NESDI Program Launches New Projects

Efforts Include Using Biochar to Remove Regulated Contaminants from Dry Dock Discharges

THE NAVY ENVIRONMENTAL Sustainability Development to Integration (NESDI) program launched 14 new initiatives in fiscal year 2018 to address some of the Navy's most pressing environmental operational challenges. These projects range from testing the efficacy of biochar to remove regulated contaminants from shipyard dry dock discharges to eliminating hexavalent chromium from magnesium conversion coating processes at the Navy's Fleet Readiness Centers (FRC).

Each year, the NESDI program collects environmental needs from across the Navy's shore community. Based on selected needs, project teams are formed to demonstrate, validate and integrate innovative technologies, processes and materials into fleet operations. In late 2017, the program gave the green light to the following 14 "new start" projects listed in the table on the next page.

The first seven projects in the table were highlighted in the winter 2017-18 issue of *Currents*. The second set of seven projects are described in the sections below.

Learn More

TO READ MORE about the first seven projects included in the table on the next page, read our article "NESDI Program Initiates Several New Projects" in the winter 2017-18 issue of *Currents*. You can browse the entire *Currents* archive at http://navysustainability.dodlive.mil/currents-magazine.

Biochar Adsorption for Dry Dock Effluent (project no. 560)

This NESDI project will establish the efficacy of biochar in removing regulated contaminants from shipyard dry dock discharges.

Navy shipyard dry docks generate industrial process water that may contain metal particulates as well as nutrients from stormwater runoff, non-contact cooling systems and other activities that are regulated under the National Pollutant Discharge Elimination System (NPDES) program. NPDES permit requirements at Navy shipyards are becoming increasingly more restrictive—particularly with respect to the concentrations of metals and nutrients allowed in point source discharges.

NO.	PROJECT	TITLE	PRINCIPAL INVESTIGATOR
1.	553	Study of Waste Management and Minimization for AFFF Wastewater	Daniel Edwards (NAVFAC EXWC)
2.	554	Addressing Temporal Variability in Industrial Buildings during Vapor Intrusion Assessments	Trish Venable (NAVFAC EXWC)
3.	555	Demonstrating the Effectiveness of Novel Treatment Technologies for the Removal of Poly- and Perfluoroalkyl Substances from Groundwater	John Kornuc (NAVFAC EXWC)
4.	556	Enterprise-wide Hazardous Material Standardization and Minimization of General Use Consumables	Renata Laing (NAVSUP WSS)
5.	557	Initiation Decision Report of Laser Coating Removal on Naval Aircraft Components	Stephen Starnes (FRC-SE)
6.	558	In-situ Automatic Stormwater Sampling Device for Use at Tidally Impacted Sampling Locations	Ernie Arias (SSC Pacific)
7.	559	Background Analysis and Tracer Study to Identify Metal Contaminant Source Contributions to Stormwater Runoff	Jim Leather (SSC Pacific)
8.	560	Biochar Adsorption for Dry Dock Effluent	Lewis Hsu (SSC Pacific)
9.	561	Development and Demonstration of a Portable, Temporary Barrier to Aid in Cargo and Equipment Inspections to Prevent Brown Treesnake Dispersal	Jean Pan (NAVFAC EXWC)
10.	562	Elimination of Hexavalent Chromium from Magnesium Conversion Coating Processes at Fleet Readiness Centers	Alan Grieve (NAWC AD Pax River)
11.	563	Low VOC Primers for Ground Support Equipment Application	Michael Brindza (NAWC AD Pax River)
12.	564	Implementation of Biotic Ligand Model-Based Water Quality Standards for Copper at Navy Sites	Gunther Rosen (SSC Pacific)
13.	566	Source Metal Particle Removal for Stormwater Compliance	Jim Howell (NSWC Carderock)
14	567	Business Processes and Requirements Enabling Technology Integration	Martin McMorrow (NAVFAC EXWC)

Due to these stringent limits (on the order of parts per billion) and the limited capacity to treat large-volume continuous flows, shipyards may be at risk for exceeding NPDES permit limitations for metals such as copper, zinc and aluminum among others.

