Sailors: LEDs last up to five times longer than conventional fluorescent lights, so that means Sailors spend 80 percent less time swapping out bulbs and more time doing their primary mission. Other benefits of LEDs include better light quality, durability, energy savings, improved safety due to less frequent relamping of hard to access spaces, and none of the hazardous waste found in florescent lights.

NAVSEA is also aggressively working with commercial lighting firms to qualify additional vendors to provide LED lighting for naval vessels.

On the energy and environmental fronts, delivering the message to key internal and external stakeholders about the Navy's many initiatives remains essential. We

conducted outreach in both topic areas at Baltimore Navy Week (September 10–14), the Naval Air Station Oceana Air Show (September 19–21), and San Francisco Fleet Week (October 9–14) with energy/environmental exhibits and information materials. San Francisco Fleet Week also included the commissioning of USS America (LHA 6) on October 11. USS America is the Navy's second amphibious assault ship to be equipped with an electric auxiliary propulsion system in addition to its main propulsion plant for energy efficient steaming at lower speeds when the main plant can be shut down. This concept is becoming the new standard for energy efficient propulsion.

mapping, or ocean current and temperature information, is expensive and takes time to collect, compile and analyze. When feasible, it would be ideal to be able to better share and leverage that type of information among agencies to mitigate costs and avoid potential duplication of effort. I recently participated in a meeting with William Brown, Bureau of Ocean Energy Management (BOEM) Chief Environmental Officer, and Don Schregardus (Deputy Assistant Secretary of the Navy for Environment) to discuss partnering opportunities for the Navy and BOEM relative to



There are numerous examples of the Navy's efforts to be a good environmental steward while fulfilling our mission.

As part of our ongoing marine mammal research, the Navy's Living Marine Resources (LMR) program funded an additional round of behavioral response studies off southern California in the late September/early October timeframe. The studies involve independent research organizations temporarily attaching digital data tags to marine mammals and recording their reactions to underwater sounds. The sound sources range from simulated sonar and other sounds played via underwater speakers, to actual mid-frequency sonar transmissions from naval warships. As with any research, the results of these studies take a long time to fully analyze, but this data has great potential to help us better understand how marine mammals may be affected by Navy at-sea training and testing activities.

There are numerous examples of the Navy's efforts to be a good environmental steward while fulfilling our mission. I and others on my team have written at length about many of those programs and projects in past columns, web pages and blogs, and will continue to do so. I'm also impressed by and would suggest you visit U.S. Fleet Forces Command's "Stewards of the Sea" Facebook page (www.facebook.com/USNavyStewardsoftheSea) which is another excellent resource for timely information about Navy environmental and energy topics and initiatives.

Collecting data about the ocean environment, be it marine mammal research or monitoring, bathymetric

our marine mammal program. In the coming months, we hope to identify opportunities for collaboration on our ongoing and future marine mammal initiatives.

Finally, I would like to again congratulate the winners of the fiscal year 2013 Chief of Naval Operations (CNO) Environmental Awards. The 27 winners were honored via a video teleconference (VTC) ceremony on August 20. Awardees from around the country and overseas participated in the VTC from their respective sites, while the CNO, Vice Admiral Phil Cullom (N4), and I hosted from the Pentagon. Distinguished visitors representing DoD/Navy leadership and non-government organizations also participated. While the VTC saved significant travel dollars and reduced the carbon footprint that would have resulted from an in-person ceremony, it was a great opportunity for the CNO to personally thank each winning team for their efforts in promoting and supporting Navy's environmental stewardship. For more information about the ceremony, please see page 48 of this issue.

Thank you for your interest in and continued support of the Navy's energy and environmental initiatives. I'm proud of our Navy team and really do believe their efforts and commitment makes a difference every single day. 📍

Rear Admiral Kevin R. Slates
 Director, Chief of Naval Operations Energy and
 Environmental Readiness Division



John F. Williams



Electromagnetic Railgun

& Other Innovations Continue
Dahlgren's Tradition

Cutting Edge Ordnance Testing Evolves
with Environmental Commitment

Since the middle of the 19th century, the name Dahlgren has been synonymous with state-of-the-art weapons and ammunition testing. Today, Naval Surface Warfare Center (NSWC) Dahlgren offers proof that advanced ammunitions testing, innovation, and development can co-exist with sound environmental management.

The Need for Weapons Testing

On February 12, 1844, a 12-inch gun exploded aboard the steam frigate USS Princeton, killing Secretary of State Abel P. Upshur and Secretary of the Navy Thomas W. Gilmer, as well as six others. Following this incident, in 1847, the Navy decided to implement a more scientific and methodical approach to naval gunnery and ordnance testing, selecting Lieutenant John A. Dahlgren to carry out the task at the Washington Navy Yard.

According to an early history of the base (*The Sound of Freedom: Naval Weapons Technology at Dahlgren, Virginia, 1918-2006* by Rife and Carlisle), Lieutenant Dahlgren was an experienced oceanographer and a professor of gunnery. One of Lt. Dahlgren's top concerns was gun ranging. In the mid-1800s, each gun produced had slightly different characteristics, requiring that each and every gun be test-fired repeatedly to determine its range and accuracy. Lt. Dahlgren established an experimental battery mounted on a gun deck overlooking the Anacostia River, with a range of five miles. It had a clear line of sight across the Potomac to a target area just upriver from Alexandria, Virginia. The Anacostia battery became the prototype for shore-based Naval gun testing. Lt. Dahlgren also designed special instruments, including a gunner's quadrant for measuring distances, and an alidade (an instrument for recording the impacts of shots).

Eventually, this testing moved from the Washington Navy Yard to an experimental battery and proving ground near Annapolis, then moved again after the Navy established an official U.S. Proving Ground at Indian

Head, Maryland in 1891. Here, all guns issued by the Washington Navy Yard were tested, as well as armor, shells and mounts.

As World War I escalated, longer-range and more powerful guns, including a 16-inch battleship gun, were being developed. The need to test fire these longer-range guns endangered the local population, so an even more isolated location became necessary. On April 26, 1918, under special congressional authoriza-

tion, a new 994-acre proving ground was established adjacent to Upper Machodoc Creek, a small tributary of the Potomac River in Virginia. On November 4, 1918, an adjacent 372-acre farm was added to the first tract, and in January 1919, the Secretary of the Navy officially named the proving ground "Dahlgren." In 1921, all gun testing shifted from Indian Head to Dahlgren, and in 1932, the Bureau of Ordnance formally separated Dahlgren from Indian Head, creating a separate command.



Rear Admiral John A. Dahlgren.

The Navy has effectively balanced mission requirements with concern for the public interest throughout its history at Dahlgren.

The Dahlgren Area

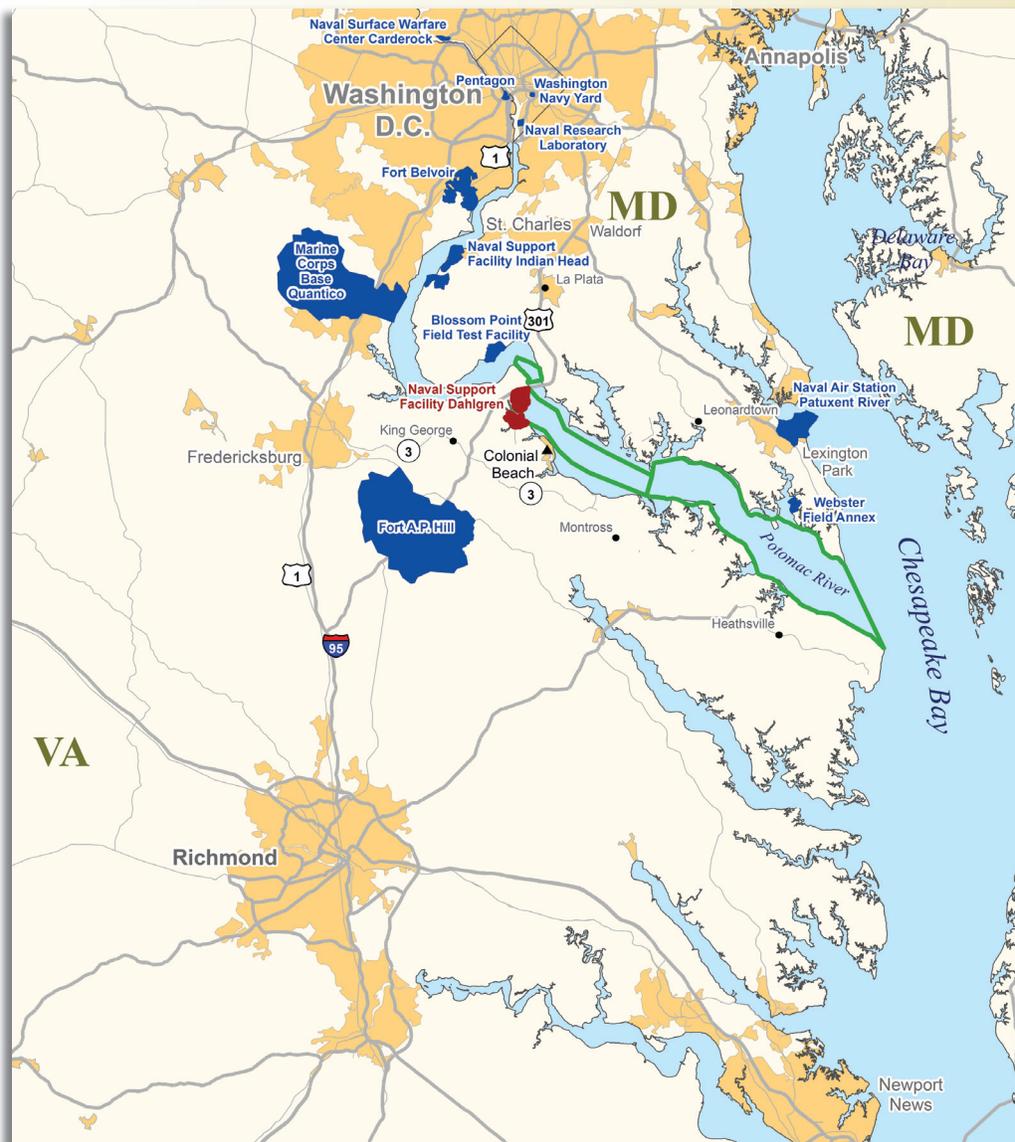
The area surrounding the future location of the town of Dahlgren was sparsely settled until the mid-19th century. By the 1860s, small settlements were concentrated along the Potomac River shoreline, and during the Civil War, large portions of the area were occupied by Union Soldiers. After the Civil War, the area remained rural, consisting primarily of small farms. Various plantations occupied present-day Dahlgren, including “The Cottage” plantation, where the Navy first established the proving ground, and Barnesfield Plantation, which eventually functioned both as a plantation and dairy.

By fostering a cooperative relationship with the local community and taking a proactive approach to environmental management, the Navy has effectively balanced mission requirements with concern for the public interest throughout its history at Dahlgren. This concern was in evidence from day one, when the Navy hired an expert on

Chesapeake Bay’s ecology to survey and lay out the new proving ground. Naval Reserve Lieutenant Swepson Earle, who later became Maryland Conservation Commissioner, took pains to plan the range so that large shells would fall into deep water, a safe distance from the main oyster bars that were crucial to the local economy.

Dahlgren’s Unique Location

Dahlgren’s location was strategically significant in the early days of the country, as the Potomac and Chesapeake Bay were heavily used during the War of 1812 and the Civil War. Today, its location is less strategic, yet ideal for weapons testing. Because weapon systems and sensors function differently in different settings, it is important to test them in a coastal environment that blends land, air, and water with a variety of weather conditions. Dahlgren is one of the few Navy locations that can provide these conditions for research, development, test and evaluation purposes.



Local Concerns

To recruit and retain the highly specialized work force required, the Navy provided housing, food and medical services, schools and recreational facilities, as well as many other community services. After World War I, the Navy Bureau of Yards and Docks, the organization responsible for housing design and layout at Dahlgren, opted to adopt the newest theories of suburban planning, including the incorporation of main thoroughfares, curving streets, parks, and open spaces. Other developments during this era included the construction of a golf course on reclaimed marshland in 1927.

At the turn of the century, the oyster harvest from the Chesapeake region was the world's largest, and millions of pounds of crab and shad were also being realized. Though this yield began to decline in the 20th century due to destructive harvesting techniques, the Navy activities at Dahlgren posed little to no restriction on the industry.

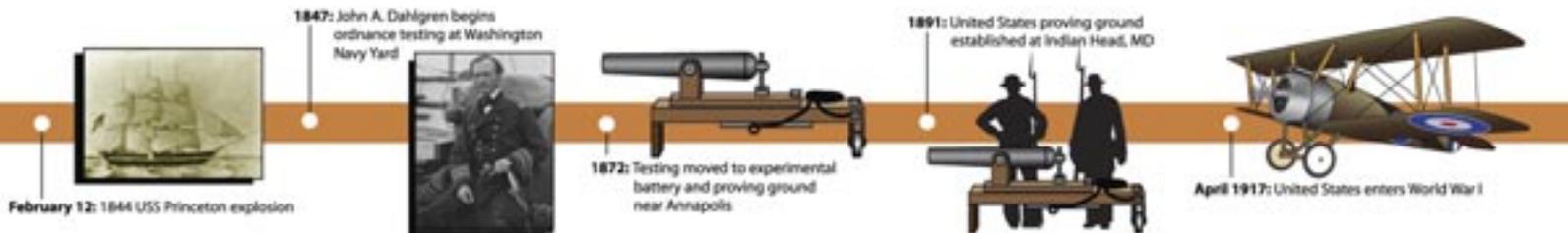
Although the Navy has not had a significant impact on the local fishing industry, one impact that has endured throughout the Navy's history at Dahlgren is mission-related noise. As the surrounding community and the Navy's activities grew, so did noise complaints. As there was no longer an option to move to a more remote location, the Navy sought

ways to accommodate both their mission and their neighbors.

Since 1975, in an effort to reduce noise complaints from surrounding communities, the Navy at Dahlgren has used the Sound Intensity Prediction System (SIPS) to predict noise impacts to sensitive surface areas prior to gunfire and ordnance treatment operations. These noise predictions have helped the Navy determine whether to go forward with an operation or wait until conditions provide more favorable predicted noise levels at sensitive surface areas. Today, NSWC Dahlgren has a formal outdoor noise management process that includes mitigation measures to ensure Navy

personnel and the public are not exposed to hazardous noise levels.

The Navy at Dahlgren today also has a process for managing public boat traffic in the Potomac River Test Range (PRTR). The Range Operations Center (ROC) notifies the public of any Navy activities that will restrict access within and from Upper Machodoc Creek or when any test is scheduled to take place before or after normal PRTR operating hours (8 am to 5 pm weekdays). Notification—including information on daily range schedules, types of testing, use of substances such as smoke or lights, hours of testing, where on the PRTR the tests will occur, whether tests are on schedule, whether





Dahlgren has always been an important national resource for testing naval guns and ammunition.



noise will be made, and contact numbers for additional information—is provided on the NSWC Dahlgren range website, as well as via a toll-free information line and local newspapers. In addition, the ROC coordinates with operators of private vessels via range control boats or marine radio to minimize delays when activities are taking place on the PRTR and public access to an operational area is restricted.

Vessels are allowed to pass through PRTR operational areas during lulls in testing; in fact, delays for smaller craft are typically no more than 30 minutes. For larger vessels that must use the shipping channel in the middle of the range, delays are normally no longer than one hour.

A History of Accomplishments

Dahlgren has always been an important national resource for testing naval guns and ammunition. In 1918, it began its role as a proving ground with the successful firing of a 7-inch, 45-caliber tractor-mounted gun. In 1919, an Mk II, 14-inch/50-caliber railway gun was developed. This gun, mounted on a railway car, was utilized in the closing months of World War I. Dahlgren Naval Proving

Ground’s developmental and experimental work increased dramatically when Dr. Louis Thompson became the civilian director in April 1923. Thompson’s work was experimental and based in the Navy’s post-war interest in physics and high-level mathematics. Between 1923 and 1925, Thompson led such prescient projects as automatically piloted and radio-controlled aircraft, or flying

bombs, much like today’s unmanned aerial vehicles or drones. However, budgetary issues forced the discontinuation of these projects (Rife and Carlisle).

During the 1920s and early 1930s, various iterations of the Norden bombsight were tested at Dahlgren. Named for Carl Lukas Norden, the mechanical engineer largely respon-



World War I tractor mounted gun.



Spring 1918: Hydrographic engineer Sweption Earle lays out new proving ground at current location.

1922: Unmanned “flying bomb” completes successful 25-minute flight



1932: Carl Norden contracted to develop high-tech bombsights to Navy and Air Force



December 7, 1941: United States enters World War II



Early 1940s: Increased proof testing. Dahlgren expands by 3,500 acres



sible for its development, this gyro-stabilized bombsight allowed accurate bombing from high-altitude aircraft and became the standard for all bombers in World War II. In the early 1940s, scientists at Dahlgren worked on a special top-secret project that, unbeknownst to them, was the triggering device for the atomic bomb.

