

2010 Annual Report



Technology Transition—Supporting DoD Readiness, Sustainability, and the Warfighter

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Since 1991, the NDCEE has served as a national leadership organization to address high-priority environmental, safety, occupational health, and energy (ESOHE) challenges for the Department of Defense (DoD), other government organizations, and the industrial community.

The NDCEE's mission is to support DoD sustainability and readiness through:

- Research, development, and test efforts to identify available ESOHE alternatives
- Demonstration, validation, and transition of technologies to defense installations, industrial activities, and private industry
- Training that supports the fielding of new, validated technologies

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A MESSAGE FROM THE EXECUTIVE AGENT



"Each year, the NDCEE provides the DoD with mission-driven solutions that reduce total ownership costs and fulfill ESOHE requirements. The NDCEE serves as a force multiplier addressing ESOHE challenges faced by the operational force, installation management, and training and acquisition programs. With a mission well aligned with net zero energy, water, and waste objectives, in FY10 the NDCEE conducted technology assessments and demonstrated and fielded multiple solutions in support of sustainable military installations and operations.

Alternative materials, processes, and technologies were also validated and optimized within the weapon systems acquisition lifecycle, helping the warfighter to achieve performance advantages on the battlefield while enhancing efficiency and cost-effectiveness in manufacturing facilities and depots. The NDCEE also strives to improve the health and safety of military and civilian personnel, ensuring readiness and further reducing costs. Prospective DoD and other Federal client offices will find that the Army's partial underwriting of the NDCEE is an effective leveraging opportunity to research and validate high-impact ESOHE technology solutions."

*– Hershell "Hew" E. Wolfe, Deputy Assistant Secretary of the Army
(Environment, Safety, and Occupational Health)*



DoD Executive Agent
Office of the Assistant
Secretary of the Army for Installations,
Energy and Environment

2010: YEAR IN REVIEW



For nearly 20 years, the NDCEE has served the DoD, Government agencies, and supporting industries by transitioning advanced technologies that directly impact DoD readiness, sustainability, and the warfighter. The NDCEE focuses on ESOHE challenges for a broad spectrum of applications—from installation and range management to weapon system design and maintenance to workforce protection and warfighter readiness. This report showcases the NDCEE's Fiscal Year (FY) 2010 successes, highlights exciting new technical approaches to complex problems, and underscores progress made in FY10 toward fulfilling our mission and supporting the missions of our clients.

"The goal is net-zero: net-zero energy, net-zero water, and net-zero waste... (We're) working on developing strategies, we're testing various scenarios. Those are our challenges to both our operational forces and our permanent installations."

— Honorable Katherine Hammack, Assistant Secretary of the Army for Installations, Energy and the Environment

STRIVING FOR NET ZERO ENERGY, WATER, AND WASTE AT MILITARY INSTALLATIONS

To enhance national security, improve sustainability, and reduce operating costs, military installations are being challenged to achieve net zero energy, water, and waste goals—and the NDCEE is providing solutions. In FY10 the NDCEE supported the Army Senior Energy Council's efforts to ensure sustainability of the operational force by analyzing energy security in military operations and developing tools to evaluate emerging technologies. With a focus on contingency operations, the NDCEE provided insight into the fully-burdened cost of waste, conducted research on available waste-to-energy systems, and developed a prototype system for reforming JP-8 to enable the use of fuel cells in theater.

Energy, water, and waste reduction are tied to NDCEE efforts to modernize Army ammunition plants, reducing costs and ensuring a steady supply of ammunition to the warfighter. At Fort Campbell, KY, newly constructed military housing incorporates net zero energy designs validated by the NDCEE, and a geothermal system is cost-effectively heating and cooling a Pennsylvania National Guard building at Fort Indiantown Gap. The NDCEE also investigated wind turbines, solar radiant floors, and photovoltaics in FY10 to respond to the alternative energy challenge.

Extending our support of installation sustainability, the NDCEE also ensured the DoD's continued stewardship of training lands and water resources. For example, the NDCEE optimized a technology to treat energetic materials on range scrap—anticipated to divert an expensive hazardous waste stream to a profitable recycling outlet. Other efforts included support of the first deep water investigation in the U.S. to look at conventional and chemical munitions disposed off the coast of Hawaii and validation of three in-situ groundwater sampling technologies.