There are four dry docks at Pearl Harbor Naval Shipyard and Intermediate Maintenance Facility (PHNSY&IMF), six dry docks at Puget Sound Naval Shipyard and additional docks at other Washington State and California installations with similarly restrictive permit levels.

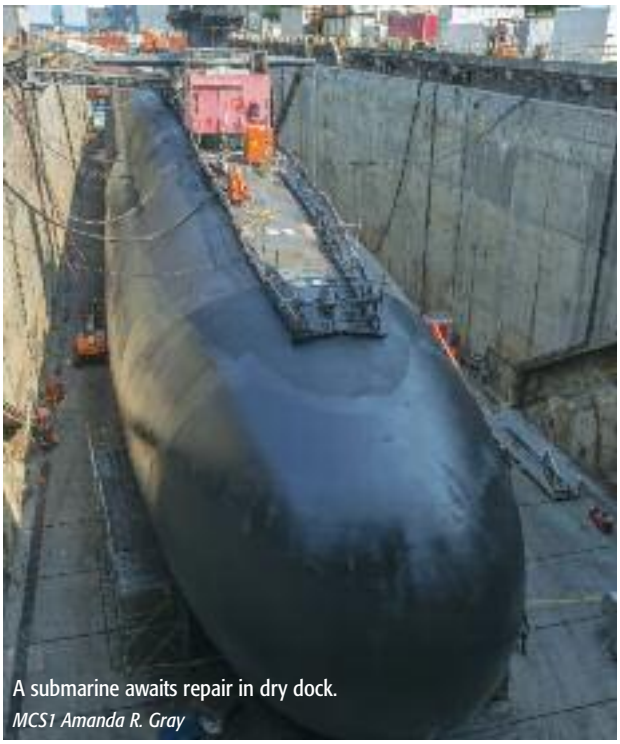
The State of Hawaii is aware of the significant challenges imposed by NPDES permit limitations and has granted PHNSY&IMF a Schedule of Compliance and interim permit limits for pollutants such as copper. Although PHNSY&IMF can consistently attain its current interim limit for copper, the facility continues to struggle to meet the final permit limitation, which will go into effect by October 2022. Best management practices (BMP) have helped to significantly lower metal and nutrient concentrations from the end-of-pipe discharge but do not appear adequate to meet long-term goals. There are presently no additional measures or opportunity to remove contaminants from discharges passing through the dry dock drainage system.

Recent testing has indicated that the use of biochar can be an effective means of removing metals and nutrients from stormwater and process water streams.

Recent testing has indicated that the use of biochar can be an effective means of removing metals and nutrients from stormwater and process water streams. A carbonaceous byproduct of bioenergy production, biochar is an inexpensive, highly porous filtration media with high contaminant retention rates.

This project team will place weirs within existing dry dock drainage troughs which will result in the temporary pooling of process water. This water will then be forced to flow up through a biochar device to provide adequate contact time and sequestration of contaminants. This upflow configuration has been found to be more effective than cross flow or other schemes. Lessons learned from previous studies indicate that rinsing the biochar prior to use increases the contaminant holding capacity and this practice will be implemented during the demonstration.

Other deployment strategies to be tested include the use of biochar as a treatment step within the dry dock sand trap and utilizing clarifying inserts being developed under another NESDI project (project no. 543: Preventative Management of Contaminated Silt). In this case, biochar will be a drop-in media filtration component in the clarifying inserts. Remedy effectiveness will be laboratory tested via U.S. Environmental Protection Agency (EPA) approved methods.



A submarine awaits repair in dry dock.
MCS1 Amanda R. Gray

The data from this demonstration will be made available to end users to determine if this technology is a good fit at their respective sites. If so, the passive filtration fixtures used may be fabricated by shipyard tradespeople or contractors using commercially available biochar. Coordination with shipyard personnel and commercial biochar manufacturers will aid in the integration of this technology and provide an effective and useful means of deploying it. A final report including recommended testing and design criteria will be prepared to assist in future implementations.

Regulators will have access to the data from this demonstration as evidence of BMP improvement efforts targeting permit violation reductions. If successful, this technology will be included in future updates to BMPs found in shipyard Dry Dock Water Pollution Control Plans and future NPDES permits if applicable.