The Navy continued testing gun components, projectiles, and fuzes at Dahlgren after World War II. However, this role gradually diminished as Dahlgren, building upon its early use of simple computers in developing new technologies, evolved into one of the Navy's primary research centers. For instance, during the height of the Cold War in the 1950s, the Navy sponsored development of the Naval Ordnance Research Calculator, a first generation vacuum tube computer (the most powerful of the time) and selected Dahlgren as its installation site. In 1955, Dahlgren was designated as a prime Bureau of Ordnance agency for computation, ballistics, and warhead characteristics.

In 1957, the Soviet Union launched the Sputnik I satellite. Two years later, the Naval Space Surveillance Operations Center was established at Dahlgren's Computation and Analysis Laboratory to monitor foreign satellites. At this time, the Navy officially recognized the change in Dahlgren's mission from that of a traditional

proving ground to a research and development facility by designating Dahlgren as a weapons laboratory.

At the beginning of the 1970s, the Navy designated Dahlgren as the lead laboratory for biological, chemical, and surface weapons, with a particular focus on surface gunnery systems. By 1972, computing requirements had increased, and consequently, a 6700 mainframe computer replaced the Naval Ordnance Research Calculator. Two years later, the Navy consolidated Dahlgren with the White Oak Naval Ordnance Laboratory, located in Silver Spring, Maryland. This created the Navy's largest Research, Development, Test, and Evaluation (RDT&E)

center, which became known as Naval Surface Weapons Center Dahlgren Laboratory (NSWC DL).

In 1976, the Navy chose NSWC DL to develop the proposed Aegis Combat System, designed to use powerful computers and radar to track and destroy enemy targets and to defend against air, surface, and subsurface threats. This brought NSWC DL into the emerging field of systems engineering. Other technological advances created during the late 1970s and early 1980s included targeting software for Tomahawk cruise missiles, the Phalanx Close-in Weapons System for defense against anti-ship missiles, and improvements to the Aegis system. In 1984, the



Historic naval cannon.



In the early 1940s, scientists at Dahlgren worked on a special top-secret project that, unbeknownst to them, was the triggering device for the atomic bomb.

Cruise Missile Weapons Systems Division was established, and two years later NSWCDL became the lead laboratory for the standard surface-to-air missile. Given these expanded areas of interest, in 1989 the Navy officially recognized NSWCDL as a warfare center, rather than a weapons center.

NSWCDL played a large role in the early 1990s in Operations Desert Storm and Desert Shield, including:

1. Upgrading threat libraries for Saudi Arabian ships
2. Developing chemical, biological, and radiological defense systems
3. Creating an "Identification Friend-or-Foe" device to help distinguish types of ground vehicles in order to prevent friendly-fire incidents

In January 1992, the Navy combined the following three entities into the new Naval Surface Warfare Center Dahlgren Division:

1. NSWCDL
2. White Oak Laboratory
3. Panama City, Florida Coastal Systems Station

In the early- to mid-1990s, new NSWC Dahlgren programs at Dahlgren included the present day Joint Warfare Analysis Center and the Department of Defense Counterdrug Technology Development Program. In the late 1990s, as the U.S. military's focus shifted away from traditional warfare and toward counter-terrorism measures, Admiral Jay L. Johnson established the Naval Operations Other Than War Technology Center at Dahlgren.

As a result of base realignment and closure, White Oak Laboratory formally closed in 1997. Personnel and functions from that facility were reassigned to warfare centers at Dahlgren, Virginia; Panama City, Florida; Carderock, Maryland; and Indian Head, Maryland. In 1999, work began at Dahlgren on a new chemical-biological laboratory, and in 2003, major reorganizations began to more effectively address new threats to security and to counter terrorism.



Osprey nest at NSWC Dahlgren.

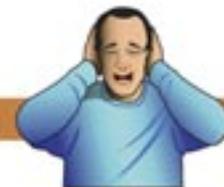


1976: Development of Aegis Combat system

1991: Downsizing forms new Naval Surface Warfare Center Carderock Division



2005: Electromagnetic railgun project initiated



2011: Noise management process established



2013: Final Environmental Impact Statement issued

Dahlgren Today

Given the historic shipboard disaster that led to the establishment of Dahlgren, it is no surprise that to this day the RDT&E performed at the facility includes work to ensure the safety and capability of guns, ammunition, and other types of ordnance. The gun emplacements at Dahlgren are capable of firing all types of naval guns, including all naval guns currently used in the Fleet as well as older guns no longer used by the Navy but still used by its allies.

The Electro-magnetic Railgun

The 32-megajoule (MJ) electromagnetic railgun is a long-range weapon that fires precision-guided projectiles using electricity instead of chemical propellants. (Note: 32 megajoules of energy is equivalent to a vehicle weighing one imperial ton (2,240 pounds) travelling at 100 miles per hour.) Electricity is stored over several

seconds in a pulsed power system, and when an electric pulse is sent to the railgun, magnetic fields created by high electrical currents accelerate a sliding metal conductor, or armature, between two rails to launch projectiles. Using high-power electromagnetic energy instead of explosive chemical propellants to propel projectiles farther and faster than any preceding gun, the electromagnetic railgun satisfies the Navy's requirement for a long-range, multimission-capable weapon. This innovative weapon system will enable the Marine Corps and the Navy to operate farther from hostile shores and out of the range of enemy fire.

Complementing kinetic weapons currently onboard surface combatants, the electromagnetic railgun offers a few specific advantages. For example, the electromagnetic railgun projectile costs an order of magnitude less than an interceptor missile. In addition to providing the capability to shoot down incoming

aircraft, cruise missiles, and even ballistic missiles, the electromagnetic railgun enables the conservation of expensive missiles for use against only the most complex threats, thereby preserving the capacity of the current missile inventory.

In addition to the electromagnetic railgun's innovative propulsion system, the high-velocity projectiles fired are expected to be able to destroy targets using kinetic energy—the sheer force of the impact—rather than conventional explosives. Electromagnetic railgun projectiles offer distinct logistical advantages over propellant-based gun projectiles as well because thousands of projectiles can be loaded into the same magazine volume that accommodates only hundreds of propellant-based projectiles. Since electromagnetic railgun projectiles do not require explosive chemical propellants, explosives-related hazards and logistics are minimized.



One of two ONR electromagnetic railgun industry prototype launchers.
John F. Williams

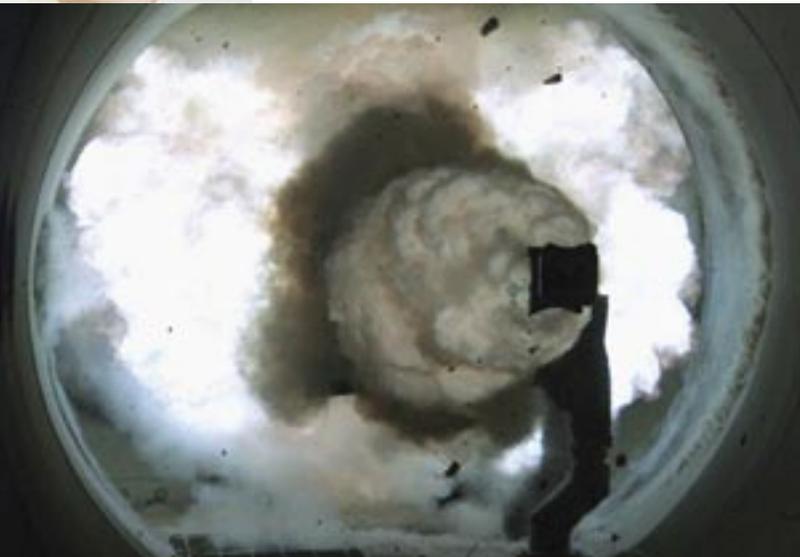


Electromagnetic railgun at NSWC Dahlgren.



ABOVE RIGHT: Charles Garnett, left, NSWC Dahlgren Division Electromagnetic Railgun project manager, briefs Vice Admiral Kevin McCoy, commander of Naval Sea Systems Command (NAVSEA), Brian Persons, NAVSEA deputy commander, and Rear Admiral James Shannon, commander of Naval Warfare Centers, following the world record-setting 33 MJ shot of the electromagnetic railgun in December 2010.

RIGHT: In 2008, Jim Poyner, senior engineer, Gun Weapons Branch, gives then-Chief of Naval Operations Admiral Gary Roughead a tour of the electromagnetic railgun at NSWC Dahlgren.



LEFT: High-speed camera image of the electromagnetic railgun firing a world-record setting 33 MJ shot in December 2010. At full capability, the railgun will fire a projectile more than 100 nautical miles.

BELOW LEFT: The electromagnetic railgun is the result of Naval Science and Technology research being developed by ONR as one of several Innovative Naval Prototypes.

John F. Williams



Photograph taken from a high-speed video camera during a record-setting firing of the electromagnetic railgun at NSWC Dahlgren in January 2008.

Initiated in 2005, phase I of the electromagnetic railgun Innovative Naval Prototype (INP) focused on the development of launcher technology with adequate service life, development of reliable pulsed power technology, and component risk reduction for the projectile. Phase I of the INP was also focused on increasing the state-of-the-art in railgun muzzle energy from 8 MJ to 32 MJ. Phase II, which started in 2012, advances the technology for transition to an acquisition program and will concentrate on demonstrating a 10-rounds-per-minute firing rate. Thermal management techniques required for sustained firing rates will be developed for both the launcher system and the pulsed power system.

At full capability—when the electromagnetic railgun is tested on a larger range than Dahlgren’s or on a ship at sea—a 32-MJ muzzle velocity electromagnetic railgun is expected to fire a projectile more than 100 nautical miles (nm) using hypersonic muzzle and impact velocities. In contrast, the standard gun used on Navy ships—the MK 45 five-inch gun—has a range of slightly more than 13 nm and a subsonic muzzle velocity.

The Navy located the 32-MJ electromagnetic railgun system on a Dahlgren range because of NSWC Dahlgren’s extensive experience in conducting high-energy electromagnetic pulsed-power research and because Dahlgren was the only location that combined sufficient real estate with the proper infrastructure to support the system. The full-scale electromagnetic railgun system could be integrated into Dahlgren’s existing naval surface weapons RDT&E program run by Dahlgren’s resident scientists and engineers, who are

among the nation’s foremost experts in combat and weapons systems.

To prepare for this increased activity, an Environmental Assessment (EA) was prepared for electromagnetic railgun RDT&E facility construction and operation at Dahlgren. In 2009, based on the analyses presented in the EA and coordination with the Commonwealth of Virginia Departments of Historic Resources, Conservation and Recreation and Game and Inland Fisheries, and the U.S. Fish and Wildlife Service, the Navy issued a Finding of No Significant Impact (FONSI) recognizing that the proposed action would have negligible impact on the coastal zone, cultural resources, noise levels, and health and safety and that no significant impacts to the natural and human environment were expected.

High Energy Lasers

Other energetic innovations developed by NSWC Dahlgren involve the use of lasers. (Note: The term “laser” is an acronym for Light Amplification by Stimulated Emission of Radiation.)

While most light is incoherent—made up of many frequencies that scatter and diffuse quickly (such as a flashlight beam)—lased light is coherent and able to focus to a tight spot. Lasers are being pursued as directed-energy weapons because when this intense beam is focused on a target, energy is transferred to a target, producing a non-lethal or lethal effect.

Directed-energy weapons such as High Energy Lasers (HEL) allow the Navy to counter asymmetric (unconventional) threats, including unmanned and light aircraft and small attack boats that could be used to deny U.S. forces access to certain areas. Offering an affordable and safe way to target threats at the speed of light with extreme precision and an unlimited magazine, despite the challenges of being on a ship at sea, HELs have already demonstrated themselves as critical targeting tools, and strategically, the Navy needs this technology to defend against enemy attacks. The challenge is developing HELs that can be used effectively in maritime environments where laser



An artist rendering shows the ONR-funded electromagnetic railgun installed aboard the joint high-speed vessel USNS Millinocket (JHSV 3).

High Energy Lasers offer an affordable and safe way to target threats at the speed of light with extreme precision and an unlimited magazine

beams become less coherent and more diffuse, as well as more easily distorted by density and temperature variations, than in dry conditions.

Selected by the Navy and the Office of Naval Research (ONR) as the center of excellence for High Energy Laser RDT&E, NSWC Dahlgren has been performing indoor laser RDT&E at Dahlgren since the 1970s and outdoor laser RDT&E since the early 1990s. Dahlgren provides state-of-the-art facilities for this work, including the nation's premier solid-state fiber laser laboratory—the Electromagnetic Research and Engineering Facility as well as the Counter Explosive Test Facility.

The Directed Energy Warfare Office (DEWO) at NSWC Dahlgren is a leader in the transition of HEL capability from science and technology to warfighting solutions and systems, with responsibilities that include stewardship of basic research, concept development, experimentation, modeling and simulation, war gaming, requirements definition, research and system development, prototyping, system engineering and integration, product development test and evaluation, test and evaluation support, and major product improvements. The DEWO works within and collaboratively across the Navy to ensure the total set of capabilities required to acquire, field, and sustain directed energy systems is developed and maintained.

In addition to having the Navy's leading experts in HEL RDT&E already on site, NSWC Dahlgren also

offers testing in a coastal, maritime environment and has fully-instrumented operating ranges and facilities capable of accommodating land-to-land and land-over-water-to-land range tests of HELs. Laser operations areas are integrated with the existing RDT&E ranges, which have been safely performing maritime RDT&E testing for over 90 years.

Environmental management has also kept pace with evolving laser technology, and the history of laser RDT&E at Dahlgren is an important consideration when evaluating the environmental impact of proposed laser actions. This history was noted in an October 2009 Environmental Assessment (EA) for expansion of the HEL RDT&E program at Dahlgren. Analysis presented in the EA demonstrated there would be no significant environmental impacts from the proposed action.

Over the summer of 2014, one of the new HEL systems developed at NSWC Dahlgren—an updated version of the Laser Weapon System (LaWS)—was deployed to the Persian Gulf aboard the USS Ponce for at-sea testing.

Unlike some of its predecessors, LaWS is a solid state fiber laser, meaning that solid materials such as specially treated glass or crystals are used to generate powerful laser beams and that the material producing the laser's light is an optical fiber. Given that fiber lasers have been used for years in industry to cut and weld metal, the Navy found this proven commercial technology to be an attractive design option. Consequently, LaWS leveraged advances in commercial laser technology and also borrowed other technology from industry, such as a commercial tracking mount and commercial optics with customized software controls.



An updated version of the Laser Weapon System was deployed to the Persian Gulf aboard the USS Ponce for at-sea testing.

MC3 Kayla Jo Finley



Ron Flatley, left, high-energy laser area director at the Directed Energy Warfare Office, briefs Chief of Naval Research Rear Admiral Matthew Klunder on the Solid State Laser-Quick Reaction Capability system's beam director.
John Joyce

In 2009, during tests conducted in California, a LaWS prototype developed by the DEWO HEL team successfully demonstrated tracking, engagement, and destruction of five threat-representative Unmanned Aerial Vehicles (UAV). This was a first for the Navy and the results validated the military utility of HEL for counter-UAV missions. Then in 2010, in tests conducted off the coast of southern California, the laser recorded four shots and four kills while demonstrating an ability to destroy materials used in rigid-hull inflatable boats, as well as to jam electro-optical and infrared sensors.

The 2014 deployment follows successful tests conducted in 2012, whereby LaWS downed several unmanned aircraft. Since that time, LaWS has been upgraded and has proven that targets tracked with a Phalanx Close-In Weapon System can be shared with the laser's targeting and tracking system. Similar to a video game controller, the single laser

weapon console allows a sailor aboard the ship to operate all laser functions as commanded, from disabling to completely destroying a threat.

In addition to being highly effective weapons, HELs are also cost-effective. For example, LaWS cost the Navy a modest \$40 million through 2012, and upgrades for the USS Ponce deployment are expected to cost another \$38 million. At a projected cost of less than one U.S. dollar per shot, these weapons are far less expensive to operate compared to existing technology, such as a 5-inch gun shell at \$5,000 or a Tomahawk cruise missile, which comes in at \$1.3 million.

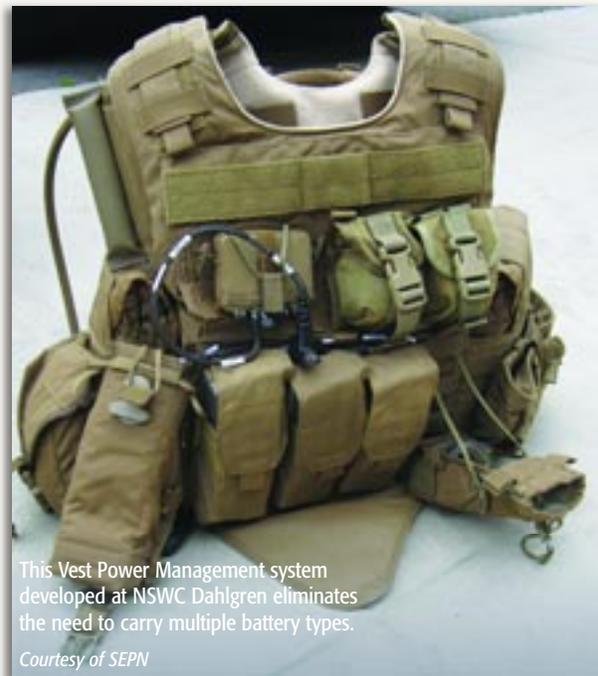
Other Energy Innovations

NSWC Dahlgren scientists and engineers today perform RDT&E that delivers innovative technology to the warfighter, and in some cases, significant energy and environmental innovation as well. The Squad Electric Power Network (SEPN) project is one



A Scan Eagle UAV is launched from the NSWC Dahlgren test range to confirm the Navy Expeditionary Overwatch (NEO) system's ability to detect and engage fictional insurgents. NEO is the collection, integration and demonstration of manned and unmanned engagement systems, platforms, and integrated sensors to enable tactical decision making by agile expeditionary units that conduct distributed operations in both ground and littoral environments.