ADDRESSING ESOHE ASPECTS OF WEAPON SYSTEMS AND MAINTENANCE OPERATIONS

By focusing on the lifecycle impacts of weapon systems, the NDCEE has made significant contributions to design, manufacturing, and maintenance improvements that balance ESOHE and financial considerations with mission requirements. In FY10, the NDCEE supported two tactical

vehicle initiatives, including a demonstration of bio-based fuel performance and an evaluation of cadmium and chromium-free coatings for electrical connectors. In support of the ammunition production base, the NDCEE addressed challenging corrosion issues for green ammunition and demonstrated several process improvements that reduced hazardous waste and operating costs at Holston and Radford Army Ammunition Plants.

Weapon systems ESOHE efforts also included optimizing various depot maintenance processes and providing acquisition lifecycle support. Three demonstrations for cleaning and coatings removal at Corpus Christi Army Depot, TX, and Fort Rucker, AL, significantly reduced energy, materials usage, throughput time, personnel exposure to chemicals, and overall operating costs. On a broader scale, the NDCEE is implementing process upgrades and best practices to streamline operations and reduce costs across Marine Corps corrosion prevention and control (CPAC) facilities. Supporting the DoD supply chain, the NDCEE evaluated more than 200 bio-based products to qualify as green procurement alternatives, evaluated critical materials and identified potential alternatives for munitions production, and developed a methodology to systematically address potential ESOHE issues in defense acquisition.

"Extending the useful life of all Marine Corps tactical ground and support equipment is a key component of the CPAC Program mission. Improved efficiency and throughput of our corrosion repair facilities reduces repair and lifecycle costs, while reducing corrosion related down-time. The end result is improved readiness for the Warfighter."

— Matthew Koch, Program Manager, USMC Corrosion Prevention and Control

PROTECTING MILITARY AND CIVILIAN PERSONNEL

By helping to advance technologies and implement safety policies across the services, the NDCEE has contributed to the overall decline in injuries and death rates across the military. In protecting our warfighters and civilian

personnel, the NDCEE supports two major DoD readiness programs: the Defense Safety Oversight Council (DSOC) and the Voluntary Protection Programs Center of Excellence (VPP CX).

In FY10, the NDCEE implemented several DSOC initiatives to reduce both mission-related injuries and fatalities as well as those sustained off duty. For example, the NDCEE evaluated a rotary wing terrain awareness system on helicopters that increases pilot awareness of terrain, weather, and traffic conditions. Other initiatives focused on injuries sustained during training as well as addressing electrical hazards. To reduce motorcycle accidents, a leading cause of off duty injuries and fatalities, the NDCEE supported the DSOC in conducting six focus groups to better understand risk perceptions and collect information on motorcycle activity within the military. In addition, the NDCEE developed a tool to target high-risk motor vehicle drivers for in-depth safety training, and demonstrated a Sports Injury Portal for DoD service academies.

Workplace safety cultures are improving, one installation at a time, with an increased commitment to VPP across the DoD. The VPP CX has prepared 38 military and federal agency worksites for VPP Star recognition, with many more looking forward to submitting their applications. The NDCEE supported additional endeavors to promote a safe culture by advancing the use of new technologies including: immersive 3D safety training; a scheduling tool to mitigate fatigue-related mishaps; an industrial hygiene handheld tool; and anti-vibration power hand tools.

"Safety and readiness are closely intertwined and... the VPP is the cornerstone for addressing workplace safety in DoD. One of the goals of the DSOC is to keep safety at the forefront for DoD leadership. VPP gives us the tools in DoD to make sure we preserve our assets, our people, and our equipment. It gives us the tools to be the best we can be."

— Joseph J. Angello Jr., Executive Secretary of the Defense Safety Oversight Council

TECHNOLOGY TRANSITIONS

In conducting ESOHE assessments, development, and demonstrations, the NDCEE advances the technology readiness level (TRL) of potential solutions, ultimately supporting the fielding of technology for military end users. Technology transition does not necessarily occur at a single point in time, but rather it is the comprehensive set of activities by which a potential solution is fully vetted and inserted for a specific application. In some cases, just as important to this process is the knowledge gained from those alternatives that were explored but didn't work, as well as those solutions that ultimately succeed. In FY10 the NDCEE performed value-added activities in all phases of the transition process — Assessment, Development, Demonstration/Validation, and Transition — as shown by the examples below.