Development and Demonstration of a Portable, Temporary Barrier to Aid in Cargo and Equipment Inspections to Prevent Brown Treesnake Dispersal (project no. 561)

The goal of this project is to create and demonstrate a portable, temporary barrier to help prevent the spread of brown treesnakes (BTS) through cargo shipments in the Pacific.

The brown treesnake (*Boiga irregularis*) is an invasive species with the largest current and potential impact to DoD activities in the Pacific. Since the late 1940s, the treesnake has caused the extinction or extirpation of many endemic species on Guam, including 10 of 12 forest birds. Were the treesnake to successfully invade other locations, particularly the Commonwealth of the Northern Mariana Islands (CNMI) and Hawaii, it could wreak both biological and economic havoc. Given the increased military activities in the region and military construction on Guam from the Guam and CNMI military relocation, there is a high risk of the treesnake being dispersed into these areas through the Department of Defense (DoD) transportation network.

Currently, the DoD spends millions of dollars a year on the management and control of the BTS. Much of this funding goes toward overseeing inspections of all outbound cargo and equipment from Guam for BTS stowaways. Inspection of cargo at inbound locations may also be required, depending on the location. The primary BTS inspection method is canine inspection followed by

human visual inspection. Cargo is inspected when it arrives at the outbound site and then daily until it is loaded onto a departing vessel. The speed at which cargo and equipment can be loaded and unloaded is limited by the number of canine teams and the time it takes for them to inspect each piece of cargo. If the canine teams fall behind cargo loading and off-loading, this can delay cargo and equipment transport and military missions.

To reduce delays for DoD shipments and military missions, this project team plans to use portable, temporary barriers to prevent the movement of BTS. Cargo and equipment that have passed an initial canine inspection can be stored within these barriers until the day of loading or transport, where they can undergo a final canine inspection before being moved. A portable, temporary barrier can also be used as a rapid response tool during the inspection process at a receiving jurisdiction when a canine alerts on the cargo item, but the BTS is not immediately visible. The barrier would serve as a quarantine structure until the BTS can be found and removed.


Brown treesnake.

While such barriers exist and are in use by the DoD, existing designs require ground penetration or disturbance (e.g., posts, walls, rebar) inserted into the soil, to be able to withstand local environmental conditions. This requirement for temporary barriers is problematic on Guam and the CNMI due to unexploded munition and cultural resource issues.

Utilizing some of the design elements of other temporary barriers, the team will design and test a new prototype barrier under controlled conditions. The successful design will then be field tested on Guam to determine its effectiveness against BTS and its ability to withstand environmental conditions. Following the successful deployment of these tasks, a full-size barrier will be built and utilized in realistic transportation situations.

The team will transition this technology to a variety of audiences (e.g., end-users, DoD personnel, regulators). For long-term technology transition, the Naval Facilities Engineering Command Marianas team member will transition this technology within the DoD, at transportation venues and with regulators on Guam, CNMI and Hawaii. The team will also produce a guidance document on how to use the barrier, as well as in-person training and a training video.

Elimination of Hexavalent Chromium from Magnesium Conversion Coating Processes at Fleet Readiness Centers (project no. 562)

This project will evaluate the use of hexavalent chromium (hex chrome) -free conversion coatings on magnesium alloys and demonstrate their effectiveness as a drop-in replacement.

Metal finishing processes are performed at all major Navy FRCs. Conversion coatings are the most common of these processes. They are thin films on a metal surface generated by reaction between the metal and a chemical solution. They are applied to alloys to provide some measure of corrosion protection and to promote adhesion between the alloy and subsequent surface treatments. While process specifications vary among FRCs, all current processes for applying conversion coatings to magnesium alloys use hex chrome-based chemistries, long established as both toxic and carcinogenic.

At the FRCs responsible for processing magnesium parts, the total magnesium conversion process tank volume exceeds 3,200 gallons, meaning that at any given time there is over 3,200 gallons of solution containing some level of hex chrome. At a single FRC, the cost associated with cleaning to limit heavy metal exposure to personnel exceeds $1 million per year. Similar costs are borne across other FRCs—and this does not even include the further costs associated with management of associated hazardous waste. Elimination of hex chrome from magnesium finishing processes would be of great benefit toward the Navy's goal of reducing heavy metal usage.

Several hex chrome-free conversion coating formulations were evaluated by the Navy for use on magnesium alloys.