John F. Williams



This Vest Power Management system developed at NSWC Dahlgren eliminates the need to carry multiple battery types.

Courtesy of SEPN

The coupling of power management and energy harvesting allows troops to sustain their squad's electronic needs while in austere locations.

such example. The SEPN project team has developed a wearable power management system called the Vest Power Manager (VPM) which interfaces with all types of batteries and devices, eliminating the need to carry multiple battery types. The SEPN provides troops with the capability to interface with "on the move" energy harvesting technologies. This coupling of power management and energy harvesting allows troops to sustain their squad's electronic needs while in austere locations, thus reducing the need and frequency of re-supply.

Currently, the SEPN project continues forward progress and has been successfully prototyped and evaluated by users. Following a Marine Corps Base Camp Pendleton demonstration in May 2014 and a warfighting exercise in July 2014, NSWC Dahlgren plans to transition the system to the Marine Corps Systems Command in September 2014.

In another example, the NSWC Dahlgren Manned Systems and Platform Branch is supporting the United States Marine Corps Auto Cell with the integration of an Auxiliary Power Unit (APU) onto the Medium Tactical Vehicle Replacement (MTVR) to demonstrate potential increases in fuel efficiency. Reports indicate that the MTVR spends as much as 50 percent of its

mission profile stationary with the engine idling. The APU allows the operator to shut off the truck's main engine and continue to conduct silent-watch operations powering radios and counter-Improvised Explosive Device jammers with the APU. In addition, the integration kit includes environmental control systems to provide cabin heat and air conditioning when the truck's main engine is not running. In an effort to maximize fuel efficiency and minimize kit cost, much of the legacy vehicle environmental systems such as dashboard controls, blowers, and the air conditioning compressor, refrigerant and condenser, are utilized with the new kit. The APU provides 10 kilowatts of AC and DC power for use while stationary or on the move. The APU can be removed from the truck quickly to provide 'exportable' power to a Forward Operating Base while the truck continues on to support other logistics missions. The first truck was delivered in February to support pre-deployment Integrated Training Exercise 3-14 (ITX-3-14) at Marine Corps

Base (MCB) Twenty-Nine Palms. A second truck will be sent to the Aberdeen Test Center for a full environmental evaluation to determine how much fuel is being saved with the APU, and three additional trucks were sent to MCB Twenty-Nine Palms by the summer of 2014 to support ITX-5-14 and the Experimental Forward Operating Base (ExFOB).

Evolution of Environmental Commitment

In order to keep pace with technological advancements, environmental management has also evolved. Prior to the 1970s, nationwide disposal practices were very different from those used today, which are based on our enhanced knowledge of contaminants and

LEFT: Squad Leader checks State of Charge and Power information on display of his VPM.

RIGHT: Squad Leader using his VPM to power his radios.

Courtesy of SEPN



associated risks to human health and the environment. Disposal formerly meant placing waste, both solid and liquid, into unlined landfills. Today, remediation has been completed on most of these disposal sites at Dahlgren, and natural resources are managed based on an Integrated Natural Resources Management Plan. NSWC Dahlgren operates under environmental permits, with activities well within permitted limits and meeting all environmental requirements. In addition, NSWC Dahlgren supports an environmental stewardship goal to sustain multiple uses of natural resources—such as mission activities, forestry, outdoor recreation, aesthetics, and ecosystem conservation—over the long-term, while promoting the health of the natural systems within which these activities occur. One example of successful natural resources management at Dahlgren is the growth of the bald eagle population over the past two decades. Once-rare sightings of this protected species have become very common, with up to six active nests each year. To help revive the bald eagle population, Dahlgren established protective zones around existing and new bald eagle nesting sites and restricted activities within those zones along with protecting their foraging habitat. Bald eagle populations continue to be monitored with aerial nest surveys conducted annually.

Migratory bird nesting habitat has also been improved at Dahlgren by the installation, monitoring, and maintenance of nesting boxes for eastern bluebirds and wood ducks. These and other conservation efforts help to support regional goals under the North American Waterfowl Management Plan and the Joint Agreement of

Cooperation to Perpetuate North American Waterfowl Populations, which was signed by the United States Fish and Wildlife Service and the Department of Defense in 1988.

Consistent with the NSWC Dahlgren environmental policy, each test at Dahlgren is planned to minimize environmental impacts and anticipate the unexpected. Environmental considerations are written into the standard

operating procedures for each test activity, and RDT&E activities are conducted in strict accordance with all environmental regulations.

In addition to integrating environmental considerations into ongoing RDT&E, NSWC Dahlgren simultaneously pursues environmental innovation. For example, the building that houses the chemical/biological laboratory at Dahlgren has been chosen by



Great Blue Heron.



NSWC Dahlgren wetlands habitat.



Nowhere else has such a comprehensive EIS covering so many baseline activities and such extensive future RDT&E been accomplished.



the Navy's Energy Technology Validation program to install an air-cooled magnetic bearing chiller for demonstration. The new chiller utilizes an oil-free compressor, thereby providing a more sustainable system, and an embedded computer capability that improves the ability to document system performance. This technology supports the U.S. Environmental Protection Agency's Responsible Use Vision, which encourages manufacturers, owners, and system designers to invest in those technologies that provide the highest efficiency and lowest emissions on a sustainable basis and where performance can be documented on an ongoing basis.

A Groundbreaking Environmental Impact Statement

An Environmental Impact Statement (EIS) is a detailed study prepared according to the National Environmental Policy Act and Council on Environmental Quality regulations for federal actions that may have significant effects on the quality of the

human and natural environments. An EIS provides the public and agency decision-makers with an assessment of the potential consequences of a proposed federal action on the affected environment.

To evaluate the environmental effects of increased RDT&E activities planned at Dahlgren, NSWC Dahlgren recently completed an EIS for Outdoor Research, Development, Test, and Evaluation Activities. The first of its kind, this EIS represents a novel approach to performing environmental planning simultaneously across multiple, diverse mission areas. Nowhere else has such a comprehensive EIS covering so many baseline activities and such extensive future RDT&E been accomplished. Despite the challenges presented by the sheer scope of this assessment, the end result not only assures that NSWC Dahlgren can continue their mission uninterrupted, with confidence in their environmental planning, but also establishes a model for others

to use in their environmental planning processes.

The first step in the EIS process is determining what is presently happening to be able to assess possible future activity and analyze the impacts that that activity may have. Over three years, data were collected and more than 75 NSWC Dahlgren program managers were interviewed in an effort to accurately describe existing conditions, analyze future needs, and develop alternatives for future levels of NSWC activity at Dahlgren.

Activities of local economic interest were evaluated in the EIS—such as the impact to the local commercial fishing industry. Commercial fishing in the Potomac River currently involves fishing, crabbing, and less frequently, oystering. EIS study efforts included surveying local fishermen, and although there were few responses, those that did participate indicated no issues with NSWC Dahlgren activities, presumably because most fishing activity takes place in the lower danger zone which has and would continue to

The Energy Technology Validation Program

The purpose of the Navy's Energy Technology Validation program is to assess the effectiveness and the viability of Navy-wide implementation of selected technologies that have potential for reducing the Department of the Navy's energy consumption. For more information about this program, visit <https://navyenergy.navfac.navy.mil/projects/techval.html>.



have (under the EIS preferred alternative) relatively few testing activities compared to the middle danger zone. Fishermen are usually able to work around activities in the middle danger zone. Thus, no significant adverse impacts are expected. Furthermore, the Navy has found that action proposed in the EIS would result in no or minimal adverse impacts to the coastal zone resources of Virginia and Maryland and is consistent with the enforceable policies of both the Virginia Coastal Zone Management Plan and the Maryland Coastal Zone Management Plan.

In support of the EIS, a biological assessment was conducted to evaluate potential effects to two sturgeon and three sea turtle species that occur in the Dahlgren vicinity. From this assessment, NSWC Dahlgren determined that the proposed projects were not likely to adversely affect any species listed as threatened

or endangered under the jurisdiction of the National Marine Fisheries Service (NMFS). NMFS concurred with this determination.

Range Management

Other important assessments conducted in support of the EIS were the Range Sustainability Environmental Program Assessment (RSEPA) and the Water Range Sustainability Environmental Program Assessment (WRSEPA). The Navy's RSEPA process was developed to provide a consistent approach for assessing and addressing the environmental condition of the Navy's operational land ranges. When the Navy's water range sustainability policy was released, NSWC Dahlgren was developing the draft EIS and recognized that much of what would be entailed in a WRSEPA would feed directly into the EIS effort. Likewise, much of what would be done for the EIS had direct applicability to the WRSEPA.

For example, numerous descriptions, such as the ranges themselves, land-based assets firing into the water bodies, underwater sanctuaries, habitats, commercial fishing, endangered species, and marine mammals are all necessary parts of the EIS and the WRSEPA. As a result, NSWC Dahlgren decided to pursue both efforts concurrently.

Record of Decision

In October 2013, the Navy prepared a Record of Decision (ROD), which established the proposed action, described the public involvement and agency decision making process, and presented the commitments to avoid, reduce or minimize impacts to affected resources. The final EIS analysis determined that all alternatives would result in no significant impacts and therefore, will not contribute significantly to cumulative impacts on any of the resources analyzed. While the ROD marks the end of the EIS process, the business



Fishing in the lower danger zone is very rarely impacted by testing activities.

Today, NSWC Dahlgren focuses not only on meeting existing operational needs, but also on fundamentally reshaping the way the U.S. Navy will fight and defend the country in the future.

of continued environmental compliance and stewardship continues.

Future Innovation

Today, electromagnetic railgun science and technology are planning the transition from RDT&E to an acquisition program designed to meet warfighting needs, thereby requiring NSWC Dahlgren to look beyond the Dahlgren environment to other test environments. Recently, the railgun program has begun a series of railgun projectile tests out of a powder gun at the White Sands Missile Range. These tests precede a railgun demonstration from the flight deck of a Joint High Speed Vessel (JHSV) in 2016.

The Dahlgren “Who’s Who”

The naval base at Dahlgren is part of the Naval Support Activity South Potomac (NSASP), a major shore command within Naval District Washington. NSASP serves as the host command for Naval Support Facility (NSF) Dahlgren, Virginia and Naval Support Facility Indian Head, Maryland. As the host command, NSASP provides base operations support for about two dozen commands and tenant activities, a workforce approaching 10,000, and over 900 base residents between both installations. NSWC Dahlgren represents the largest tenant activity at NSF Dahlgren.

While the JHSV is not an operational platform for the electromagnetic railgun, this ship’s wide flight deck and ample cargo bay are well-suited for at-sea testing because a railgun and supporting equipment can be temporarily deployed on the ship without intrusive modification. And while the gun will not be integrated into the JHSV systems, the Navy does plan to integrate the electromagnetic railgun on a ship before the middle of the next decade. In addition to the capabilities provided at sea, the Navy is working with the U.S. Army on potential ground combat applications for the electromagnetic railgun, as well as the Missile Defense Agency on potential future applications for the weapon.

The next step proposed for the electromagnetic railgun program would occur at the Naval Sea Systems Command’s Surface Combat Systems Center, located on the National Aeronautics and Space Administration’s Wallops Flight Facility on Wallops Island, Virginia. Here, the Navy would install a 5-inch powder gun and an electromagnetic railgun, test and integrate Hypervelocity Projectiles (HVP) with the electromagnetic railgun, and integrate the HVP/electromagnetic railgun weapon system with combat systems.

With the Secretary of the Navy’s decision to make the next Navy surface combatant ship—the DDG-1000—all-electric, a fundamental shift to electric propulsion has begun that will open the door for a new generation of electric weapons, including the electro-

magnetic railgun and HELs. Integrated power systems can dedicate most of the power onboard the ship to electric propulsion motors for high-speed operations, but when the tactical situation requires, the power can be shared with electric weapons and sensors.

Moving into the Future while Honoring the Past

When Rear Admiral Dahlgren established an over-water proving ground for naval ordnance, he laid the groundwork for what is now the nation’s largest fully instrumented, over-the-water gun-firing range and the Navy’s primary RDT&E facility for surface-launched weapons systems.

Today, NSWC Dahlgren focuses not only on meeting existing operational needs, but also on fundamentally reshaping the way the U.S. Navy will fight and defend the country in the future. By integrating environmental management into their mission, NSWC Dahlgren, with its unique coastal environment, extensive and cutting-edge equipment, fully integrated RDT&E capabilities, and extraordinary team of scientists and engineers remains at the core of U.S. Naval strength—a position held at Dahlgren for nearly a century. ⚓

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Vieques Community Outreach Promotes Safe & Efficient Cleanup of Unexploded Ordnance

Protecting the Public, Reducing Risk & Controlling Cleanup Costs are Top Priorities

DURING DECADES OF military training, the U.S. Navy and its allies expended thousands of munitions at the Vieques Naval Training Range, Vieques Island, Puerto Rico. After training exercises ceased in the early 2000s, personnel from the

A Half Century of Military Training

From the 1940s until 2003, the U.S. Navy used portions of Vieques Island and the surrounding waters for an array of live and inert ordnance military training activities, including amphibious exercises, naval gunfire,



The Navy is keeping people safe while finding a cost-effective way to clean up the hazardous remnants of more than a half century of military training.

Naval Facilities Engineering Command (NAVFAC) Atlantic began cleanup of the closed range under the Munitions Response Program. So far, approximately 40,000 munitions items have been removed safely from the former range, which is now a National Wildlife Refuge managed by the U.S. Fish and Wildlife Service (USFWS). The refuge is located adjacent to the towns and residential areas of Vieques, and NAVFAC has worked closely with the local community to promote awareness of the dangers of unexploded ordnance (UXO) and to develop a safe and efficient cleanup program.

artillery fire, and air-to-ground bombing. As a result, thousands of acres on the east end of the island were impacted by a wide variety of munitions, including bombs, rockets, guided missiles, sub-munitions, mortars, and projectiles.

Vieques currently has a population of over 9,000, and thousands of tourists and recreational boaters visit the island every year. Although many beaches are open to the public, some beaches and their surrounding waters, as well as thousands of acres of inland area, still pose an explosive hazard from UXO. The Navy is keeping people safe while finding a

cost-effective way to clean up the hazardous remnants of more than a half century of military training.

A Legacy of Distrust

Years of tension on Vieques were brought to a head in April 1999, when a local Navy security guard was killed and four others were injured during a live fire training accident. Hundreds of demonstrators established protest camps, and the protests attracted the attention of activists from around the world, including environmental attorney Robert F. Kennedy, Jr. and actor Edward James Olmos. The public outcry ultimately culminated with a

decision to close the training range. In 2003, the range was transferred to the jurisdiction of the Department of the Interior for use as a National Wildlife Refuge, administered by USFWS. Although the protests ended, local residents felt lingering resentment toward the Navy over health and safety, economic development, and the island's natural and cultural resources. As the Navy shifted from military training to munitions cleanup and environmental restoration, the majority of the local community entered into a class action lawsuit filed against the Navy regarding alleged health and economic impacts from operations at the former range. The long-term distrust within the local community compounded the technical challenges related to the cleanup, and cleanup workers were viewed with suspicion.

Building Trust & Reducing Cleanup Cost through Innovative Community Outreach

NAVFAC began its community outreach program on Vieques in 2000, prior to the closure of the range. Even today, community outreach focuses on overcoming lingering distrust, building mutual understanding, and fostering two-way communication with community members about the progress of the Navy's munitions response and other environmental restoration activities. This effort requires sensitivity to cultural differences and

Vieques Restoration Overview

THE NAVFAC ENVIRONMENTAL Restoration Program is dedicated to conserving, protecting, and restoring the environment and natural and cultural resources at U.S. Navy facilities worldwide. The munitions response work at the former Vieques Naval Training Range, Vieques Island, Puerto Rico poses unique challenges to NAVFAC and contractor staff. Dense jungle covers much of the work area, requiring painstaking removal of vegetation by hand to expose and safely remove a wide array of munitions types. Workers must deal with high temperatures and humidity, stinging insects, thorny plants, steep slopes, and intense rains. Munitions removal activities must limit disturbance of endangered species and valuable habitat, such as sea turtles, coral, mangrove forests and dwarf coastal vegetation.

The Vieques restoration team was recognized with the 2009 and 2011 Chief of Naval Operations Award and the 2009 Secretary of the Navy Award for Environmental Restoration.