Assessment
The NDCEE conducted a requirement-driven assessment to down-select fieldable technologies capable of converting solid wastes into energy for use in contingency operations.



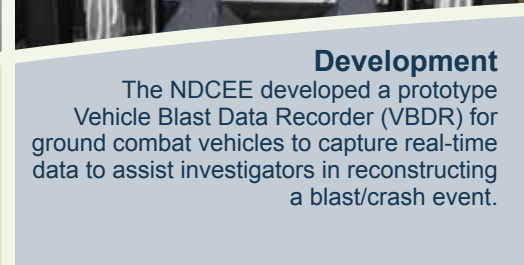
Development
The NDCEE developed a prototype Vehicle Blast Data Recorder (VBDR) for ground combat vehicles to capture real-time data to assist investigators in reconstructing a blast/crash event.



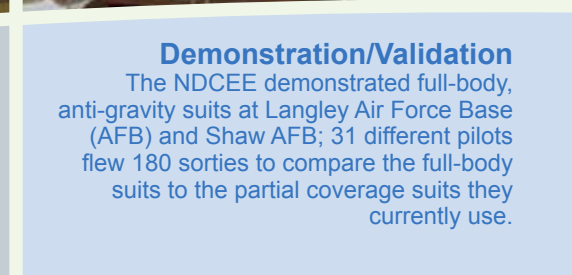
Demonstration/Validation
The NDCEE demonstrated full-body, anti-gravity suits at Langley Air Force Base (AFB) and Shaw AFB; 31 different pilots flew 180 sorties to compare the full-body suits to the partial coverage suits they currently use.



Assessment (TRL 1-8)
Literature searches, data mining, surveys, and other methods are employed in this phase to identify alternatives, explore research opportunities, or track emerging technologies. Potential aspects include understanding the problem, context, drivers, and end-user needs; obtaining available technical, economic, and ESOHE data on current and alternative technologies; and utilizing information gained to focus technology transition efforts.



Development (TRL 1-5)
This phase includes those activities involved in the evolution of scientific concepts and research towards tangible technical solutions, including: preliminary design, system or process development and fabrication, computer modeling, and bench-scale or laboratory testing.



Demonstration/Validation (TRL 6-8)
This critical phase includes all activities associated with testing and evaluating potential technology alternatives against user requirements. Whether at the prototype- or full-scale level, demonstration/validation testing can encompass a variety of evaluation objectives including feasibility, optimization, and/or operational acceptance testing.



Transition (TRL 9)
The final phase of the technology transition process may include implementation, start-up, training, and/or other support efforts necessary to field validated technologies for installation and weapon system end users. Now the technology is ready for operational military use at the end user's discretion.



ALERTS
Transitioned to Fort Rucker, AL, this flight data management system allows pilots to review their entire flight path with precise animation overlaid on satellite imagery—reducing human error during operation of military aircraft.



Geothermal Heat Pump System
Transitioned to the Pennsylvania National Guard at Fort Indiantown Gap, this system saved 1542 gallons of propane and reduced electricity usage by approximately 61% during its first year in operation.



Nitrates Reduction
At Radford Army Ammunition Plant, the NDCEE supported implementation of three pollution prevention solutions to reduce acid losses, recycle waste acid, and reduce nitrate discharges.



Process Modeling for Flowform Manufacturing
The NDCEE transitioned a second model to enable the flowform manufacturing of 60 mm mortar tubes at Benét Laboratories, Watervliet Arsenal, NY.



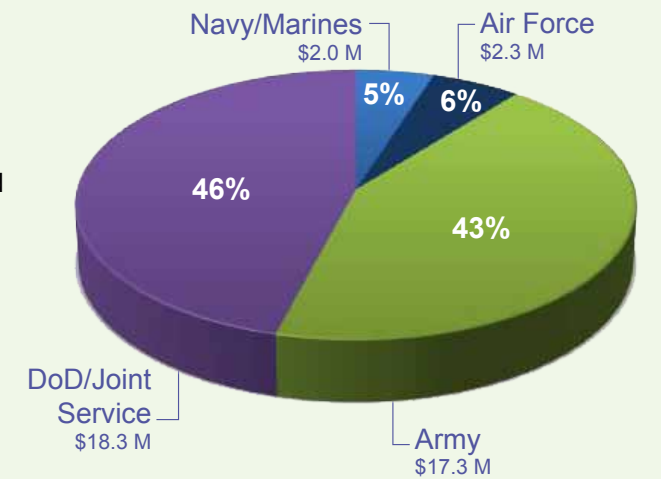
Zero Energy Housing
At Fort Campbell, KY, energy modeling in combination with technologies to reduce heat transfer and demand requirements resulted in significant energy reductions. The balance of energy was offset using roof mounted PV panels.