All current processes for applying conversion coatings to magnesium alloys use hex chrome-based chemistries, long established as both toxic and carcinogenic.

Laboratory results showed comparable performance to the hex chrome-based formulas. Attempts to transition these technologies for use on magnesium alloys were not successful for various reasons. One of the primary issues inhibiting implementation was the lack of an observable color change. The presence of hex chrome conversion coatings is readily apparent due to their characteristic iridescent gold color, making it simple for artisans to assess the efficacy of a coating process. In contrast, none of the hex chrome-free coatings were observable, making process assessment very challenging.

The project team will first compare the processes in place at each FRC such that any new process, at a minimum, meets existing requirements. Next, extensive laboratory tests will be conducted using metrics such as coating weight/thickness and appearance to identify two to three potential candidates. The evaluation of color additives will be an integral part of this process. These candidates will be subjected to corrosion resistance testing. If successful, a pilot process line will be established at a suitable FRC using the chosen formulation. Corrosion/adhesion performance will remain the primary metric, but effectiveness of the color additive will also be critical to access the performance of the modified process.

Components of the H-53 and other helicopters are target applications for a non-hex chrome conversion coating process.

Ismael Ortega

To be successful, replacement coatings need to perform at least as well as the current coatings and exhibit similar process characteristics. If successful, demonstration at a second FRC will begin at the beginning of year three. A secondary goal is to generate sufficient data and know-how for the possible future development of a detailed specification for a non-hex chrome conversion coating process with the aim of aligning processes across FRCs.

If the demonstration and validation proposed here proves to be successful, implementation will begin at the demonstration site(s) immediately, before transitioning to other FRCs. This technology could be of value to other services, in particular the Army. Army engineers have already expressed interest in the proposed program and possible future collaboration.

Low-VOC Primers for Ground Support Equipment Application (project no. 563)

The objective of this effort is to laboratory test, demonstrate, validate and qualify low-volatile organic compound (VOC) primers for use on ground support equipment (GSE).

There is a push both at the federal and local levels for the continual reduction of VOCs and hazardous air pollutants (HAP) associated with painting operations. Many of the military specification (mil-spec) primers have not changed significantly, whereas local and federal environmental regulations are continually changing. Two of these regulations, the Code of Maryland Regulations "Control of VOC Emissions from Vehicle Refinishing" (rule no. 26.11.19.23) and the Ventura County (California) Air Pollution Control District Rule "Motor Vehicle and Mobile Equipment Coating Operations" (rule no. 74.18) have the most stringent regulations in the nation with a primer maximum VOC limit of 250 gallons per liter (2.1 pounds per gallon). The current mil-specs for aircraft GSE primers have a maximum VOC requirement of 340 gallons per liter

Failure to identify low-VOC primer alternatives can adversely affect Navy GSE coatings operations and increase the compliance cost of current and future local and EPA environmental legislations.

(2.8 pounds per gallon), meaning they are out of compliance with these current regulations.

While these rules currently affect only two jurisdictions (the State of Maryland and Ventura County), environmental regulations are traditionally broadly adopted and likely to be adopted elsewhere. The effects on the Maryland jurisdiction is significant because the primary overhaul facility for aviation support equipment is located in Solomons Island, MD.

Failure to identify low-VOC primer alternatives can adversely affect Navy GSE coatings operations and increase the compliance cost of current and future local and EPA environmental legislations.

According to the Naval Air Systems Command, the preferred primer for Navy GSE are products qualified to the Army-maintained MIL-PRF-53022 specification. Acceptable alternate primers are products qualified to MIL-PRF-23377 Class N (the mil-spec for the non-chrome class of primers). This effort will identify, test and qualify GSE-acceptable primers to the MIL-PRF-23377 specification that are both HAP-free and VOC-compliant. Modified low-VOC formulations of qualified MIL-PRF-23377 Class N primers will be evaluated, as will metal-rich primer technologies and other potential low-VOC primers.

Laboratory testing will be performed on both steel and aluminum substrates with pretreatments and surface preparations that will capture the varying requirements of MIL-PRF-23377 and MIL-DTL-53022, and the capabilities of the GSE rework locations. Testing will include but not be limited to viscosity, spraying properties, pot life, dry time, adhesion, corrosion resistance, flexibility, fluid resistance, strippability as well as compatibility to qualified topcoats.