Munitions and related debris pulled from the former Vieques Naval Training Range.



an understanding of the political history associated with the Navy's presence on the island.

Because the primary language of most residents of Vieques is Spanish, the community outreach program is bilingual. All outreach materials are produced in both English and Spanish, and interpreters are present at public meetings to provide simultaneous translations of presentations and discussions. The island does not have a newspaper, so local megaphone trucks are hired to drive through the towns and neighborhoods to publicize public meetings and community events.

The Navy's community outreach program strives to involve local residents in the cleanup process to help create an efficient and cost effective program. The Navy's commitment to engaging the community in the cleanup process has reduced costs in a variety of ways. For example:

- The Navy has reduced the cost of cleanup by training and hiring local residents to work as UXO technicians, rather than bringing in non-residents to work on the island. In addition, the Navy uses local vendors for equipment, security, maintenance, and other services. Use of the local workforce has helped build trust within the community and produced an overall cost saving of \$25 million for the Navy (an average of \$3.6 million per year). In addition, integration of the local community into the cleanup program has contributed jobs and dollars to the struggling Vieques economy.



ABOVE LEFT: NAVAC Atlantic personnel teach UXO safety during the 2013 Vieques Environmental Fair.



ABOVE CENTER: Artillery rounds stockpiled for final processing.



ABOVE RIGHT: Protest signs were posted near the former Vieques Naval Training Range in 2001.

RIGHT: A protest mural was painted near the former Vieques Naval Training Range in 2001.

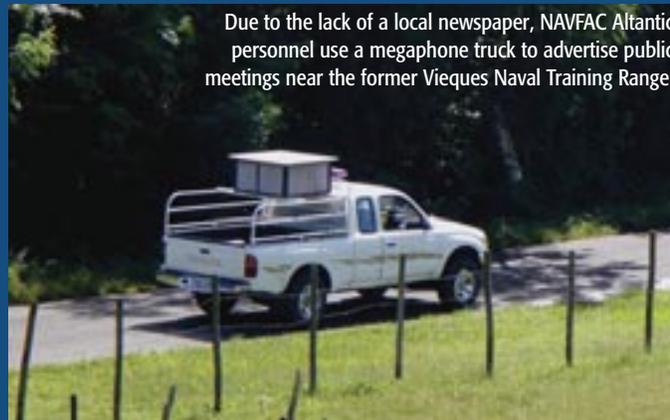
BELOW: U.S. Marines from Task Force Sledge Hammer train on the island of Vieques in August 2001.

Photographer's Mate 2 John Williams

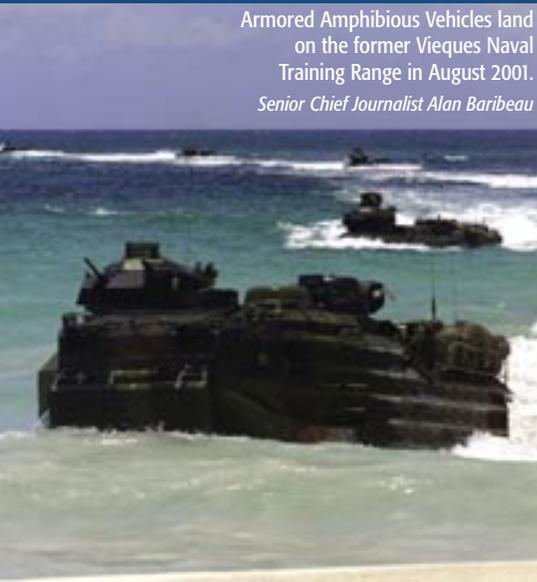


Armored Amphibious Vehicles land on the former Vieques Naval Training Range in August 2001.

Senior Chief Journalist Alan Baribeau



Due to the lack of a local newspaper, NAVAC Atlantic personnel use a megaphone truck to advertise public meetings near the former Vieques Naval Training Range.



NAVAC Atlantic personnel host a UXO site visit for community members.



Community outreach focuses on overcoming historical distrust, building mutual understanding, and fostering two-way communication.

- NAVFAC coordinated and led a public site visit to the Eastern Conservation Area on Vieques to demonstrate its sensitive ecology and promote an optimized approach to cleanup. Community leaders saw the value in preserving habitat and later spoke in support of the Navy's plan, which will protect public safety, preserve large tracts of sensitive habitat, and reduce the cleanup cost by \$8.5 million.

Promoting UXO Safety through Community Education

A critical objective of the community outreach program is to promote UXO awareness and safety, thereby protecting the local community and tourists from potential explosive hazards. The Navy conducts a variety of innovative activities to promote awareness and safety. Examples include:

- The Navy coordinated two Vieques Environmental Fairs through collaborative partnerships with local, state, and federal agencies. At these fairs, the Navy exhibit focused on UXO awareness, and Navy personnel taught safety procedures to follow if UXO is encountered. The fairs have attracted hundreds of local community members, including many school children, and have been covered by local and national news media.
- Monthly updates are distributed to the public via email or traditional mail for residents who do not have access to computers. These newsletters provide readers with information about the cleanup program, UXO safety, warnings about the dangers of trespassing, and contact information for Navy personnel who can answer questions and address concerns. In addition, informational flyers are placed at local businesses and other community gathering places.
- UXO warning signs are placed on beaches and roads, and warning buoys and barriers have been installed offshore. In addition, the Navy publishes UXO safety and awareness information in local news media. Many messages are geared specifically toward children to teach them not to pick up suspicious items that may be dangerous.
- In the decade since cleanup began, the Navy has made a genuine commitment to involve the local community. This outreach program has helped to reverse decades of distrust, thereby leading to more efficient and less costly cleanup efforts. In addition, Navy outreach has focused on educating the local residents and tourists about UXO safety, promoting awareness of what to do if UXO is encountered. Overall, the outreach program has been a success in protecting public safety and providing millions of dollars in cost efficiencies for the Navy.

Vieques at a Glance

VIEQUES IS A small island (about 20 miles long and four miles wide), located seven miles off the southeast coast of mainland Puerto Rico. The former Navy property comprises large areas on the eastern and western sides of the Island. After military training operations ended, the U.S. Congress transferred the majority of the property to the U.S. Department of the Interior to be managed as a National Wildlife Refuge by the USFWS. Additional property on the western end of Vieques was transferred to the Municipality of Vieques and the Puerto Rico Conservation Trust. In the center of the island, more than 9,000 residents live in or around two main towns—Isabel Segunda and Esperanza. Thousands of tourists visit Vieques each year to enjoy the beauty and serenity of island's beaches and surrounding waters.

For more information on the Vieques Environmental Restoration and Munitions Response Programs, visit www.navfac.navy.mil/vieques. 

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Conserving Our Nation's Only Native Cycad Species

NAVFAC Marianas Partners to Create Living Gene Bank

ISLAND LIFE IS difficult, just ask Guam's native cycad (*Cycas micronesica*) and the animals that rely on it. "This unique native tree spent eons as a mainstay of the islands' ecosystem" said Dr. Anne Brooke, Conservation Program Manager for Naval Facilities Engineering Command (NAVFAC) Marianas. "It was the most abundant tree in the forest then almost overnight it was decimated by a new invasive insect pest."

In 2003, the arrival of a new scale insect, the diaspidid scale, felled these trees until only seven percent remained by 2011. This valuable biological and cultural resource, known as fadang in the native Chamorro language, is now being considered for listing under the U.S. Endangered Species Act.

Cycads are an ancient lineage of plants, with fossil records indicating they were prevalent when dinosaurs roamed the earth. They were once found virtually worldwide, from as far north as Alaska and Greenland to as far south as Antarctica. Today, these plants are confined in nature to certain tropical and subtropical regions. Though cycads retain many primitive features, they were able to adapt to the global changes that rendered countless of their former co-inhabiting species extinct. The fadang was also able to adapt to Guam's particular climate challenges, including drought and typhoons.

Plants and animals that evolved on this remote island had few herbivores and predators until they were introduced by modern people. The fadang evolved without chemical defenses to keep pests away so when an alien pest arrives, the plants are crippled by the lack of natural resistance to herbivory. Scale insects are particularly invasive



Healthy fadang in the forest before scale insects arrived on Guam.

Thomas Marler



Reproductive female fadang with young exposed seeds.
Anne Brooke

as the young attach to the host plant and gain sustenance from the plant's juices. Additionally, Guam has no native scale predators, so the cycad trees fell quickly to the onslaught of tiny insects.

In the years since World War II Guam has hosted a catastrophe of invasive pests from around the world that have eaten the native flora and fauna. The most notorious example is the brown tree snake, which caused the loss of ten native forest bird species. Only small numbers of fruit bats, native lizards, and other native bird species remain on the island.

Brooke works with Dr. Thomas Marler of the University of Guam on a unique project that is giving fadang trees a chance at survival by conserving them in a living gene bank. Once the danger of the scale invasion on Guam's fadang became evident, NAVFAC Marianas acted rapidly to collect seeds that truly represented the pre-invasion population. This quick move was invaluable, as only seven percent of the cycad population remained only eight years after the devastating pest arrived. Had the seed scouting and harvesting not proceeded with such speed, it would have been too late because much of the Guam gene pool would have been lost.

In 2005, more than 3,000 cycad seeds were collected throughout Guam's varied habitats. The seeds were



Fadang infested with scale insect
(Inset shows scale on leaves.)
Anne Brooke, Thomas Marler



Dr. Thomas Marler (left) discusses cycad biology with Sam Palacios. Palacios was representing the Tinian government in the inter-agency cooperative project.

Thomas Marler

Guam's native cycad was the most abundant tree in the forest then almost overnight it was decimated by a new invasive insect pest.

—Anne Brooke

cleaned of all scale-insects then transported to Department of Defense (DoD) lands on the island of Tinian because the island is free of the scale insects. A nursery was set up to start the slow process of growing the plants. Known as a germplasm repository or living gene bank, the 1,000-seedling nursery was planted in 2008 in native limestone forest.

Dr. Marler's extensive knowledge and experience has extended the conservation efforts beyond the borders of military installations of the Mariana Islands and into established international cycad conservation efforts. Human activity is devastating the

health of forests throughout the tropics, and the Marianas stand out as an ideal location for DoD to showcase an organized response to these anthropogenic effects. The lush, tropical islands have been under the protection of DoD for 70 years under territorial or commonwealth status. This conservation project illuminates just how successful DoD can be in the pursuit of these goals.

The project has not only safeguarded the gene pool of the Guam cycad population, it has also generated critical data that will aid in understanding the ecosystem supported by the nation's only native cycad species. As

cycad plants were killed in various DoD habitats in Guam by the invasive pests, numerous biotic and abiotic habitat traits were quantified. Changes to nitrogen cycling in the forest are being monitored because cycads are the only native plant that have an association with nitrogen-fixing cyanobacteria.

The conservation team has enacted a mirror approach within the Tinian germplasm collection. Starting with a native limestone forest devoid of cycad plants, the adaptive management protocols are quantifying the ecosystem changes that accrue as the cycad plants mature. "We expect to

DoD Contributes to Global Initiatives

IN 1988, **ALARMED** by the accelerating rate of species extinctions, the United Nations convened a panel of experts to address ways of preserving biological diversity around the world. From this working group, the Convention on Biological Diversity (CBD) was formed. In 2002, CBD adopted a Global Strategy for Plant Conservation.

Updated in 2010, the Global Strategy contains a multitude of goals or targets aimed at the understanding, conserving, and sustainable use of flora. Guidance for natural resource managers has been included in the new strategy.

The DoD's Mariana Islands cycad conservation efforts fit ideally into the goals for conservation and protection of threatened species by having cycads protected both in the country of origin and in collections that are outside of the plants natural habitat.

Read more about the Global Strategy for Plant Conservation and find resources for sustainable management at www.cbd.int/gspc.



see ecosystem contributions by the cycad plants such that the biogeochemistry of the habitat will advance toward the characteristics that defined Guam's cycad habitats prior to the alien invasions," said Brooke. "This dual approach will allow us to understand how cycads as a nitrogen producer changes the forest ecosystem. This approach also helps

us understand how the loss of those nitrogen producers can be restored via future restoration projects."

The cycad species is also represented in two other off-site germplasm repositories: the Nong Nooch Tropical Botanical Garden in Thailand, and the Montgomery Botanical Center in Florida. However, according to the

United Nations' Global Strategy for Plant Conservation, there is a strong preference to establish ex situ conservation efforts in the country of origin wherever possible. (See our sidebar entitled "DoD Contributes to Global Initiatives.") Of the three cycad repositories, only the DoD's Tinian germplasm is being maintained in native forests that are analogous to the forests of the natural areas of occupancy in Guam and Rota. This is a perfect example of how DoD is exhibiting stewardship that is in conformity with an international conservation agenda. ↴



Thomas Marler (University of Guam) and Anne Brooke (NAVFAC Marianas) inspect healthy cycad leaves of robust cycad plants five years after planting in the DoD's Tinian germplasm collection.

Thomas Marler

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DID YOU KNOW?



How did I save energy for the Navy?

We installed Solid State Lighting (SSL)—Light Emitting Diode replacements for legacy incandescent and fluorescent fixtures—on numerous DDG, LSD and LHD class ships. Depending on ship class, SSL has an annual savings of 95–416 barrels of oil per ship.

Name: Andrea Vigliotti

Age: 37

Hometown: Sturgeon Bay, WI

Job: Ship Systems Engineering Station Energy Program Manager

Command: Naval Surface Warfare Center, Carderock Division

Do you think culture change, in regards to energy conservation, is important for our Navy?

Yes. Advances in technology will only be able to achieve a certain amount of energy savings overtime. In order to really increase energy efficiency for our Navy, we need to change the culture of our ship operators and maintainers. In fact, significant savings can be realized simply by changing how ships are operated and maintained. By providing tools, such as the Shipboard Energy Dashboard, we will enable Sailors to make more energy efficient decisions and help facilitate the necessary culture change.



ENERGY SECURITY ENHANCES COMBAT CAPABILITY

Did you know that the Shipboard Incentivized Energy Conservation program began in 2000 and has saved the Navy millions of barrels of fuel?

As Ship Systems Engineering Station Energy Program Manager at the Naval Surface Warfare Center, Carderock Division, I oversee and coordinate a variety of energy conservation initiatives and efforts in support of the Navy's energy goals. From conducting the first full scale maritime gas turbine engine qualification test for a 50-50 blend of F-76 and Hydro Refined Diesel derived from algae, to the implementation of the Shipboard Energy Dashboard for the DDG-51 class ships—a tool that provides near real time information on energy consumption for the Sailor—we are able to not only increase energy savings but also reduce the number of refueling operations at sea which decreases vulnerabilities for the ship and the Sailors.

Due to my experience as a former Navy Surface Warfare Officer, I understand the importance of meeting mission requirements; fuel efficiency and the risks associated with underway replenishments. Warfighters need energy to get on station, stay on station, execute their missions, and return safely. Implementing energy efficient technologies provides Sailors with the security they need to complete their missions. This year we will be overseeing numerous additional SSL installations as well as six Shipboard Energy Dashboard installations and two thermal management control system installations.

By increasing energy efficiency and enabling ship operators to make more energy conscience decisions we can increase operational capability, time on stations, and the security of the Sailors in the fleet.



 @NavalEnergy
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<http://greenfleet.dodlive.mil/energy>

PMRF's Laysan Albatross Relocation & Other Programs Enjoy Continued Success

Nine Years of "Thinking Outside the Shell"

A PAIR OF programs at the Pacific Missile Range Facility (PMRF), Hawaii, have strengthened the populations of two endangered avian species, reduced the danger of bird strikes, and garnered awards for program participants.

PMRF again earned top Chief of Naval Operations (CNO) and Secretary of the Navy (SECNAV) honors for Natural Resources Conservation, Small Installation for Fiscal Year 2013; and its Range Sustainment Environmental Coordinator received the National Military Fish and Wildlife Association's (NMFWA) Natural Resource Conservation Management Award for Model Projects.

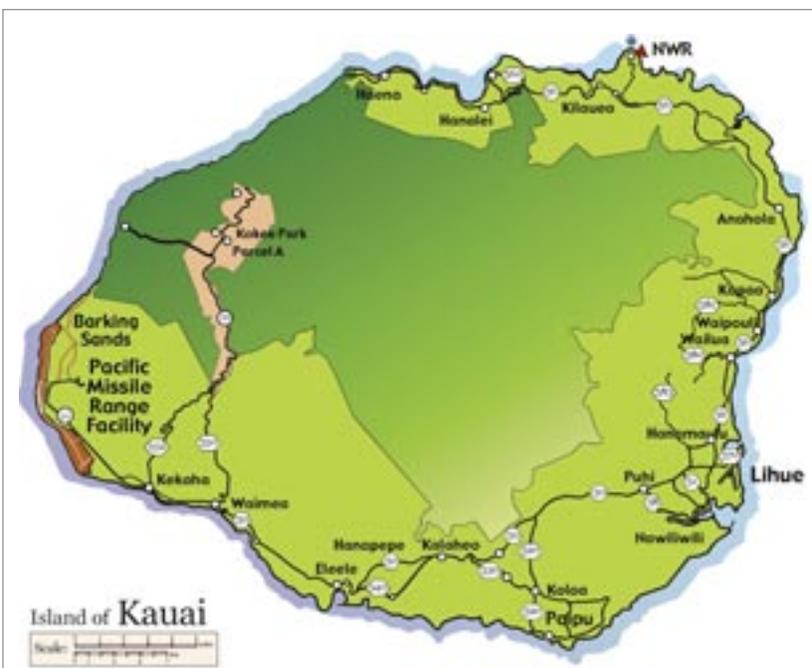
These awards cited the base's successful multi-year effort to relocate PMRF's nesting colony of Laysan albatross (*Phoebastria immutabilis*), protected under the Migratory Bird Treaty Act, and efforts to reduce the fallout of the Endangered Species Act "threatened" nocturnal fledging Newell's shearwater (*Puffinus auricularis newelli*). Both species are migratory seabirds.