OPERATIONAL STATISTICS

In FY10 the NDCEE continued the critical mission that it began in 1991: identifying, demonstrating, evaluating, and fielding technologies in support of DoD readiness, sustainability, and the warfighter. In support of this mission, in FY10 the NDCEE completed 47 task orders and initiated 37 new task orders, increasing total dollars on contract by \$39.9 million.

The NDCEE served more than 80 client and stakeholder organizations across the DoD and other federal agencies in FY10, many of whom were returning clients. Averaging 125 client deliverables per month, the NDCEE maintained an average on-time delivery greater than 99%. To ensure that pertinent technical information from NDCEE projects is shared among applicable DoD organizations, other U.S. Government agencies, and private industry, 192 deliverables were uploaded to the Defense Technical Information Center (DTIC) to make this information available.

In addition to serving a diverse client base, the NDCEE strives to achieve diversity with regard to subcontracting, especially in compliance with Public Law 95-507. This law encourages the use of small and disadvantaged businesses in Federal contracting. In support of these socioeconomic goals, to date, 55.3% of subcontracting dollars has been awarded to small businesses, including small disadvantaged businesses, woman-owned small businesses, and service-disabled veteran-owned small businesses.



The NDCEE is working across the U.S. Army, Navy/Marines, Air Force, and DoD. This chart shows the percentage of FY10 contract awards supporting each client.

Outreach Activities

NDCEE outreach activities directly support technology transition by disseminating information on ESOHE technologies to audiences within the DoD and across other Federal agencies. Extending the base of knowledge is an important part of the NDCEE's mission. FY10 NDCEE outreach activities included:

- Exhibiting and presenting at six ESOHE conferences. Technology demonstrations were featured in the NDCEE booth and subject matter experts contributed 37 technical presentations and posters.
- Production and distribution of program publications including Winter/Spring and Summer/Fall Newsletters, Capability Summary, FY09 Annual Report, FY09 Technologies Publication, Task Descriptions, and Technology Fact Sheets.
- Continuing to upgrade and populate the NDCEE web site (www.ndcee.ctc.com). Average number of visits to the site per month increased by approximately 33% to 16,000 in FY10.
- Conducting a DoD-wide NDCEE Program Review held on March 10-11, 2010 in Arlington, VA. The event attracted 149 participants from government and industry.
- Submitting six articles related to NDCEE task accomplishments to military and technical publications (four published, others pending publication).

This annual report provides highlights of several NDCEE projects that encompass many of our capabilities and services. The NDCEE is committed to delivering quality solutions to address our clients' mission critical requirements and we invite and encourage you to take advantage of our offer — How Can We Support Your Mission?

FOR ADDITIONAL INFORMATION, PLEASE VISIT WWW.NDCEE.CTC.COM

STRIVING FOR NET ZERO ENERGY, WATER, AND WASTE AT MILITARY INSTALLATIONS

During FY10 the NDCEE continued to support the DoD in ongoing efforts to increase the sustainability of installations while meeting mission goals at permanent installations and at forward operating bases (FOBs). NDCEE support has focused on energy and water conservation, integration of alternative energy technologies, facility modernization strategies, and efforts promoting environmental stewardship, particularly for training lands and water resources. The DoD's leadership in this arena has also extended well beyond the installation fence line, contributing to the sustainability of regions where installations are located.



ENSURING SUSTAINABILITY OF THE OPERATIONAL FORCE

Demand, cost, and security aspects of water, energy, and waste management continue to be critical issues for the DoD, particularly in areas where providing reliable energy, clean water, and acceptable waste disposal options puts warfighters at risk.

The NDCEE is playing a vital role in energy security activities by supporting the Army's Senior Energy Council as it champions the net zero energy Army. For example, the NDCEE developed and demonstrated a methodology to analyze Army energy security in military operations. The methodology established cost-benefit criteria that can be used to assess emerging energy technologies including those that support FOBs and Brigade Combat Teams. The NDCEE also assessed the policy, planning, and practical implications of implementing the methodology in military operations. A critical aspect of strategy implementation is evaluating its success; thus, the NDCEE developed a metrics tracking process in the Army Strategic Management System to measure and monitor Army progress toward meeting overall energy security goals. These goals encompass use of renewable energy, increasing energy efficiency, and increasing energy security across installations, deployed bases, weapon systems, and soldier power.

