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 authorization, 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.

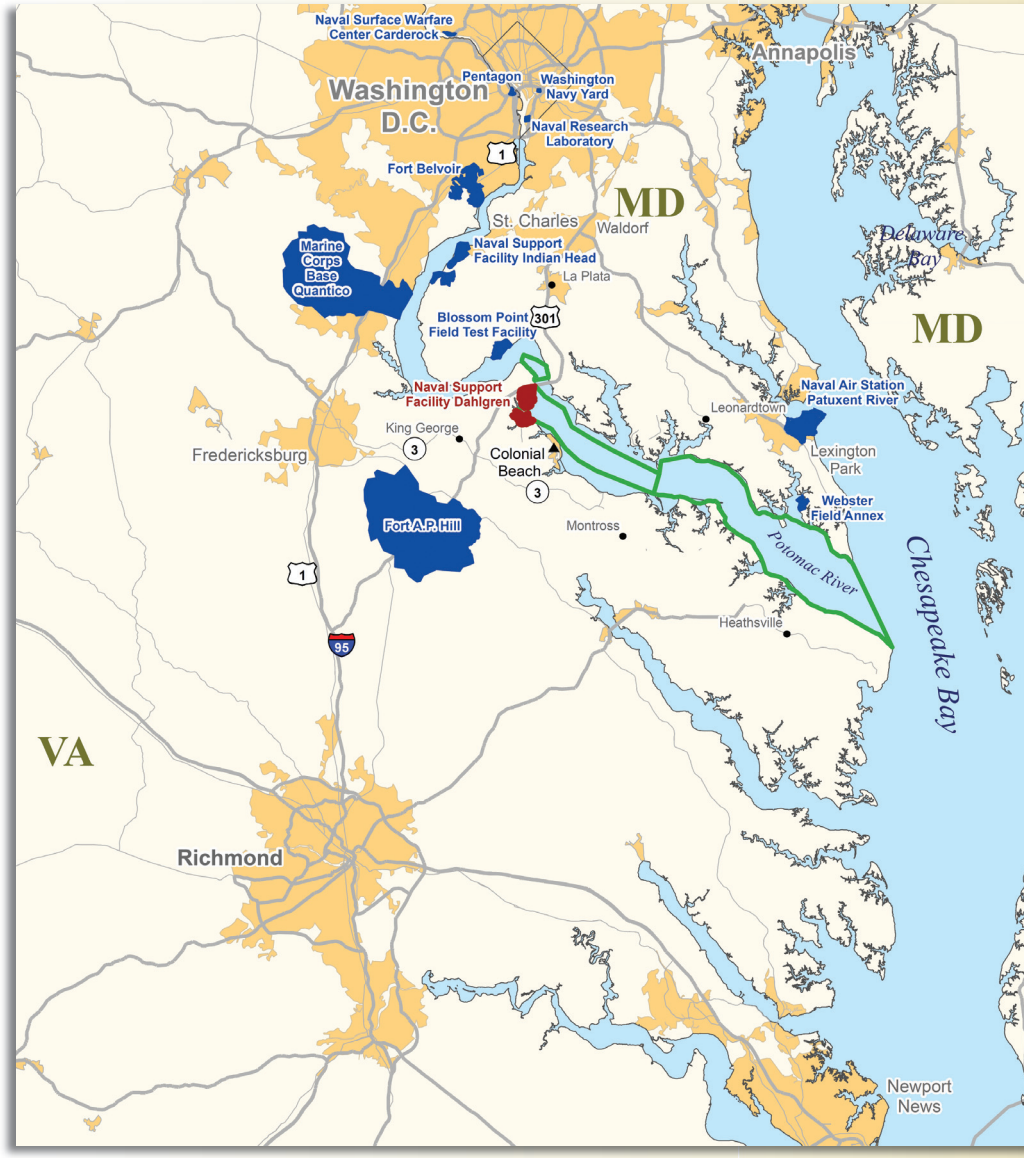
The Dahlgren Area

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.

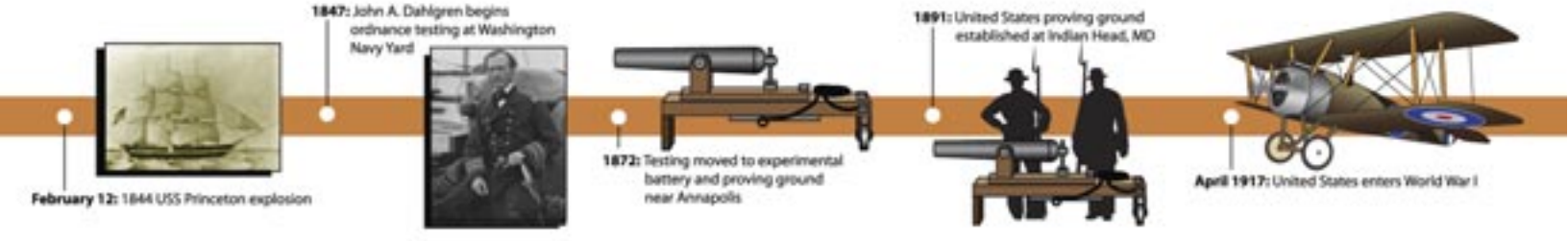
At the turn of the century, the oyster harvest from the Chesapeake region was the world's largest, and millions of pounds of crab and shad were also being realized. Though this yield began to decline in the 20th century due to destructive harvesting techniques, the Navy activities at Dahlgren posed little 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

An 18-inch, 47-caliber gun at NSWC Dahlgren.