Upon successful laboratory testing, demonstration and validation of the low-VOC primers is anticipated to occur at FRCs in North Island, CA and Solomons Island, MD. The low-VOC primers will be applied on both land-based and shipboard GSE. The coating(s) will be evaluated for application characteristics and user friendliness. The durability of the new coating systems will be evaluated by photo documentation and direct visual inspection. Land-based evaluation intervals will be every six months for a total of two years. Shipboard GSE will similarly be evaluated as close to the six-month interval as ship schedules permit.

Primer is applied to GSE such as this mid-range tow tractor (left) and fire truck (right).
Atish Gupta

The proposed primers must pass the rigorous performance requirements that are currently asked of MIL-PRF-23377 products and perform satisfactorily to many of the performance requirements of MIL-DTL-53022.

Upon successful laboratory testing and field demonstration, MIL-PRF-23377 will be revised and the Qualified Products List will be populated with low-VOC and HAP-free products. If an acceptable primer(s) is identified that satisfies both GSE and aerospace requirements, the "Cleaning and Corrosion Control" manual (NAVAIR 01-1A-509) and the "Airborne Weapons and Associated Equipment" manual (NAVAIR 01-1A-75) will be updated at their next revision or Interim Rapid Action Changes will be generated.

Implementation of Biotic Ligand Model-Based Water Quality Standards for Copper at Navy Sites (project no. 564)

This project will provide guidance and empirical evidence of the utility to Navy end users towards imminent EPA approval of an update to the Estuarine/Marine Copper Aquatic Life Ambient Water Quality Criterion.

Copper is a ubiquitous contaminant in and around Navy-relevant water bodies. Currently, states use national water quality criteria (WQC) to establish standards by which to regulate copper discharges under NPDES permits. Navy managers are required to either use the default national WQC or conduct and approve costly site-specific studies involving extensive toxicity testing, chemical analyses and rulemaking.

The EPA recently released a draft criterion document that incorporates a simple, scientifically defensible Biotic Ligand Model (BLM) towards calculation of water-body-specific water quality standards without the need to conduct costly laboratory-based studies. Based on comments by nearly four dozen stakeholders nationwide, including the Navy, the consensus was that the document included overly high levels of conservatism, improper assumptions and incorrect use of peer reviewed data available, potentially making compliance with a BLM-based standard more challenging than intended.

Concerns expressed by the stakeholders are currently being evaluated by EPA, with the expectation that issues will be addressed and Navy compliance will improve if the concerns are incorporated. However, if the finalized BLM-based standard is overly stringent, it will not improve copper compliance at Navy facilities, and the Navy will likely be required to continue down a path of uncertain and costly means of achieving compliance.

This project will provide scientific contributions towards finalizing EPA's saltwater copper criterion document and provide examples based on historical and ongoing data collection regarding whether or not the new criterion should be used as a regulatory tool for environmental compliance at Navy sites.

The BLM is a metal bioavailability model that uses receiving water body characteristics and monitoring data to develop site-specific WQC. The BLM for copper has already been developed and validated for protection of the most sensitive EPA-accepted test mechanisms (e.g., *Mytilus galloprovincialis* mussel embryos).

The first task for this project will be the consultation and closure of data gaps with key personnel (EPA headquarters) regarding their remaining concerns associated with the draft final criterion document. As soon as EPA releases the final WQC document, the project team will collect any available historical data sets for affected Navy sites and run them through the BLM to determine whether the Navy would be expected to be compliant.

In addition to EPA concurrence of the saltwater BLM for copper, objectives of this work include development of a Navy document that will guide end users towards integration of an overdue update to copper compliance in marine environments. This will occur based on consultation with the Copper Development Association and International Copper Association which have been working on implementation of the freshwater BLM for copper and continue to support this need for saltwater. The freshwater BLM has been implemented in multiple states and provides examples towards implementation of the marine BLM.

This project will provide scientific contributions towards finalizing EPA's saltwater copper criterion document.