Security is a challenge for fuel supply convoys in theater, increasing the overall cost of fuel needed to power everything from vehicles to lights to heaters to medical equipment. To provide efficient alternative power at FOBs, the NDCEE identified a potential technology to allow molten carbonate fuel cells (MCFCs) to operate on JP-8, the single battlefield fuel. In a technology evaluation, MCFCs were identified as the best alternative to diesel generators for energy support in theater, if they could operate on JP-8. The NDCEE identified a potential solution to remove the sulfur (which interferes with fuel cell operation) in JP-8 and completed the design and construction of a prototype reformer to be tested in FY11.

Molten carbonate fuel cells (MCFCs) are a promising alternative to diesel generators used in theater. The NDCEE designed and constructed a prototype plasma arc reformer to allow MCFCs to run on JP-8, the DoD's single battlefield fuel.
top left

To assist the DoD in understanding the fully burdened cost of waste management in contingency operations, the NDCEE supported the development of an analytical method based on prior efforts to analyze the fully burdened cost of delivering fuel and water.
top right

Like the fully burdened cost of fuel, waste poses an increasingly costly burden on base camps. On behalf of the Army Environmental Policy Institute the NDCEE developed an analytical method for determining the fully burdened cost of solid, hazardous, and medical waste in contingency operations. The cost estimating method was applied to two waste reduction case studies at Bagram AFB: using reverse osmosis water purification units to replace bottled water, and recycling used oil. Results indicated that 1) Army materiel costs more than the price charged at commodity procurement and 2) waste management in theater is largely unplanned. This fully burdened perspective addresses all transportation, infrastructure and personnel costs associated with managing waste and also considers indirect costs and liabilities. Estimating the fully burdened cost of materiel use in contingency operations is one way to assess the overall lifecycle effects and improve overall sustainability, while also supporting the mission.

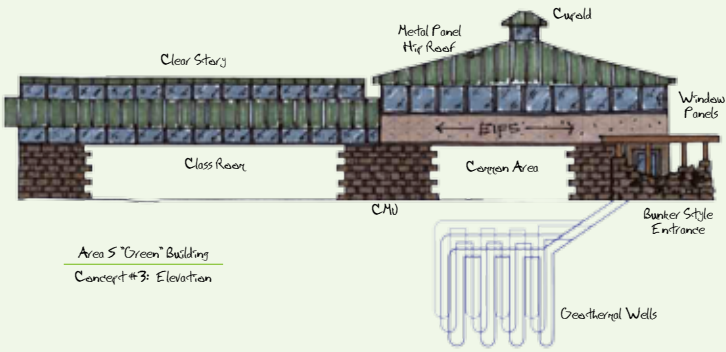
ACHIEVING NET ZERO INSTALLATIONS

Integrating net zero energy, water, and waste concepts is a key aspect of the NDCEE's support to installations as they modernize. This is especially true at Army ammunition plants (AAPs) where process and facility upgrades must meet sustainability objectives while complementing a steady, reliable supply of munitions. The NDCEE has been working with the Program Executive Office-Ammunition (PEO-Ammo) and the Joint Munitions Command to improve ammunition management for seven depots and six ammunition plants by introducing ammunition procurement flexibilities and incorporating next generation technologies. The NDCEE supports the Army as it develops a methodology to enable 25-year use contracts. A core issue to achieving this goal is to identify the optimum set of operating conditions for the AAPs; energy, water, and waste minimization are integral to optimization and reducing costs.

In FY10, the NDCEE also continued to support several Army and National Guard installations in investigating, demonstrating, and validating alternative technologies to reduce the consumption and cost of energy. These technologies are scalable so that installations can implement them as they upgrade facilities. Many are also being incorporated into new military construction, particularly where the DoD is pursuing Leadership in Energy and Environmental Design (LEED) certification.