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

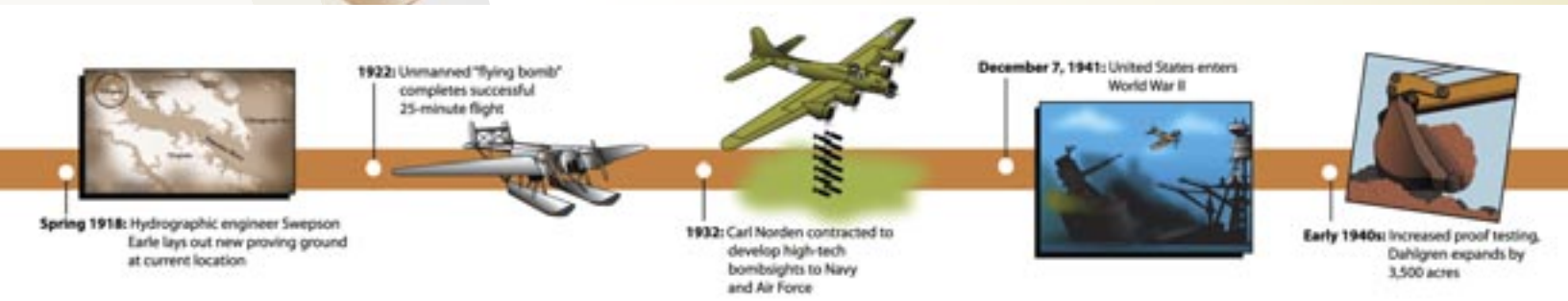
noise will be made, and contact numbers for additional information—is provided on the NSWC Dahlgren range website, as well as via a toll-free information line and local newspapers. In addition, the ROC coordinates with operators of private vessels via range control boats or marine radio to minimize delays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



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 (NSWCDL).

In 1976, the Navy chose NSWCDL 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 NSWCDL 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

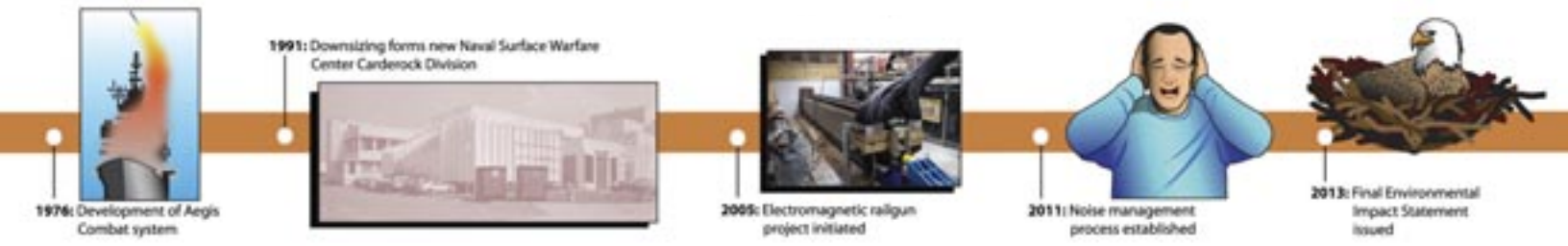
In January 1992, the Navy combined the following three entities into the new Naval Surface Warfare Center Dahlgren Division:

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.



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 Electromagnetic 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.

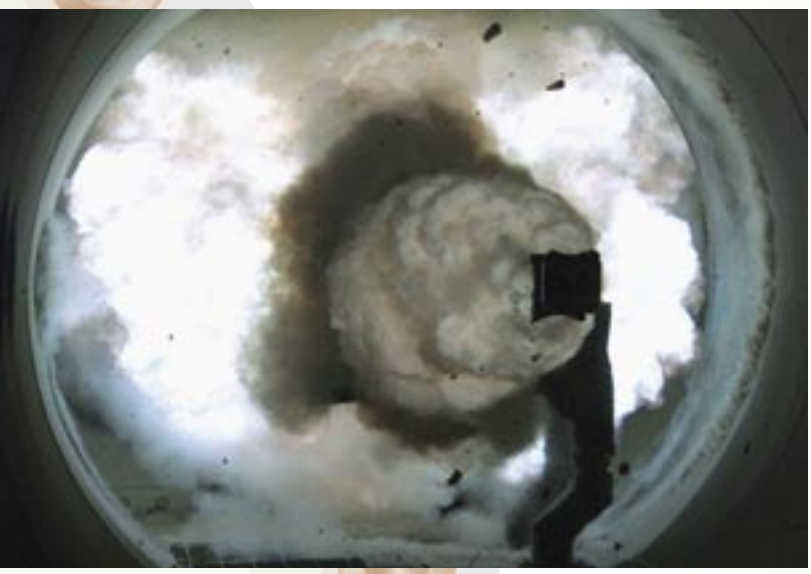
In addition to the electromagnetic railgun's innovative propulsion system, the high-velocity projectiles fired are expected to be able to destroy targets using kinetic energy—the sheer force of the impact—rather than conventional explosives. Electromagnetic railgun projectiles offer distinct logistical 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.

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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 Devise 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).

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

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

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 electromagnetic 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.

CONTACT

Bridget Hoopes
Naval Surface Warfare Center
Dahlgren Division
540-653-7713
DSN: 249-7713
bridget.hoopes.ctr@navy.mil