The Laysan Albatross

PMRF Barking Sands, located on the island of Kauai, is the site of both regular flight activity and a substantial colony of Laysan albatross. The Laysan albatross had established a pattern of nesting near the airfield, and with a wingspan of nearly seven

feet, this raised significant bird aircraft strike concerns for the daily flights of assorted Navy and civilian contractor aircraft. Starting in the 1990s, PMRF began relocating the nesting adults to the Kilauea [Point] lighthouse area. However, this effort never proved successful.

"Removing nesting adult birds is ineffective because they are imprinted to return to the base, so the only effective solution is to prevent new birds from hatching and imprinting on the base as a future breeding location," explained Cory Campora, Naval Facilities Hawaii and Navy Region Hawaii Natural Resources Manager.





A Laysan albatross hatchling at Na Aina Kai Botanical Gardens from an egg donated through PMRF's egg swap program.

Tom Savre

Other tactics, such as trying to relocate nests, were also unsuccessful. When a nest is moved as little as 10 to 15 feet, the adults will no longer recognize the nest as theirs and will not use the nest or care for the sole egg that may have been in the nest. They might try to build a new nest, but will not produce a new egg that year.

The ultimate solution evolved as a result of a budgetary shortfall. In 2004, the Commander of Naval Installations directed that funds for aircraft safety programs were to come from Air Operations. Previously the bird relocation program, carried on as a safety program, was funded through PMRF's Environmental Department. The decision, coming after the budget for fiscal year 2005 had already been drafted and approved, meant that funds were suddenly unavailable for the necessary contract services provided by the U.S. Department of Agriculture Animal and Plant Health Inspection Service for Laysan albatross

management, which at that time included U.S. Fish and Wildlife Service Depredation Permit authorization for destruction of all eggs laid on Barking Sands. Eventually, funding was found, but not until nesting season was well underway, with eggs on the verge of hatching. These eggs could not be destroyed.

Kilauea Point National Wildlife Refuge (NWR) provided the solution. The refuge had adult albatrosses and nests with compromised eggs (infertile eggs that would never hatch, or were damaged or destroyed). Wildlife technicians and field biologists rushed to locate viable eggs on PMRF and move them to available nests at Kilauea Point, with the hope that the Kilauea Point birds would foster the eggs. The experiment worked, and the first generation of albatrosses was born to surrogate parents at the refuge in the spring of 2005.

But this effort was far from the end of the story. With a life span of 40-50 years, adult birds that were fledged at PMRF still return to their birth site every year, and the process repeats itself. "The birds are programmed to return to the location they fledge from," said John Burger, former PMRF Environmental Coordinator and winner of the NMFVA award.

Each year since, the egg swap process is repeated at PMRF. However, this effort has been continuously improved, starting with the procurement of special incubators in 2006, designed for emu eggs, that could incubate the large Laysan albatross eggs; and transfer of the eggs near the runway immediately into the incubators upon discovery. As soon as the refuge population could be accurately assessed, transfer of viable incubator eggs to surrogate parents on the refuge was undertaken. Further procedural refinement to incorporate natural incubation at a safe distance from

The Basics About the Laysan Albatross

THE LAYSAN ALBATROSS is Hawaii's most common seabird. Named for Laysan, one of the northwest Hawaiian islands, this seagull-like bird commonly has a wingspan of seven feet. Laysan Albatrosses spend most of their lives flying over the open Pacific, from tropical waters up to the southern Bering Sea. They lay one egg at a time, and build their nests on open, sandy or grassy islands. The albatrosses were first recorded at PMRF in 1967, were breeding by 1977, and by 2012 had a colony of 84 nesting pairs.



John Burger won the 2013 NMFWA Natural Resource Conservation Management Award for Model Projects.

Stefan Alford

The Basics About Pacific Missile Range Facility

LOCATED WITHIN THE Hawaiian archipelago on western shores of the Island of Kauai, PMRF Barking Sands is the world's largest instrumented multi-environmental range capable of supported surface, subsurface, air, and space operations simultaneously. It occupies over 1,100 square miles of instrumented underwater range, 2,342 acres of land space, and over 42,000 square miles of controlled airspace.



the runway has been initiated to maximize hatching success while reducing the bird aircraft strike hazard. To date, over 100 Laysan albatross eggs have been transferred under the "Surrogate Parenting" program, resulting in an increase in the species' overall productivity on the island, with no impact to PMRF's mission capabilities.

The Laysan albatross project is one aspect of the base's Integrated Natural Resources Plan cited in the CNO and SECNAV awards, and one of two projects for which Burger received the NMFWA award.

Both awards also detail the base's and Burger's work in reducing bird "fall-out" over PMRF's night skies.

The Newell's Shearwater

During the fall season, federally listed, nocturnal fledging Newell's shearwaters fly over PMRF and may become disoriented by lighting on the base. Fledglings of these species are particularly at risk due to their lack of navigation experience as they head out to the Pacific Ocean for the first time. They navigate by starlight and moonlight, and can easily become confused by artificial lighting on cloud-covered nights and during the "new moon" cycle, and "fall-out" either from exhaustion or from collision with a base structure, sometimes with lethal consequences. Once on the ground, they are unable to fly, and become targets for predators.

Burger led the way in helping PMRF modify exterior lighting and lighting practices to create a dark-sky philosophy. This involved changing conventional lamps to light emitting diodes (LED) and using full-cutoff fixtures to prevent viewing of the light source from above. This resulted in a "dark sky" as well as an added bonus—significant energy savings.

During the early phase of the lighting changeover, volunteers monitored the area, rescuing downed birds and delivering them to an aid station set up by a local non-governmental organization. Coupled with an educational outreach program for PRMF personnel, the number of shearwater fallouts fell sharply once the new lighting was installed—by 80 percent in 2012; and by 2013, not a single fallout was recorded.



New LED light fixtures saved energy and resulted in a dark sky as viewed from above.

The Basics About Newell's Shearwater

THE NEWELL'S SHEARWATER, or 'a'o in Hawaiian, is a bird of the open tropical seas and offshore waters—primarily on and around Kauai. During its nine-month breeding season from April through November, the Newell's Shearwater typically nests in burrows under ferns on forested mountain slopes. These burrows are used year after year and usually by the same pair of birds. Although the Newell's Shearwater is capable of climbing shrubs and trees before taking flight, it needs an open downhill flight path through which it can become airborne.



The Laysan program also noted a pair of accomplishments in 2013. For the first time, another reserve, Na Aina Kai Gardens, participated in the egg swap, receiving and hatching “translocated” Laysan eggs. And a previously-banded “PMRF bird” was the first to nest on private property that had been redesigned, planted and constructed to attract and protect the species. The Navy team assisted these landowners in their efforts as part of the cooperative conservation and outreach initiated in anticipation of crowding at the refuge.



Adopted Laysan albatross chick and its surrogate “parent.”
Brenda Zaun

Teamwork is Key

Commenting on his award, Burger said, “Considering the strong conservation ethic on Kauai, being able to show the community that PMRF and the Navy share that commitment in deeds, not just words, helps establish that PMRF is ‘our’ base and not just ‘the’ base.”

While he initiated both the egg swap and lighting programs, Burger is quick to point out that Tom Savre is now leading both efforts as well as other conservation programs. “We could not ask for a more qualified and committed wildlife biologist to support environmental stewardship at PMRF,” said Burger.

He added, “Factual, documented program success at the most local level is critical to establish credibility and build productive partnerships in the future. The majority of the most valuable and protected natural resources on federal property are recognized to be found in the isolation provided by Department of Defense Ranges.” 📍

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NAVFAC Hawaii Implements Sustainable Approach to Remediate Contaminated Soil

Constructive Stakeholder Interaction, Flexible Remediation Plan Key To Success

EX-SITU CHEMICAL OXIDATION of soil can be a sustainable and cost effective alternative to dig and haul and in-situ chemical oxidation for the remediation of petroleum contaminated source soil.

Personnel from the Naval Facilities Engineering Command (NAVFAC) Hawaii along with project contractor CH2M HILL Kleinfelder, a Joint Venture successfully executed a project, funded by the Defense Logistics Agency, to remediate petroleum-contaminated soil at Spill Site Stripper Pit No. 43 (SP43) on Joint Base Pearl Harbor-Hickam, Hawaii.

present in soil and soil gas above the remedial action cleanup goals (RACG) identified in the Final Decision Document. Additionally, up to one foot of light non-aqueous phase liquid (LNAPL) was measured in site monitoring wells. (Note: LNAPL is fuel present in the subsurface as separate (not dissolved) phase.)

A Decision Document signed in 2011 for the remediation of the site required the implementation of land use controls (LUC), in-situ chemical oxidation (ISCO) using calcium peroxide, and monitored natural attenuation (MNA), with the option of conducting limited excavation

The dynamic and flexible approach used in the execution of this project allowed the team to change and implement a more sustainable and cost-effective remedy than originally planned.

The dynamic and flexible approach used in the execution of this project allowed the team to change and implement a more sustainable and cost-effective remedy than originally planned. This eventually turned into the conservation of invaluable landfill space and saved hundreds of thousands of dollars.

Problem Statement

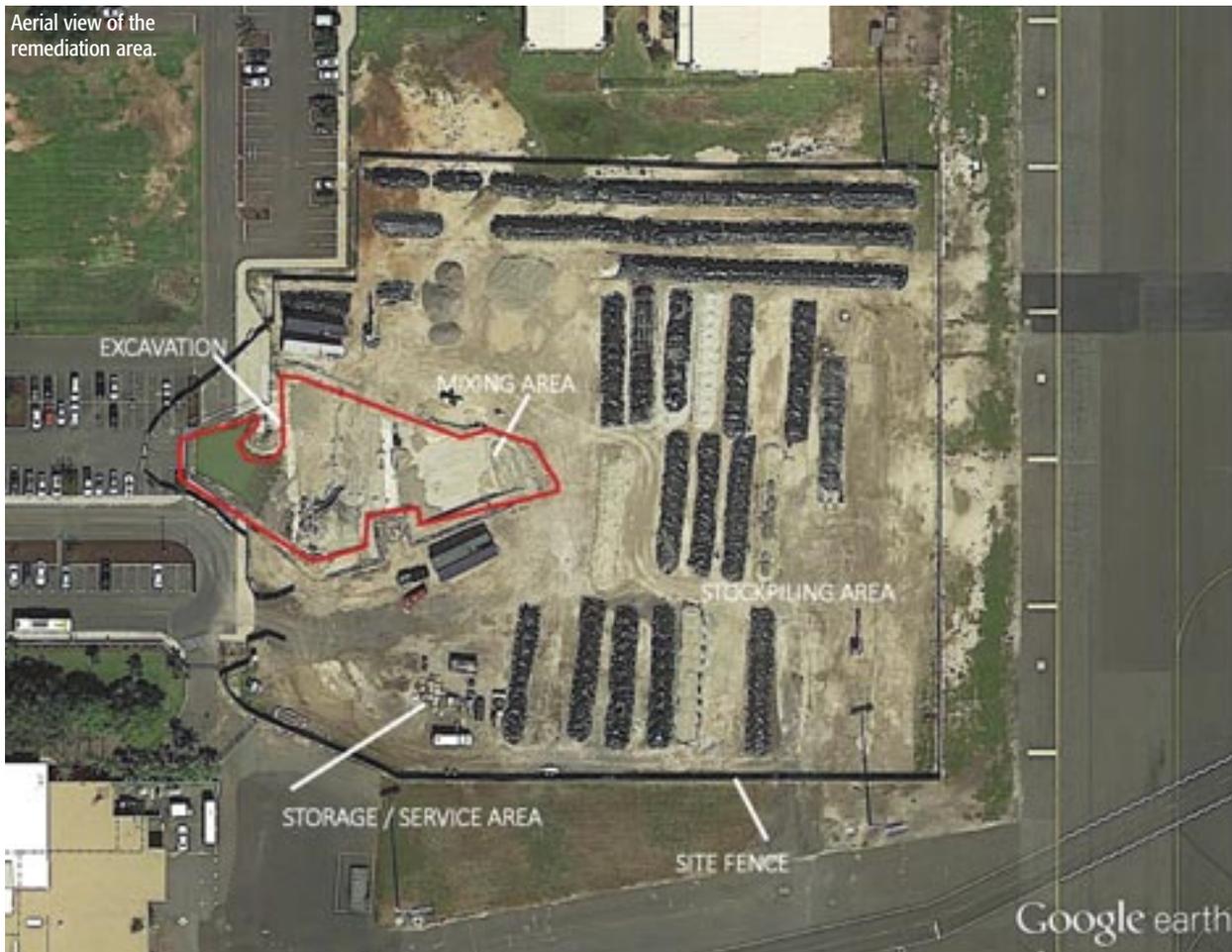
A reported 2,000 gallons of jet propulsion fuel were accidentally released in 1997 along a subsurface pipeline system that crossed Site SP43. Investigations and a streamlined risk assessment conducted at the site demonstrated that concentrations of petroleum constituents were

and offsite disposal of petroleum contaminated soil from the source area. ISCO is a remediation technology that involves the injection of a substance (oxidizing compound) in the ground to destroy contaminants in place.

Project Scope & Objectives

The overall objectives of this project were to prevent human exposure and implement source treatment/removal to reduce petroleum constituent concentrations below the site-specific RACGs.

After evaluating offsite disposal options, the project team recognized the necessity to identify a more cost-effective and sustainable remedial option. Landfill space in Hawaii is



rapidly decreasing. As an island state, available land is limited and highly valuable, making landfill disposal a less desirable and more expensive option than in other states. In addition, the State of Hawaii recently enacted legislation requiring that counties develop policies aimed at reducing waste sent to landfills.

Through significant collaboration with Hawaii regulatory authorities, the project team re-evaluated the remedy selected in the Decision Document to identify options that would allow the implementation of a more sustainable and cost-effective remedial action.

In an agreement with the State of Hawaii Department of Health, a

revised remedy was developed which included LUCs, excavation and ex-situ chemical oxidation (ESCO) with reuse/disposal of petroleum contaminated soil, ISCO of subsurface soil/soil gas outside of the source area, and MNA. ESCO is a remediation technology that involves mixing the oxidizing compound with the contaminated medium (in this case soil) after removing it from the ground. This remedy was potentially more sustainable and cost effective, but success was highly dependent on treatment (chemical oxidation) efficiency.

Local small businesses were subcontracted to conduct soil remediation activities using equipment and resources available on island, in an

effort to successfully implement a sustainable approach while supporting the local economy.

Methods & Results

Extensive laboratory bench scale testing to evaluate several formulations and activation methods was conducted using representative site soil samples and resulted in the selection of activated sodium persulfate as the most effective oxidant to treat contaminated soil at the site. A treatment efficiency between 70 and greater than 99.9 percent was achieved in the laboratory. Effective activation methods were identified including alkaline activation that uses base (e.g., lime or sodium hydroxide) to achieve a pH of 11 or

Soil mixing with lime-activated sodium persulfate and water.



higher—a condition necessary to activate the persulfate oxidative reaction.

Soil within the source area was excavated, treated onsite with lime and sodium persulfate to achieve alkaline-activated persulfate oxidation of petroleum contaminants, and stockpiled for 14 days for the reaction to occur. Treated soil was then sampled to evaluate if concentrations were reduced below the RACGs.

Approximately 3,200 cubic yards of petroleum contaminated soil were excavated and treated within a mixing pit setup in the excavation area. The petroleum contaminated soil was mixed with 50,000 pounds of solid sodium persulfate activated with 24,000 pounds of hydrated lime and water. An excavator was used to mix the soil. Thirty-two stockpiles of 100 cubic yards each were generated

and covered with polyethylene plastic sheeting for 14 days. Approximately 1,300 cubic yards (13 stockpiles) of soil were remixed to further reduce petroleum constituent concentrations.

After the oxidative reaction was complete, one incremental sample composed from 30 increment locations was collected at each stockpile for laboratory analyses. Stockpiled soil analytical results indicated concentrations below the RACGs, with up to 85 percent destruction of petroleum constituents. No LNAPL was observed at the site after remedial actions were completed, except for 0.02 foot of LNAPL measured in one well immediately outside the source area.

Treated source soil was reused on site as backfill, resulting in a more sustainable and cost-effective remedy than originally planned (i.e., excava-



Soil mixing pit within excavation area.



Soil stockpiling area.