For example, to reduce energy costs in remote training areas in Hawaii, the NDCEE installed a solar radiant floor to heat a building at Pohakuloa Training Area and is collecting data to validate technology performance. The NDCEE is also conducting a side-by-side demonstration of two photovoltaic (PV) technologies installed on a carport at Fort Hood, TX, and collecting cost and performance

data for these building-integrated PV systems. In addition, the NDCEE evaluated performance of a geothermal heat pump system installed at Fort Indiantown Gap, PA. Based on the results—the system reduced the cost of heating and cooling by \$4,550 during the first year—the NDCEE is supporting the Pennsylvania National Guard as it incorporates geothermal heating into new construction. The goal is to achieve building certification at the Silver level of LEED for the new construction and develop a template that will allow the National Guard Bureau to replicate green building success in the future.



FTIG Training/Multipurpose Building

PROMOTING ENVIRONMENTAL STEWARDSHIP

Live-fire training and testing are key to maintain a trained and ready force, but these activities have created both legacy and new challenges for installations. For example, munitions and range-related debris may not only interfere with training, but they pose a waste management burden for installations. Such debris must be processed to remove any explosive hazards and may have to be managed as hazardous waste due to explosives residue contamination. The NDCEE modified and optimized a decomposition/hydrolysis technology to treat explosives residues remaining on munitions and range-related debris that will be demonstrated in FY11. Once treated, materials can be recycled, reducing the amount of waste an installation generates and creating a potential revenue stream. Treating explosive residues on such debris will also reduce potential for soil and water contamination and may provide added benefits to range clearance activities.

Addressing a challenging legacy issue, the NDCEE worked with the University of Hawaii (UH) to conduct the first deep-water assessment in the U.S. to characterize a site suspected to contain both conventional and chemical munitions disposed off the coast of Oahu, HI. To locate munitions at these depths, UH conducted a series of SONAR surveys that identified trails of highly reflective targets as candidate study sites. Using manned submersibles and a remotely operated vehicle, it was determined that the reflective targets were munitions. UH's major conclusions were: (1) most munitions in the



area were cast overboard while the ship was underway; (2) the integrity of munitions span a broad spectrum; (3) with the exception of one unconfirmed detection of mustard, munitions constituents were not detected in any sample; (4) sediment samples collected within two meters of munitions showed little to no influence from the munitions; (5) data and observations do not indicate any adverse impacts on ecological health in the study area; and (6) the risk to human health from consumption of fish and shrimp collected near the study area were within EPA's acceptable risk levels. The NDCEE and UH are continuing its support to the Army and DoD on this issue in FY11 by expanding the SONAR surveys and providing both reconnaissance and detailed mapping of sea-disposed munitions.

To further support installation sustainability and reduce the amount of investigative-derived waste that must be disposed, the NDCEE demonstrated and validated three in-situ groundwater sampling technologies. The technologies that were demonstrated—InSTED, Snap Sampler, and HydraSleeve—can be used without purging the wells to be sampled. In addition to reducing the labor and costs associated with well purging, in-situ sampling technologies also reduce the total water volume that must be collected and shipped to analytical laboratories, further reducing costs. Analytical results from the demonstration showed that the technologies provide more accurate data on aquifer conditions and may be valuable for collecting samples for explosives analysis, especially in deep or difficult-to-access wells.



This carport roof at Fort Hood, TX, provides a unique opportunity for the NDCEE to conduct a side-by-side evaluation of two photovoltaic technologies, microcrystalline and thin film panels.
top left

Remotely operated vehicles, deep-sea human-occupied vehicles, and sidescan sound navigation and ranging technology were employed to determine the distribution and integrity of discarded military munitions in the coastal waters off Oahu, HI.
top right

The NDCEE demonstrated the Snap Sampler and two other in-situ sampling technologies at Milan Army Ammunition Plant, TN. Sampling of explosives (HMX and RDX) in ten ground water monitoring wells showed a reduction of waste generated and reduced cost of sampling while providing technically defensible analytical results.

ADDRESSING ESOHE ASPECTS IN WEAPON SYSTEMS AND MAINTENANCE OPERATIONS

New and emerging ESOHE requirements at the state, Federal, and international levels potentially impact military operations and force the DoD to balance regulatory compliance with mission needs. For example, the DoD is decreasing reliance on petroleum and reducing operational costs by using bio-based products and biofuels. However, performance concerns currently present a barrier to wide-spread adoption in critical applications such as tactical vehicles. In other cases, regulations challenge the production of critical military materials, driving operational and process changes. Maintenance operations are also affected as the DoD depots must reduce use of hazardous materials, energy consumption, and waste generation. The NDCEE identifies, demonstrates, and validates new technologies and processes that help the military address these and other challenges as it complies with environmental requirements and maintains critical mission capabilities.