The results of the analysis and documents produced by this project will be transitioned to end users in a consolidated technical document geared towards implementation by states and permit writers. This document will be shared through webinars directed to Navy end users summarizing the findings, which will be in part developed through peer review and participation in at least one high visibility national technical conference.

Mussel larvae are among the most sensitive toxicity endpoints used for EPA water quality criteria derivation for copper.

Source Metal Particle Removal for Stormwater Compliance (project no. 566)

This project is demonstrating a new surface cleaning vehicle capable of removing metal particulate from stormwater discharge.

Metal particles (such as copper, zinc, nickel and iron) in stormwater can lead to violations or exceedances for Navy facility stormwater discharges related to Clean Water Act and NPDES permits. This can be a serious issue for industrial areas such as metal processing/reworking facilities, metal storage facilities, recycling yards and pier areas where paint stripping and sand blasting activities occur.

San Diego area Navy installations (Naval Base San Diego (NBSD), Naval Base Coronado (NBC) and Naval Base Point Loma) are having an increasingly difficult time meeting new California metal benchmarks/Numerical Action Limits (NAL) for their stormwater discharges, which are now at 33.2 parts per billion (ppb) for copper and 260 ppb for zinc. Between 2011 and 2014, NBC had 87 copper and 221 zinc benchmark exceedances, as well as 96 exceedances for acute toxicity.

These installations employ BMPs directed at reducing source metal particles from pier and metal processing areas; however these practices are ineffective in meeting

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 NAVFAC 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 the Department of Energy.

For more information, visit the NESDI program web site at https://epl.navfac.navy.mil/nesdi (Common Access Card required).

the new limits. Recent discharge sampling data (from December 2016) show NAL exceedances for copper and zinc at all three installations. Sustained, high concentrations of these pollutants in industrial stormwater discharges are elevating acute toxicity levels beyond permit limits at an increasing rate.

San Diego metro Navy installations spend over three million dollars a year on stormwater compliance monitoring and reporting including expensive phased studies that are required under new NPDES permit requirements when discharges exceed benchmarks. In addition to these costs, exceeding benchmarks on a regular basis increases the potential for lawsuits from non-governmental agencies.

This project was formed to evaluate a new surface cleaning technology—the Municipal Cleaning Vehicle (MCV). This multi-purpose surface cleaning vehicle is based on the Mobile Cleaning, Recovery and Recycling System developed by Naval Surface Warfare Center Carderock Division (NSWCCD). The MCV is a closed loop, surface power washing, filtration, recovery and recycling system that can recover ferrous and non-ferrous solids ranging in size from sub-micron to two inches and can clean up to 10,000 square feet of surface area per hour. The system provides total suspended solids control and a physical barrier to larger particles. It leaves no discernable solids residue and its performance exceeds the individual cleaning capabilities of pressure washing, vacuuming and sweeping.

After initial discussions with NBSD, NSWCCD has identified numerous high-risk outfall locations that are exceeding benchmark limits. Two outfalls at Naval Amphibious Base (NAB) Coronado will be the site for the technology demonstration. The MCV will be deployed for a period of approximately three months, during which time training of the vehicle and its systems will be conducted, along with the actual surface cleaning and sampling at the targeted outfalls.

NSWCCD has already made a site visit to the targeted hotspot areas at NAB Coronado and will soon be working with NAVFAC Southwest and San Diego metro installation representatives to develop a test and sampling plan that will best show the effectiveness of the MCV technology.

If the MCV cleaning technology is shown to be effective in removing problematic metal particulate, then San Diego metro representatives can work with their in-house departments to procure MCV platform(s) as desired.

The Municipal Cleaning Vehicle.
Courtesy of Triverus

NBSD/NBC environmental offices and stormwater/surface cleaning operations personnel will be part of the testing and evaluation process as well as any technology transfer follow-up actions.