Based on post-ESCO soil concentration results within the petroleum contaminated area, Site SP43 is now suitable for future construction.

tion and disposal of source soil). This option also resulted in significant cost savings for the field implementation of source removal. If compared to the excavation and disposal option, ESCO resulted in cost savings (including subcontractor, materials, and disposal costs) of approximately \$300,000.

Conclusions & Lessons Learned

Source reduction using ESCO was successfully completed at Site SP43 reusing all excavated soil, which resulted in significant cost savings and the implementation of a more sustainable option than originally planned in the Decision Document.

Approximately 3,200 cubic yards of petroleum-contaminated soil originally planned for landfill disposal were treated and replaced on site. ESCO was demonstrated to be a more sustainable and cost-effective solution

compared to dig and haul or ISCO for the source area soil. Site soil was remediated and specific objectives were achieved. Critical for the project success was a very constructive interaction among key stakeholders and a flexible remediation plan. Based on post-ESCO soil concentration results within the petroleum contaminated area, Site SP43 is now suitable for future construction. ⚓

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Navy Explores the Future of 3D Printing

CDSA Dam Neck, CNSL & NAVAIR Host Workshops for Deckplate Sailors & Industry Partners

THE U.S. NAVY hosted a series of “Print the Fleet” workshops to introduce three-dimensional (3D) printing and additive manufacturing to Sailors and other stakeholders.

The Navy’s events took place on the heels of the first White House Maker Faire that was held on June 18, 2014. The White House event showcased the work of entrepreneurs and forward thinkers from around the country, as well as students exploring Science, Technology, Engineering and Math (STEM) related skills.

“When you consider the cost and vulnerabilities of our existing Navy logistics and supply chains as well as the resource constraints we face, it quickly becomes clear that we have to reimagine how we do business,” said Vice Admiral Phil Cullom, deputy chief of naval operations for Fleet Readiness and Logistics, during a brief on June 23, 2014. “When additive manufacturing and 3D printing become widely available, we envision a global network of advanced fabrication shops supported by Sailors with the skills and

training to identify problems and make products.”

Admiral Cullom also welcomed (via pre-recorded video) participants to the Navy’s first “Print the Fleet 3D Printing Workshop” held at the Combat Direction Systems Activity (CDSA) in Dam Neck, VA. (Visit <http://youtu.be/dkZl6X9ucBg> to view the entire video.)

The Office of the Chief of Naval Operations, Director of Logistics Programs and Business Operations (OPNAV N41) has supported all workshops held to date. “Educating Sailors on the

increased readiness, savings and efficiencies afforded through additive manufacturing is one of our primary objectives,” said Dave Barrett, OPNAV 41. “One of the greatest benefits of introducing this technology to Sailors is the creativity it affords them in an otherwise very structured and standardized environment. Additive manufacturing can liberate the Sailor and empower them to get the job done without being overly dependent on others to resolve their problems. We are confident that Sailors will experience an increase in job satisfaction by empowering them with these new capabilities.”



The amphibious assault ship USS Essex (LHD 2) was successful at installing and using a 3D printer and also provided training to its Sailors on computer-aided design software.

MC3 Raul Moreno Jr.

The terms additive manufacturing and 3D printing are often used synonymously in mainstream media. However, 3D printing is technically a subset of additive manufacturing processes that refer to material buildup through a nozzle or other printing technology. Traditional subtractive manufacturing entails the removal of material (often by lathing, cutting, chipping or grinding) to create a final product. In contrast, 3D printing joins (adds) materials to make objects using 3D model data, usually layer by layer.

The traditional method is often time consuming, wasteful and costly. 3D printing, however, negates these issues while also affording the design of complex shapes that could not be created through traditional manufacturing techniques.

The Navy aims to train Sailors with this expertise in the future, according to Cullom. Adopting the 3D printer and other additive manufacturing capabilities could drastically reduce the wait for replacement parts, improve

readiness, decrease costs and avoid shipping parts around the world.

CDSA Dam Neck Hosts First “Print to Fleet” Event

Personnel from OPNAV N41, Navy Warfare Development Center (NWDC), and CDSA Dam Neck co-sponsored the first Maker Faire—a two-day event on June 24 and 26, 2014—titled “Print the Fleet 3D Printing Workshop.” Each event was attended by about 60 individuals, both civilian and military, who learned more about additive manufacturing and discussed potential future uses of the technology across the Navy.

“Think of it as another tool in the toolbox,” said Jim Lambeth, additive manufacturing lead at CDSA Dam Neck. “If there is a part needed and it doesn’t exist in the inventory, not only can we cut costs, but we can design the part on demand. That’s what additive manufacturing is going to solve.”

The Basics About Combat Direction Systems Activity Dam Neck

CDSA DAM NECK provides force-level integrated and interoperable engineering solutions, mission critical control systems, and associated testing and training technologies to meet maritime, joint, special warfare and information operation requirements related to surface warfare in the following four areas of expertise:

1. Integrated Training Capabilities for Maritime, Joint, Coalition, Interagency and Inter-Service Domains

CDSA Dam Neck currently provides key leadership and products for The Joint National Training Center (JNTC) located in Suffolk, VA.; The Joint Knowledge Development and Distribution Capability (JKDDC); and The Maritime Integrated Training Capabilities Laboratory Complex at Dam Neck which delivers Battle Force Tactical and Total Ship Training Systems to the fleet.

2. Force Integration & Interoperability Taskings for the Maritime, Joint, and Coalition Warfighter

The Multi-functional Land Based Test Site (LBTS) and Joint Test and Training Facility (JTTF) are two assets within CDSA’s Integration and Interoperability Laboratory Complex that enables them to serve the fleet and the warfighters from the Hampton Roads area while collaborating with other Department of Defense (DoD) commands, organizations, or agencies.

3. Engineering Expertise for the Acquisition and Delivery of Modern Integrated Combat Control Systems

The knowledge of CDSA Dam Neck engineers is leveraged daily for Advanced Sensor Distribution Systems (ASDS) and Ship’s Self Defense System (SSDS) MK II, Combat Systems Integration and the Carrier Modernization Program.

4. Modernization of Information Operations and Rapid Response Engineering Focused on Global Maritime Security Operations

CDSA engineers collaborate within the Naval Sea Systems Command and other DoD commands to deliver the right capabilities at the right cost to the warfighters who need specialized tools to complete unique missions every day.

For more information, visit www.navsea.navy.mil/nswc/damneck.





ABOVE LEFT: Carolyn Lambeth, a mechanical engineer at CDSA Dam Neck, right, explains the process on additive manufacturing and 3D printing to Sailors during the U.S. Navy's first "Print the Fleet" workshop. The event showcased additive manufacturing techniques for Sailors and other stakeholders attending the two-day event.

MC Seaman Jonathan B. Trejo

ABOVE RIGHT: LT Chris Baxter, division officer at Fleet Readiness Center Norfolk, examines products created with 3D printing during the U.S. Navy's first Maker Faire titled "Print the Fleet."

MC Seaman Jonathan B. Trejo

RIGHT: LT Ben Kohlmann, U.S. Fleet Forces Command (left) discusses 3D printing with Dr. Marty Irvine, Head, Maritime and Joint Systems Department, Naval Surface Warfare Center Dahlgren/Dam Neck (center) and Ms. Karen R. Jackson, Secretary of Technology for the State of Virginia (right) at the "Print the Fleet" workshop.



LEFT: Chief of Naval Operations Admiral Jonathan Greenert reviews parts manufactured using 3D printing technology at NAVAIR's AVMI laboratory during his visit to NAS Patuxent River.

Chief MC Peter D. Lawlor

BELOW LEFT: CAPT Eric Tapp from CDSA Dam Neck addressing "Print the Fleet" workshop participants.

Kenneth Hess

BELOW RIGHT: LT Ben Kohlmann (center) and Carolyn Lambeth (far left) discuss additive manufacturing and 3D printing with Lance Bacon, *Navy Times* Reporter (far right), and Mike Gooding, WVEC ABC13 Reporter (bottom left) at the "Print the Fleet" workshop.

Kenneth Hess



Within days or hours of identifying a needed part on a ship, a 3D model can be designed and uploaded to a printer for production, allowing for a more rapid response to the ship's needs.

Earlier this year, the amphibious assault ship USS Essex (LHD 2) installed a 3D printer on board. Essex was successful in using the printer as well as training its Sailors on computer-aided design software.

3D printing is effectively done at a number of shops on land, but being able to utilize a 3D printer within the dynamic environment of a carrier or destroyer is the Navy's biggest test.

"It's the biggest thing happening on the deck plate," said CAPT Jim Loper, concepts and innovations department head at NWDC. "We put the printer on Essex specifically to get it in Sailors' hands so they could play with the technology and so we could learn the best way to use the printer."

When additive manufacturing and 3D printing become widely available, we envision a global network of advanced fabrication shops supported by Sailors with the skills and training to identify problems and make products.

—Vice Admiral Phil Cullom

CDSA Dam Neck partnered with the Naval Supply Systems Command and NWDC to identify printable parts and create a suitable infrastructure in hopes of bringing these parts to the fleet.

"The future of logistics is 3D printing," said Loper. "The amount of supplies that we carry on board the ship can be reduced significantly if we can 3D print those products on the ship itself. There really are no limits to the advantages of 3D printing."

Items printed by CDSA Dam Neck's 3D printer were on display and include Ouija Board pieces (modeled by USS Essex), a buoy replica, and an F-18 replica. (Not shown is a bracket for phone jack boxes.)

Kenneth Hess

Naval Air Systems Command Embraces 3D Printing Technology

The Naval Air Systems Command (NAVAIR) has also embraced 3D printing technology to deliver capabilities to the warfighter at a rapid pace and a lower cost.

Together, the NAVAIR team and industry providers focused on developing a roadmap for the future as they discussed the current opportunities and challenges associated with 3D printing at the NAVAIR Additive Manufacturing Industry Day held on July 24, 2014.

Vice Admiral David Dunaway, NAVAIR's commander, laid out the

goals and the reasons why additive manufacturing (3D printing) will play a part in the command's future.

"Naval aviation is well capitalized. If you look at our production curve, it is going to tremendously decrease by 2018 or 2019," Dunaway said.

"We're in the sustainment phase. We're going to have to think about how we apply the limited resources we have. I think additive manufacturing will allow us to optimally use those resources."



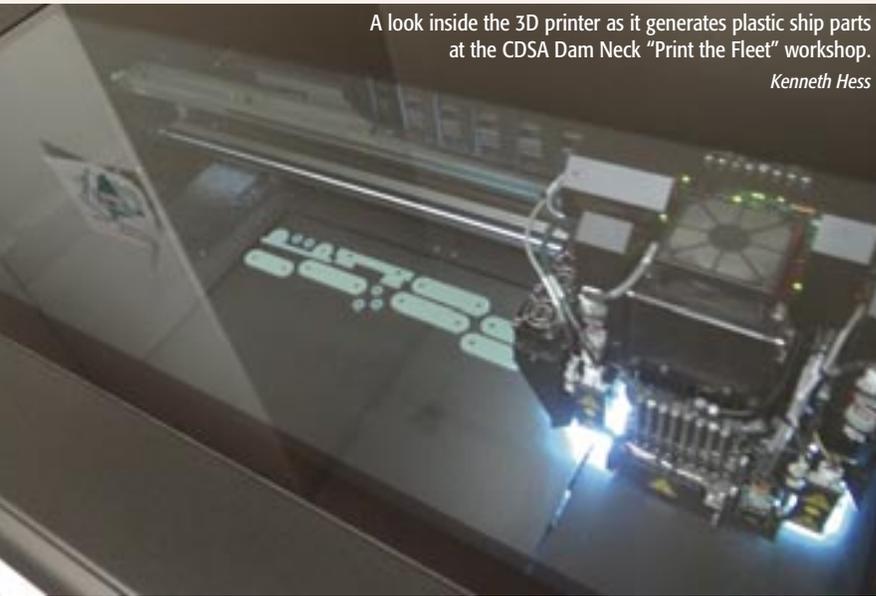
Currently, the Air Vehicle Modification and Instrumentation (AVMI) group is using 3D printing to support naval aircraft flight testing and prototyping projects at Naval Air Station Patuxent River, Maryland.

Using their two 3D printers, AVMI engineers have fabricated components such as antenna covers, environmental cooling system ducts and mechanical spacers, as well as geometrically-representative models for form and fit checks.

Commander, Naval Surface Force Atlantic Hosts Two 3D Printing Symposia

Commander, Naval Surface Force Atlantic (CNSL) also hosted its first 3D printing symposium directed at waterfront warfighters on August 6, 2014 at Naval Station Norfolk. OPNAV N41, NWDC, and CDSA Dam Neck supported the event as well.

CNSL held this symposium to reinforce command priorities of



A look inside the 3D printer as it generates plastic ship parts at the CDSA Dam Neck "Print the Fleet" workshop.

Kenneth Hess



"Print the Fleet" workshop participants listen to pre-recorded remarks from Vice Admiral Phil Cullom, Deputy Chief of Naval Operations for Fleet Readiness and Logistics, at the first Maker Faire at CDSA Dam Neck in June 2014.

Kenneth Hess

improving surface warrior tactical and technical competence, delivering combat-ready warships and synchronizing lines of effort.

"At its very core, this technology further enhances the leadership opportunities of our Sailors," noted symposium coordinator LT Matthew Hipple, a CNSL action officer.

About a dozen Sailors and civilians attended the symposium on 3D printing, also known as additive manufacturing, rapid prototyping and direct digital manufacturing.

"For challenges in your engineering plant, at your console, or on the bridge—additive manufacturing (like 3D printing) could one day allow Sailors to create their own novel solutions, or overcome pauses from logistical delays," Hipple continued. "That's ownership, and an important part of cultivating new generations of leaders and experts."

These workshops were created to push junior deckplate leadership—the guys who are doing the technical work, the maintainers who are

encountering the day-to-day problems—to harness 3D printing technology for their uses," Hipple explained. "It's a great opportunity for them, not to just decrease their man-hours spent working on equipment, but also to increase the amount of leadership and input they have into this new technology."

During the CNSL symposium, those in attendance learned that 3D printing has the capability to bring parts to the warfighter quickly and cheaply. By printing parts on nearby military installations or eventually on ships at sea, inventory can be reduced and shipping costs can be nearly eliminated for many items. Within days or hours of identifying a needed part, a model can be designed and uploaded to a database for printing, allowing for a more rapid response to warfighters' needs.

"This is about helping Sailors overcome acquisition problems," he pointed out. "And it's about using taxpayers' dollars well. 3D printing is a new process that can streamline our logistics and give the Sailor new problem-solving tools.

"You and I have been given these resources by the American people and it is our job to use them wisely; 3D printing looks like it's going to be one way to do so. We're investigating if this can give the Navy, our Sailors, and the people the best bang for our buck," Hipple concluded.

CNSL sponsored a second 3D printing symposium aboard Naval Station Norfolk on August 20, 2014. [📍](#)

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NAVFAC Northwest Designs & Installs Bio-infiltration Pond at NAVMAG Indian Island

Technology Allows Installation to Meet Environmental Benchmarks

THE NAVAL FACILITIES Engineering Command (NAVFAC) Northwest Public Works Department Naval Base Kitsap Bangor discovered that a stormwater outfall at Naval Magazine (NAVMAG) Indian Island was exceeding benchmarks established by the U.S. Environmental Protection Agency's (EPA) requirement to protect finfish, in particular juvenile out-migrating salmonids.

Stormwater sampling at outfalls is a requirement of the current stormwater permit at NAVMAG Indian Island located near Port Townsend, WA. The EPA imposed additional monitoring for copper and zinc at NAVMAG Indian Island due to concerns with endangered fish species including salmon, steelhead and bull trout, on a monthly basis at three outfalls which discharge into the marine waters of Port Townsend Bay.

Even after a heavy rain there is no direct discharge into Port Townsend Bay. All stormwater at this outfall is running through the bio-filter.

Two of the three outfalls passed the additional monitoring requirement however a third outfall (SW-120) located adjacent to the ammunition wharf trestle failed and prompted a corrective action to design and install a filter cartridge within the catch basin. This filter binds copper and zinc before the water flows out into Port Townsend Bay and the environment. With no copper or zinc sources stored in the area the most likely source was from truck brake pads and tires. This outfall is located near a paved area that receives vehicle traffic transiting onto the pier. Even though Washington State has banned copper from vehicle brakes, there are still vehicles with brakes containing copper.

To clean up the water before it flows into Port Townsend Bay, the NAVFAC Northwest Public Works Department

Naval Base Kitsap Bangor designed a bio-infiltration pond to collect the discharge. This pond is designed with specific mulch that binds up the metals from the stormwater runoff. Plantings such as Common Rush (*Juncus effusus L.*) were planted within the retention basin. Common Rush is a salt tolerant species which can grow in standing water and is the most common type of Rush found in coastal marine wetlands.

Even after a heavy rain there is no direct discharge into Port Townsend Bay. All stormwater at this outfall is running through the bio-filter. With no direct discharge the EPA has removed the additional sampling requirement and stormwater sampling is no longer necessary at outfall SW-120. The cost of this project was less than \$48,000 but still represents a cost-savings to the Navy as sampling and analysis from this outfall is no longer required.