BALANCING MISSION NEEDS WITH REGULATORY DRIVERS

The Energy Independence and Security Act of 2007 requires Federal agencies, including the DoD, to annually increase the use of alternative fuels to move the U.S. toward greater energy independence and security. To help meet the target annual increase in use of alternative fuels—10% from a 2005 baseline—the DoD uses biodiesel blends to fuel some non-tactical vehicles. However, performance and maintenance concerns have prevented their use in combat vehicles. Biodiesel can gel at low temperatures, cannot be stored as long as petroleum diesel, has an affinity for water that can encourage microbial growth, and may be incompatible with certain materials used in engine components. To obtain data that will provide decision makers with information necessary to address these concerns, the NDCEE is evaluating the performance of B20 biodiesel in non-deployed tactical vehicles in three distinct climate zones in partnership with the Naval Air Systems Command (NAVAIR); Air Force Petroleum Office (AFPET); the U.S. Army Tank Automotive Research, Development, and Engineering Center (TARDEC); and the Environmental Security Technology Certification Program (ESTCP). Performance, economic, and environmental impact findings are expected in FY11. This data will provide a critical first look at the measurable operational performance issues of biodiesel blends in military tactical vehicles across a diverse spectrum of environments—from arid desert conditions to cold-weather zones.

Executive orders (EOs) must also be implemented without impacting the DoD mission. In EOs 13514 and 13423, the president directed Federal agencies to reduce the quantity of toxic and hazardous chemicals that they use. Two mission critical metals—cadmium and hexavalent chromium—are probable human

Testing a B20 fuel blend (20% refined cooking oil blended with 80% petroleum diesel), the NDCEE is collecting performance, maintenance, and climate data on non-combat tactical vehicles at Fort Shafter, HI; Port Hueneme, CA; the Marine Corps Air and Ground Combat Center at Twentynine Palms, CA; Fort Leonard Wood, MO; Moody Air Force Base, GA; and the Naval Surface Warfare Center in Crane, IN.

top left

The NDCEE tested five alternatives to cadmium coatings and two alternatives to hexavalent chromium top coatings used to protect electrical connectors in military ground systems from corrosion. Three of the cadmium alternatives and one of the chromium alternatives showed promising results.

top right



carcinogens, but they are widely used because they provide superior corrosion protection. Many electrical connectors used in military ground systems and tactical vehicles are coated with cadmium and hexavalent chromium. Drawing on more than 15 years of experience with cadmium and chromium alternatives, the NDCEE identified and tested several replacement coating materials for electrical connectors used in the Abrams (M1, M1A1, M1A2), Family of Heavy Tactical Vehicles (FHTV), Family of Medium Tactical Vehicles (FMTV), and Stryker for the Tank-Automotive Command (TACOM). The tests validated that several candidates can achieve comparable performance under simulated operational environments and moved TACOM closer to regulatory compliance meeting the objectives of the EO and other DoD policy directives. An economic analysis of data collected from a similar depot operation found that eliminating cadmium electroplating would save each facility more than \$20,000 per employee working the plating line per year by reducing workplace hazards and the need for medical surveillance.

Reducing use of hazardous materials within the DoD is also driving the production of green ammunition. The military's demand for ammunition remains at historically-high levels due to sustained conflicts in Iraq and Afghanistan. Can the military transition to a more environmentally-friendly ammunition without compromising supply or product reliability? The NDCEE is helping answer "yes". In FY10 the NDCEE addressed a challenging corrosion issue that was impacting performance in the field. A black phosphate coating used at the Lake City Army Ammunition Plant (LCAAP) for the M855 lead-free slug was susceptible to damage during assembly and in transport and corrosion in storage; this led to weapon jams, gun barrel damage, and decreased warfighter confidence in the field. The NDCEE conducted a series of tests on organic and ultra violet (UV) cured corrosion resistant coatings as a replacement for black phosphate. Two of those coatings achieved the desired corrosion resistance at costs well below the DoD target of \$0.01 per round (\$0.005 and \$0.001).