Business Processes and Requirements Enabling Technology Integration (project no. 567)

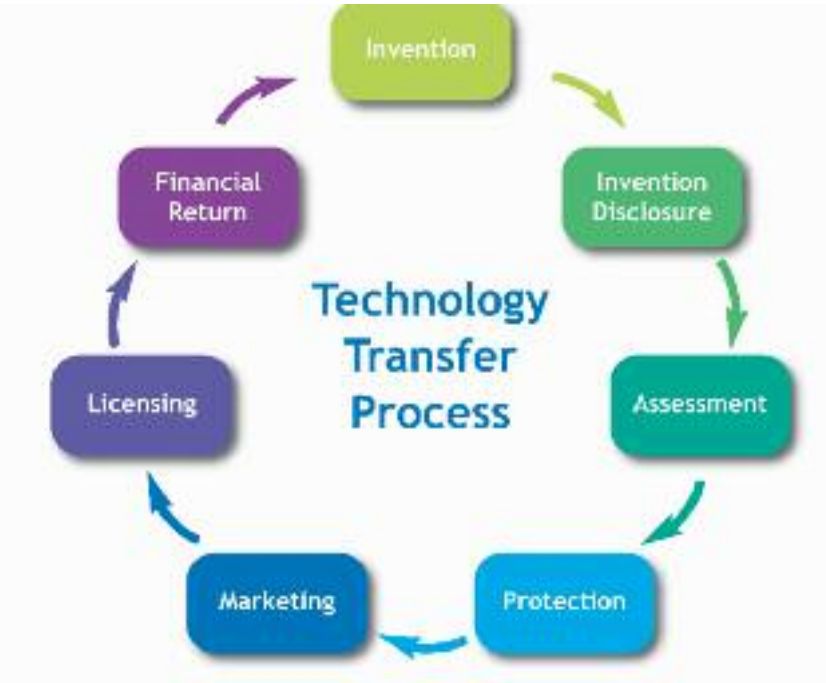
This project will produce a systems engineering process and manual that provides clarity on the actions and activities required for completing successful technology integration.

Navy facility commands need a framework that allows facility or installation stakeholders and technology advocates to collaborate and advance cost-effective solutions to their environmental challenges. When a technology, techniques, tools (TTT) solution has been validated through the NESDI and other programs, the conventional approach to technology integration has focused only on advertising the technical data and fact sheets related to that technology and seeking to sell the TTT as a package

This vehicle is a closed loop, surface power washing, filtration, recovery and recycling system that can recover ferrous and non-ferrous solids.

that presumably fits with every Systems Command. While this approach reflects a genuine desire for integrating technologies, it neglects a more holistic business plan and strategy for customizing TTT solutions for different installations and stakeholders. What's needed is an enduring system of actions and activities that enable the successful integration of TTT solutions, as well as a method for identifying where additional needs for a particular technology exist.

This project will propose a systems engineering process (a sequence of events that functions together to produce the capability that satisfies a particular need) to enable effective and efficient technology integration across NAVFAC.



A basic technology transfer process.

Technology transition programs for weapons systems and platforms have formal processes to smooth and speed the path to operational adoption. Examples include the Navy Shore Energy Technology Transition and Integration (NSETTI) program and the Energy Systems Technology Evaluation Program (ESTEP). Each of these programs has a multi-gate project review process to ensure early consideration of stakeholder needs and administrative processes. It is the intention of this project team to create a similar system for Navy facilities use.

The system engineering process and accompanying manual will be based on the Shore Facilities Planning System and Office of the Chief of Naval Operations (OPNAV) instructions, along with information acquired from internet literature searches addressing stakeholder engagement business practices. A case study analysis of completed and/or ongoing approved real property work will be conducted in accordance with the framework to validate the process and associated manual.

A guide for potential stakeholders and users of TTT solutions and backup documentation required by stakeholders will be produced. Methods will include mining environmental Notice of Violation and military construction databases. To ease the transition, the team will determine what data (i.e., cost estimates, analysis of alternatives) stakeholders will need. The process and manual will be transitioned as follows:

- Provided to the Naval Civil Engineers Corps Officer School for insertion and use as a training module during environmental training and other courses.
- Distributed throughout the NAVFAC enterprise via each of the NAVFAC businesses participating and contributing in development of the final deliverable and posted on the NAVFAC portal.
- Offered to other System Commands for guidance and implementation.
- Presented during annual NAVFAC business line specific workshops/conferences.
- Incorporated into Naval Postgraduate School curriculum.

One-page fact sheets of all NESDI projects are available for download via the program's web site at https://epl.navfac.navy.mil/nesdi (Common Access Card required). Select "Projects" to browse available fact sheets for NESDI-sponsored projects. ⚓

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