The shoreline and near shore ecosystem adjacent to the project site is an important habitat area utilized by juvenile salmonids as an outmigration corridor, forage fish as spawning habitat and it has an extensive eelgrass bed which provides food and refuge for a variety of finfish, waterfowl, shorebirds and marine mammals. This water quality enhancement project directly benefits this habitat area and the marine species which rely heavily on it for survival by reducing contaminant discharge which could impair and impact the substrate, nearshore vegetation, and other elements of the shoreline ecosystem.

The project was needed to satisfy a requirement of NAVMAG Indian Island's stormwater permit. The permit requires stormwater samples to be collected at various identified outfalls and analyzed for certain metals. EPA sets benchmark levels for each analyte, and if stormwater sample exceeds any of the benchmarks, then corrective action is required. The bio-infiltration pond serves as the corrective action.

It was a proactive cost-savings measure implemented by the NAVFAC Northwest Public Works Department Naval Base Kitsap Bangor's Stormwater Pollution Prevention Program and Water Quality Best Management Practices to reduce contaminant discharge from this outfall near the ammunition wharf. ⚓

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CNO Recognizes FY 2013 Environmental Award Winners Via Virtual Ceremony

Navy Saves Time & Money, Reduces Its Carbon Imprint

WINNERS OF THE Fiscal Year (FY) 2013 Chief of Naval Operations (CNO) Environmental Awards competition were recognized August 14, 2014 via a video teleconference (VTC) ceremony at the Pentagon.

Twenty-seven winners were selected in 10 categories including Natural Resources Conservation, Environmental

Quality, Sustainability, Environmental Restoration, Cultural Resources Management, and Environmental Excellence in Weapon System Acquisition.

We're leveraging some innovative thinking and technology to provide recognition that's much deserved, but also saving time and travel dollars while reducing our carbon footprint.

—Vice Admiral Phil Cullom



“Environmental stewardship is important for the Navy on many levels,” said CNO Admiral Jonathan Greenert. “How we respond to our environment is what Americans see—did we take the time to care? If we can’t get the environmental aspect of our ranges right, we’ll never get them built and operating. And once we retire, what we leave behind is how we contributed to our environment that is important for the future.”



CNO Admiral Jonathan Greenert congratulates 24 commands across the globe via VTC at the Pentagon during an award ceremony to recognize the CNO Environmental Award recipients for the Fiscal Year 2013. By using VTC technology the Navy is able to save money and reduce the carbon imprint that would have resulted from the various command representatives traveling to meet for a physical presentation of the awards.



Director, CNO Energy and Environmental Readiness Division Rear Admiral Kevin Slates reads off the individual award accomplishments of 24 commands across the globe during the VTC award ceremony.

For More Information

A COMPLETE LIST of winners, along with their submission packages, can be found the Department of the Navy’s Energy, Environment and Climate Change web site at <http://greenfleet.dodlive.mil/environment/awards/cno-environmental-awards>. A detailed summary of all award winners was featured as the cover story entitled “CNO Recognizes Award Winners for Exceptional Environmental Stewardship: Laudable Efforts Include the Safe Removal of Contaminated Siding from Dirigible Hangar at Moffett Field” in the summer 2014 issue of *Currents*. You can browse the *Currents* archive at the magazine’s on-line home at <http://greenfleet.dodlive.mil/currents-magazine>.

This is the second time the awards ceremony has been held via VTC. Prior to 2013, the ceremony took place annually at the U.S. Navy Memorial and Naval Heritage Center in Washington, D.C. During his remarks at the event, Vice Admiral Phil Cullom, deputy CNO for fleet readiness and logistics (N4), mentioned the environmental and fiscal advantages of conducting the ceremony virtually.

“We’re leveraging some innovative thinking and technology to provide recognition that’s much deserved, but also saving time and travel dollars while reducing our carbon footprint,” said Cullom.

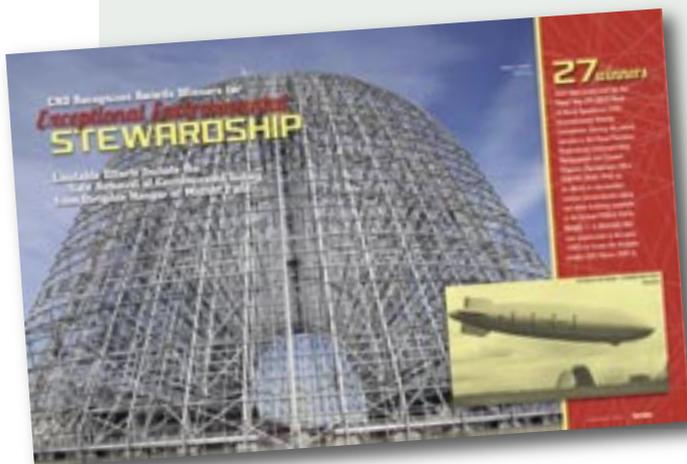
The CNO Environmental Awards has recognized exceptional environmental stewardship by Navy ships, installations, individuals, and teams annually since 1994. ⚓

Photos by Chief MC Specialist Peter D. Lawlor

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Naval Base Kitsap Replaces Fish-Blocking Culvert

After Decades, Wild Salmon Returning to Their Spawning Grounds

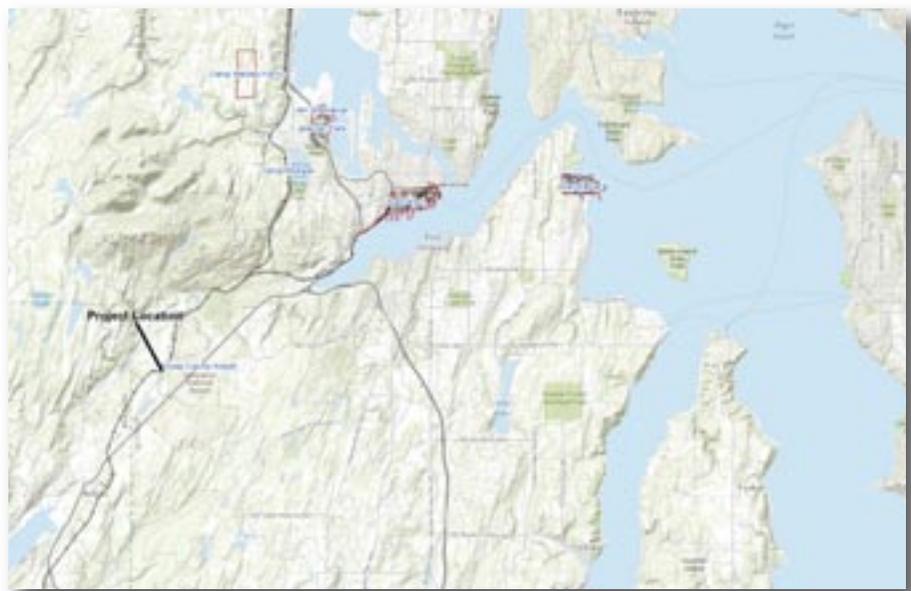
WHEN THE NAVY built a railroad through the Pacific Northwest rainforest over 60 years ago, it never dreamed it was contributing to the decline of the Pacific Wild Salmon population.

Towards the end of World War II, the Navy constructed approximately 50 miles of rail lines through the forests of Washington's western Puget Sound region to link the Puget Sound Naval Shipyard in Bremerton and the Navy Ammunition Depot at Bangor with the Northern Pacific's main line at Shelton, Washington. Today, these Navy-owned rail lines continue to serve the present day installations of Naval Base Kitsap (NAVBASE Kitsap) Bremerton and NAVBASE Kitsap Bangor under the management of the Public Works Department Kitsap (PWD Kitsap). In line with construction practices of the 1940s, the Navy installed approximately 300 culverts in the numerous streams and drainages along the railroad without full consideration that some of these culverts would present barriers to fish. Today, barriers to fish migration, such as culverts, are much better

understood and have become a major issue in the Northwest. Fixing these barriers is seen as a key step towards restoring salmon populations including threatened and endangered salmon species. This need was further solidified in March 2013 when it was ruled in Federal court that fish-blocking culverts owned by the State of Washington violate Tribal Treaty Rights.

In light of this need, PWD Kitsap began surveying culverts along the Navy railroad ten years ago to identify fish barriers and is on target to

complete surveys of all culverts in fish-bearing streams by the spring of 2015. By then all active railroad culverts in fish-bearing streams will be assigned Fish Passage Priority Index (PI) scores per Washington Department of Fish and Wildlife (WDFW) criteria in order to prioritize the repair or replacement of barrier culverts. PI scores include factors that gauge a fish passage project's feasibility including habitat gain, production potential of the blocked stream, fish stock health, and cost. The



Today, barriers to fish migration, such as culverts, are much better understood and have become a major issue in the Northwest.

higher a PI score for a barrier culvert, the higher the priority should be for its repair or replacement.

Following the most recently completed surveys in 2004, the culvert at railroad milepost 28.24 on the Airport Tributary of the Union River had the highest PI score along the Navy's railroad. The Union River supports Endangered Species Act (ESA) listed steelhead trout, coho salmon, Hood Canal summer run chum and sea-run cutthroat trout. This culvert was found to be a complete barrier to fish passage due to its length and small diameter, and because the outlet was approximately three feet above the level of the stream. The culvert was a 48-inch diameter precast concrete pipe culvert, nearly 280 feet in length. In addition, it was discovered that the culvert structure was on the verge of failure due to age and erosion with steel rebar exposed throughout the pipe. Potential failure and collapse of the culvert could have caused the entire railroad embankment to fail.

In 2011, PWD Kitsap awarded a design study for replacement of this culvert. The study indicated that at a minimum, a 15-foot wide culvert would be required to meet Washington State fish passage regulations. To further enhance fish passage, and to alleviate maintenance challenges, the Navy opted for a 20-foot diameter natural-bottom tunnel.

The construction project was awarded with Fiscal Year-end funds in 2012. Mobilization, preliminary access roads, and logging were started in April 2013 and the environmental work permits arrived in mid-May 2013, allowing the start of the in-stream work. Barring fish passage concerns, this culvert would likely have been replaced by jacking a new pipe through the embankment which is a fairly standard, and considerably less expensive, construction practice.

Replacing a 48-inch culvert with a 280-foot-long, 20-foot-wide tunnel

that's 70 feet below an active railroad line and half-mile from the nearest road was a challenge. To further complicate construction, traffic on the railroad line could not be disrupted, as multiple private entities and the Navy depend

CONTINUED ON PAGE 54



Coho salmon gather in a pool at the culvert outlet prior to reconstruction. This was the end of the line for them before the tunnel.



The culvert prior to reconstruction.



The culvert outlet prior to reconstruction.



The culvert inlet prior to reconstruction.



Biologists trapped and removed juvenile fish from the work zone prior to in-water construction.



Tunnel construction in progress.



The tunnel before backfilling.



The railroad grade above the project area.



All fish were removed from the work zone prior to in-water construction and netting was placed across the stream to prevent them from coming back during work.



After construction, the tunnel was backfilled with stream material.



Approaches to the new tunnel and laydown area were hydroseeded and revegetated with over 10,000 native plants and trees.



Completed tunnel outlet, reconstructed stream channel and new plantings.



Completed tunnel
(winter 2014).

CONTINUED FROM PAGE 51

on the railroad. Additionally, all construction had to be completed in a five-and-a-half month window before salmon began their migration back up the Union River to spawn. Chum salmon, steelhead and other salmonids spawn in small streams throughout the Northwest during the fall through winter months. The smolts (young salmon) then migrate out to sea during the spring and summer.

Before entering the creek channel, the construction crew spent several weeks building roads and lay-down areas, and ensuring a stream diversion plan was in place to allow the creek to continue flowing throughout construction. With the stream diversion in place, it was necessary to remove any fish left in isolated pools in the creek channel and move them downstream. After the creek diversion was in place, the tunneling could finally begin. Foot by foot, the tunnel team excavated into the railroad

embankment installing steel liner plates as they went. By working two 10-hour shifts, six days a week, tunneling production averaged approximately five feet per day through the summer of 2013.

After completion of the tunnel, the final steps were to restore and enhance the stream channel, including approximately 250 feet of immediate up- and downstream portions of the channel, and restore the surrounding forested areas disturbed by construction. This work involved the placement of several thousand yards of native soil and topsoil to backfill the stream channel and restore the access roads and lay-down areas. As a cost savings to the project, excess native soil was given to adjacent property owner, Waste Management, at no cost for use as additional cover on their nearby closed and capped landfill. In return, Waste Management allowed access through their property for construction. The contractor restored the

forest as personnel backed their way out of the approximate half-mile access road that was created to access the site. Native plant species, including over 10,000 fir, cedar, and hemlock trees and an equal amount of ground cover native species such as sword ferns, salal, and bracken ferns were used to restore the construction site and access route. To ensure that the access roads stay decommissioned, log barriers and root wads were placed to block vehicle access.

In October 2013, just as the wet season in the Northwest began, the tunnel and associated restoration work was completed—in time for the arrival of migrating salmon. The tunnel reopened nearly one mile of stream that had been closed to fish passage since the 1940s and is proving to be a highly successful ecological enhancement. The Navy's work supports Union River restoration plans and will provide a long-term benefit to ESA-listed species.

The tunnel reopened nearly one mile of stream that had been closed to fish passage since the 1940s and is proving to be a highly successful ecological enhancement.

During the permitting process, the Navy worked with WDFW and the Suquamish tribe to ensure the completed tunnel met State fish passage criteria. The Navy addressed all of the comments and concerns provided by WDFW and the tribe and altered design elements as necessary to ensure success. The design changes included altering the stream bed material gradation to be placed following tunneling, and softening an unnaturally sharp bend in the upstream channel. Consultations were concluded with all parties in agreement that once completed, the tunnel would meet the State's fish passage criteria and provide a signif-

icant habitat improvement to this stream. In November 2013, the Navy filed with the state to remove this culvert from their statewide inventory of barrier culverts. Long-term monitoring of the tunnel and this site will continue under both the Navy's Railroad Bridge Inspection program and NAVBASE Kitsap's Integrated Natural Resources Management Plan.

Teaming up with WDFW, the Suquamish and Skokomish Tribes, the U.S. Army Corps of Engineers, the U.S. Fish and Wildlife Service, and the National Marine Fisheries Service all reviewed the project plan during the permitting process to ensure that all

requirements were met. Cooperation by Waste Management, the Port of Bremerton, Puget Sound and Pacific Railroad, and a few adjacent private property owners was invaluable to the success of this project. The collaboration between the Navy and participating entities not only assured the success of this project, but established relationships that will ensure that future stream restoration projects are planned accordingly.

The construction cost for this project was approximately \$6 million and took 13 months from contract award to re-establishment of the site with native plants and trees. In March 2014, WDFW removed this stream crossing from its statewide inventory of fish passage barriers and assessed the new tunnel as 100 percent passable for fish.

As the PI ranking system has changed since 2004, all railroad culverts previously surveyed are now being reassessed. In addition, those culverts not previously surveyed are scheduled for assessment in the upcoming year. Once all culverts have been surveyed, priority rankings will be assigned, and PWD Kitsap will proceed with funding requests where appropriate. ⚓

Photos by John Knowles

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Restoring the Wild Salmon Population

THE SALMON POPULATION in the Pacific Northwest has undergone a sharp decline in the last few decades. By 1999, wild salmon had disappeared from 40 percent of their historic breeding grounds in Washington and Oregon (according to the Washington State Recreation and Conservation Office). As of today, 16 different species of salmonid are listed as threatened or endangered in the area.

There are numerous factors associated with this loss, and state agencies are taking various approaches to the problem, including restoration of wetlands, increasing the production of salmon at hatcheries to provide stock for anglers, and tagging wild salmon to prevent harvesting. The permanent solution, however, lies with the ability of salmon and steelhead to swim upstream to their traditional spawning grounds. Deteriorating culverts, outdated bridges, and other barriers block fish passage in many streams and undermine the state's recovery efforts.

During the past two decades, numerous fish passage barriers have been fixed through salmon restoration funds, and salmon populations in many areas are remaining static or increasing. However, WDFW estimates that there are still roughly 30,000 barriers within the state of Washington which need correction.

Sasebo Finds Sustainable Use for Food Waste

New Processes at Remote Installation Help Meet Navy Solid Waste Diversion Goals

NAVAL FACILITIES ENGINEERING Command Far East Environmental Division installed two food waste dehydration machines at Command Fleet Activities Sasebo (CFAS) this year in an effort to increase their solid waste diversion.

Personnel from the Public Works Department (PWD) Sasebo, Steve Edlavitch and John Freeman, observed that discarded food accounted for 11 percent of the waste that was landfilled or incinerated. Because of the installation's remote location, food shipped from the U.S. has a short shelf-life.

When the Environmental Division at PWD Sasebo met last year to decide how to meet or exceed U.S. Navy goals for solid waste diversion, solid food waste was a prime target.

"We have a very successful Qualified Recycling Program here, and robust prefectural laws in Japan ensure that base waste is segregated into specific recyclable commodities," said Edlavitch. "But still, our solid waste diversion rate has hovered near 50 percent. CFAS leadership wanted to ensure that we are setting an appropriate benchmark for our gracious hosts here in Kyushu."

"We generate about 750 tons of food waste from our commercial support operations, ship port calls, food service locations, base residents, and installation schools every year. Our challenge is to find ways to reduce, reuse, or recycle food waste to reduce our overseas environmental footprint," he said.

PWD Sasebo partnered with the Defense Commissary Agency (DeCA) to install two food waste dehydration machines, called 'Hungry Giants' (manufactured by ReSource Environmental Solutions), at two locations on the base.



ABOVE: Ben Englefied showing DeCA commissary staff to operate the Hungry Giant food waste dehydration machine.



RIGHT: The Hungry Giant food waste dehydration machine at the CFAS Hario commissary.

To ensure program success and reduce their food waste footprint, store employees would have to “buy in” and alter the way they perceived expired food—viewing it more as a reusable resource rather than refuse.

“When we trained commissary staff, there were some uncertainties about the efficacy of dehydrating/composting commissary store food,” said Freeman. “Store workers were accustomed to conventional disposal techniques like hauling food out to dumpsters and had questions about what kinds of foods could be deposited in the machine, and what would happen if nonfood items like bones or plastic wrap were placed in it.”

Now, instead of the dumpster, commissary employees load the Hungry Giants with food waste throughout the day and initiate a run cycle at the end of a work shift. Non-food items are expelled at the end of the cycle. The machines convert organic materials such as breads, meats, produce and starches into a sterile, nutrient-laden dehydrated soil amendment, reducing food waste by 80 to 95 percent. The end product is expelled into containers which are evaluated by environmental division staff.

“Initially, we’ve found that the machines can reduce our food waste burden (measured by weight) by around 80 percent. We’re still learning what kind of food mix offers



An example of the amendment that is discharged from the dehydration machine.

the maximum waste elimination,” said CFAS Commissary Officer Cory Reilly.

Based on early successes, CFAS plans to expand its food waste recycling program from the two Commissaries to other food-waste generating facilities throughout the installation. CFAS also plans to work with local Japanese companies to process the amendment and/or apply it to base landscaping areas. The amendment will potentially provide nourishment for shrubs and trees, thus completing the circle of sustainability. This planned program expansion is just part of what makes CFAS an overseas environmental leader. 📍

Photos by John Freeman

For More Information

FOR MORE INSIGHTS into other ways to solve food waste challenges, read our article entitled “Diverting Food Waste from Landfills Saves Money & the Environment: NESDI Project Includes New Guidance Document for Navy Solid Waste Managers” in the summer 2014 issue of *Currents*. To browse the *Currents* archive, visit the magazine’s on-line home on the Department of the Navy’s Energy, Environment and Climate Change web site at <http://greenfleet.dodlive.mil/currents-magazine>.



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NAVAIR Discovering Alternatives to Hexavalent Chromium & Cadmium

NESDI-Sponsored Projects Targeting Primers & Coating Methods

HEXAVALENT CHROMIUM AND cadmium are used in a variety of applications to protect Navy aircraft from corrosion—but both substances are known carcinogens. In 2009, the Office of the Secretary of Defense released a memo restricting the use of hexavalent chromium (Cr6+) unless no cost-effective alternatives with satisfactory performance were available. The use of cadmium faces similar restrictions. Personnel from the Naval Air Systems Command (NAVAIR), sponsored by the Navy Environmental Sustainability Development to Integration (NESDI) program, are working on five separate projects with the goal of eliminating the use of cadmium and hexavalent chromium on Navy and Marine Corps aircraft.

Demonstrating Advanced Non-Chromate Primers & Coatings (Project 458)

Hexavalent chromium (Cr6+) has been subjected to increased scrutiny and regulation from federal agencies, both domestic and foreign.

Cr6+ has also become very expensive to use and dispose of due to its classification as a hazardous material. While minimum performance requirements have satisfied other Department of Defense (DoD) agencies, such as the U.S. Air Force and Army, the U.S. Navy's harsh operational environment demands

maximum performance and therefore, further evaluation outside of qualification testing. A comprehensive demonstration and validation of mature non-chromate products is necessary to identify a product with corrosion performance that is equivalent or better than the chromate coating systems fielded today.



NESDI project 458 is demonstrating new, state-of-the-art non-chromate replacements for use in primers and coatings for Navy aircraft. The E-2C Hawkeye was one of the first aircraft to be treated with the new non-chromate primer.

MC Seaman Siobhana R. McEwen

This project, leveraged by the Environmental Security Technology Certification Program (ESTCP), has focused on the demonstration/validation of mature non-chromate primers throughout the DoD. The NESDI-sponsored portion of this effort focuses on Navy-specific products and processes. The project team's first task was to identify mature Class N primers (non-chromate based corrosion inhibitors) for extensive laboratory testing. Top performers would be down-selected for accelerated corrosion tests. Initially, two products were selected for demonstration and validation—PPG-Deft 02-GN-084 (qualified to MIL-PRF-23377, Type I, Class N), and Hentzen 17176KEP (qualified to MIL-PRF-23377, Type II, Class N). These commercial-off-the-shelf primers were applied to the outer moldline (OML) on a minimum of two of each kind of aircraft at three different Fleet Readiness Centers (FRC). These aircraft include the H-46 Sea Knight helicopter, V-22 Osprey Helicopter, H-53 Sea Stallion Helicopter, T-6 Texan, T-34 Mentor, T-44 Pegasus, T-45 Goshawk, E-2C Hawkeye, P-3 Orion, and F/A-18A-D Hornet.

The aircraft treated with non-chromate primers are being compared to analogous chromate-primed aircraft that are deployed at the same time and subjected to similar environments. Acceptable performance for full-scale demonstration and validation is two land-based aircraft completing at least two years of operational service, or two carrier deployments for aircraft that normally deploy on a carrier.

To date, the PPG-Deft 02-GN-084 primer has been successfully demonstrated on the E-2C, P-3C, T-6, T-34, T-44, & T-45 aircraft. Service inspections done post-deployment documented good corrosion and adhesion performance. As a result, NAVAIR is drafting an authorization letter which specifies minimum performance of a product in an operational environment. NAVAIR will authorize PPG-Deft 02-GN-084 over chromate conversion coating on the OML of all Navy gloss paint scheme aircraft.

NAVAIR is currently evaluating Hentzen 17176KEP primer on the following aircraft: V-22, H-46, H-53, and F/A-18A-D. Unlike the gloss paint scheme aircraft, which are primarily aluminum on the OML, the OML tactical paint scheme of these aircraft is constructed of both composite and aluminum substrates. The H-53 and F/A-18A-D aircraft were painted in Fiscal Year 2014. Upon successful demonstration, NAVAIR anticipates authorizing the Type II primer for tactical aircraft.

Exploring Cadmium- and Hexavalent Chromium-free Electrical Connector Finishes (Project 451)

Electrical connectors are ubiquitous and essential components of aircraft and other vehicles at maintenance and repair facilities across the DoD. New finishes which contain neither cadmium nor hexavalent chromium have been added to the qualified products list (QPL) for one common electrical connector specification—MIL-DTL-38999L. However, there has been no known Navy-relevant field testing of these products, meaning the corrosion risk is uncertain.

This project was initiated to perform Navy/Marine Corps field testing to determine relative performance of new and control plating classes including MIL-DTL-38999L, Classes P, T, Z, M, W, J. Performance was quantified using both the real-world marine environment and the dynamic cycling of threaded circular



Under NESDI project 451, field testing was conducted on two new connector finishes. Electrical connectors are found on all military aircraft, including the aircraft shown here.

MC3 Bryan M. Ilyankoff

connector. (Dynamic cycling refers to the opening and closing of connectors in the environment, which is more relevant than static corrosion testing because it incorporates corrosion and wear mechanisms on thread.)

At the end of a 12-month test, the cadmium plated aluminum (Class W) cadmium/Cr + 6 controls and high-purity aluminum (Class P) finish appeared to be among the best performers (on aluminum body connectors); however, electrical assessments showed a surprising degree of variation among the various combined finishes tested. Composite connectors Class J and M also performed well.

There have been significant development efforts by other organizations since this testing began in 2010, so the results of this work should be considered alongside these findings. The project's final report, available via the NESDI web site, cites these studies as well.

Testing Non-Chromated Post-treatments (Project 328)

Ion Vapor Deposition (IVD) of aluminum is a vacuum plating process which deposits pure aluminum on metal to enhance corrosion resistance. The IVD process itself is nontoxic; however, for a higher level of corrosion resistance, aircraft parts are typically subjected



NESDI project 328 is testing and authorizing a trivalent chromium process as a non-chromated replacement. Post-treatment coatings are used widely on landing gear for the AV-8B and other aircraft.

MCS Michael Achterling

to a post-treatment process that includes chromated coatings (coatings containing Cr6 +). Trivalent chromium is a less toxic alternative to Cr6 + and it was the goal of this project to test and authorize a trivalent chromium process as a non-chromated replacement.

At the onset of this project, the trivalent chromium post treatment (TCP) had already been in use for five years as a pre-treatment for helicopter parts at FRC East in Cherry Point, North Carolina. This project team subjected TCP-treated parts to laboratory testing in 2009. After passing the tests, landing gear parts on two AV-8B aircraft were coated with the TCP at FRC East. After several years of service, there were no reported problems with corrosion or paint adhesion. NAVAIR approval is currently being sought for the treatment so that it can be used Navy-wide.

Validating Nanocrystalline Cobalt Phosphorous Electroplating as an Alternative to Hexavalent Chromium (Project 348)

Electrolytic hard chrome (EHC) plating is a technique that has been in commercial production for more than 50 years. It is used both for applying hard coatings to aircraft components in manufacturing operations and for general rebuild of worn or corroded components during overhaul. Chromium plating baths contain Cr6 + . Because of this, plating operations must abide by U.S. Environmental Protection Agency (EPA) emissions standards and Occupational Safety and Health Administration permissible exposure limits. During operation, chrome plating tanks emit a Cr6 + mist, which must be ducted away and removed by scrubbers. Additionally, wastes generated from plating operations must be disposed of as hazardous waste.

Nanocrystalline cobalt phosphorus (nCoP) alloy plating is an alternative electroplating process that uses pulse plating to create a ultra-fine nanocrystalline structure on top of the component part. The nCoP coating exhibits properties that are equivalent to and, in many ways, better than EHC deposits. This technology is a direct drop-in replacement for the existing EHC process and will only require modification of plating power supplies.

Significant reductions in energy consumption and increases in throughput can be achieved with the nCoP process. The overall plating efficiency of the nCoP process is greater than 90 percent, compared to less than 35 percent for EHC. This leads to significantly less hydrogen generation than the EHC process, minimizing the likelihood of hydrogen uptake and subsequent embrittlement of susceptible materials (i.e., high-strength steels). (Hydrogen embrittlement is the process by which various metals, most importantly high-strength steel, become brittle and fracture following exposure to hydrogen. Hydrogen embrittlement is often the result of unintentional introduction of hydrogen into susceptible metals during forming or finishing operations.) Unlike EHC, the nCoP process uses no constituents on the EPA list of hazardous materials and it does not generate hazardous emissions or by-products.

This project was formed to demonstrate and validate nCoP plating as an alternative to EHC plating.

To achieve this, the team constructed two process tanks at FRC Southeast in Jacksonville, Florida. Various aircraft components were plated and tested using the nCoP process. In 2012, field testing was initiated on a T-45 Goshawk aircraft part. The part was removed for visual inspection after over 700 flight hours. It passed visual inspection and will be placed into another aircraft for continued service.

When testing is complete, this technology is expected to be transitioned to all FRCs, leading to lower health and environmental risks, and reduced lifecycle costs due to superior performance.

Validating a Zinc-Nickel Alternative to Cadmium Tank Electroplating (Project 450)

Cadmium is targeted by the EPA and is also included in NAVAIR's FRC Toxic Metal Control Program, which requires that it be replaced with available alternative technology. Like hexavalent chromium, cadmium has historically been used as a corrosion inhibitor. It is applied to ferrous,

aluminum, and copper alloys (via electroplating and other methods) to protect them from corrosion due to contact with dissimilar metals.

Besides having excellent corrosion resistant properties, cadmium offers natural lubricity where torque requirements are needed. Cadmium electroplating is used on weapon systems throughout the DoD.

Many alternatives to cadmium tank electroplating have been addressed, but with limited success due to process limitations as a direct drop-in replacement and/or performance drawbacks. For example, earlier formulations of zinc-nickel (Zn-Ni) alloy plating were susceptible to hydrogen embrittlement. Because of this danger, a nickel pre-plate step was added to the process. However, this method still resulted in inferior fatigue performance, which limited the process to use with non-critical structures.

This project is demonstrating and validating an improved alkaline Zn-Ni alloy plating process, and will validate a trivalent chrome post-treatment for use with the demonstrated process. The Zn-Ni



The project 348 team is demonstrating and validating pulsed electroplated nCoP alloy coatings as a technically feasible replacement for the current hexavalent chromium plating process used on components for the T-45 and other military aircraft.

MC3 Nathan Parde



To eliminate the use of cadmium on high-strength steel components, NESDI project 450 is demonstrating and validating an alternative process using alkaline zinc-nickel alloy electroplating. High-strength steel components are found on aircraft such as the F/A-18 series aircraft shown here.

MC2 Timothy A. Hazel

The Basics About the NESDI Program

THE NESDI PROGRAM seeks to provide solutions by demonstrating, validating and integrating innovative technologies, processes, materials, and filling knowledge gaps to minimize operational environmental risks, constraints and costs while ensuring Fleet readiness. The program accomplishes this mission through the evaluation of cost-effective technologies, processes, materials and knowledge that enhance environmental readiness of naval shore activities and ensure they can be integrated into weapons system acquisition programs.



The NESDI program is the Navy's environmental shoreside (6.4) Research, Development, Test and Evaluation program. The program is sponsored by the Chief of Naval Operations Energy and Environmental Readiness Division and managed by the Naval Facilities Engineering Command out of the Naval Facilities Engineering and Expeditionary Warfare Center in Port Hueneme, California. The program is the Navy's complement to ESTCP which conducts demonstration and validation of technologies important to the tri-Services, EPA and Department of Energy.

There are a number of ways you can participate in the NESDI program:

1. Submit a need via the program's web site.
2. Review the technologies already under development.
3. Act as a Principal Investigator on a NESDI project.
4. Provide a demonstration site for a NESDI project.
5. Support the program's integration efforts.

For more information, visit the NESDI program web site at www.nesdi.navy.mil or contact Ken Kaempffe, the NESDI Program Manager at 805-982-4893, DSN: 551-4893 or ken.kaempffe@navy.mil.

alloy tank plating process (known as DIPSOL IZ-C17 +) offers equivalent performance characteristics as current methods, but with reduced hazardous waste treatment and associated environmental/ medical monitoring costs. It also requires minimal capital investment and impact to production, as existing cadmium tanks can be lined and filled with Zn-Ni solution. This process meets the requirements for a non-embrittling process per American Society for Testing and Materials (ASTM) standards. Currently, ASTM testing for corrosion is underway at FRC Southeast. If field testing is successful, DIPSOLVE IZ-C17 + will be an immediate drop-in replacement for cadmium tank electroplating.

For More Information

For more information on any of the above projects, visit www.nesdi.navy.mil then select "Current Projects" and search by project number or keyword. [!\[\]\(edd6a0397317fe520f097f6fe8bfc3da_img.jpg\)](#)

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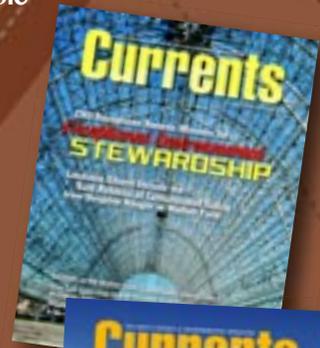
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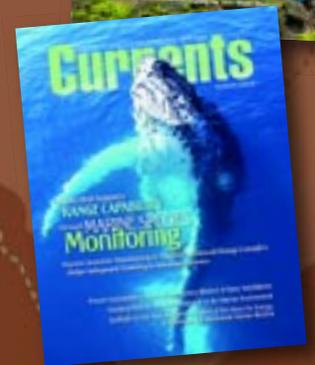
1. Among the winners of the Fiscal Year 2013 Chief of Naval Operations Environmental Awards competition was the Naval Facilities Engineering Command Base Realignment and Closure Program Management Office for its efforts to successfully remove contaminated siding and other building materials at the former Moffett Field's Hangar 1—a structure that was constructed in the early 1930's to house the dirigible airship USS Macon (ZRS-5)



2. Principal investigators sponsored by the Navy Environmental Sustainability Development to Integration program recently completed the second year of a study to assess the placement and removal of an underwater cable from the Monterey Bay National Marine Sanctuary off the coast of central California. These efforts will aid the Navy in making sound decisions regarding the long-term disposition of seafloor cables.



3. Ongoing efforts by personnel from Commander, U.S. Pacific Fleet in the Navy's Hawaii Range Complex demonstrate the Navy's commitment to research on underwater detection and tracking of marine mammals; marine mammal behavioral responses to sound; establishing hearing thresholds; determining species location and abundance; and mitigating the effects of underwater sound.



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