Balancing regulatory compliance with critical mission needs also affects production of military explosives. Munitions plants in the U.S. have increased production to meet warfighter needs, and as a result, compliance with legislation like the Clean Water Act has become even more challenging. At the Holston Army Ammunition Plant (HSAAP), the NDCEE participated in an integrated process improvement team to reduce RDX (a common component used in explosives) in wastewater that must be treated before being discharged. RDX solids are explosive when dry, so water is used to wash RDX dust on the facility floor into the drains to the wastewater treatment system. The NDCEE investigated several potential filtration options and designed a prototype that will be demonstrated on

the production floor at HSAAP in FY11. Recovered RDX will be recycled, reducing production costs while allowing HSAAP to avoid potential non-compliance with regulations.

Meeting mission needs while improving the DoD's regulatory stance was also the NDCEE's focus at the Radford Army Ammunition Plant (RFAAP), the only U.S. manufacturer of nitrocellulose, a critical component of military explosives. RFAAP accounts for most of the DoD nitrate emissions reported as part of the Toxics Release Inventory (TRI). Wastewater from RFAAP discharges into the New River, a designated Historic Wild and Scenic River, further complicating the challenge. As part of an ongoing pollution prevention endeavor, the NDCEE identified and implemented three process improvements to reduce acid losses, recycle waste acid, and reduce nitrate discharges. The NDCEE conducted additional efficiency studies and conceptual designs that have a potential to recover/recycle up to 200,000 lbs of nitric acid annually while reducing energy usage.

OPTIMIZING DEPOT MAINTENANCE OPERATIONS

Maintenance is a critical activity that ensures readiness and extends the lifespan of military weapon systems. This is especially vital when weapon systems must serve reliably in challenging environments like Afghanistan. Keeping in line with recent DoD efficiency initiatives, the NDCEE investigates and transitions technologies to reduce operating expenses, increase throughput, and reduce material and utility usage and waste generation, and facilitates incorporation of best practices into existing operations at military depots.

At Fort Rucker the NDCEE is analyzing the use of recycled solvents for cleaning aviation components. While recycled MIL-PRF-680 Type II solvents are used to clean ground support equipment parts at military airfields and depots,



The NDCEE worked with Holston Army Ammunition Plant, TN, to reduce RDX in facility wastewater and decrease operating costs by improving filtration technologies.



there are no criteria for using these recycled solvents for aviation components. Virgin solvents are therefore commonly used for all aviation cleaning activities. The NDCEE is documenting baseline criteria for performance of recycled solvents in cleaning aviation parts. Using recycled solvents would reduce material usage and waste disposal costs.

The NDCEE is also evaluating oven heating to remove cosmoline from new metal parts, reducing maintenance costs at Corpus Christi Army Depot (CCAD). Cosmoline is a corrosion preventative compound often used by original equipment manufacturers (OEMs) to protect metal parts during storage. However, removing cosmoline is labor intensive; workers use rags, cleaning solvents, and a pressure wash to remove the compound. The current process takes time, exposes workers to potentially hazardous solvents, and generates waste for disposal. Heat is commonly used to remove cosmoline, but a lack of test data has prevented facilities from using oven heating processes. If the NDCEE can validate an effective oven heating process, the new process will increase throughput of cosmoline-coated parts at depot facilities and reduce labor and waste disposal costs. The optimized process could also generate cosmoline for potential reuse or resale.

While the use of an oven is being investigated as a viable alternative for coatings removal in one maintenance area at CCAD, the NDCEE is evaluating whether an oven-baking step can be eliminated in another maintenance process at CCAD. High-strength steel and other metals can become brittle and fracture after exposure to hydrogen during forming, cleaning, and finishing operations. To eliminate hydrogen exposure, cleaned parts are typically baked for 23 hours and then allowed to cool. In NDCEE laboratory tests, steel specimens were exposed to aqueous cleaning



The results of NDCEE process upgrades at RFAAP include reductions in the volume of acid sent to the Acidic Wastewater Treatment Plant, a reduction of nitrates discharge to the New River, and a reduction of raw materials and utility demand needed to maintain production of nitrocellulose.

top left

The NDCEE is providing viable coating options for LCAAP and other government and commercial ammunition manufacturing facilities for small caliber ammunition that will withstand the rigors of production and reduce corrosion in storage.

top right

solutions with reduced bake times and then tested to see if embrittlement had occurred. The results showed that facilities will be able to reduce the post-cleaning bake step from 23 hours to 4 hours in many cases, thereby saving significant process time and energy while increasing process throughput.



The NDCEE investigated whether cleaning solutions contributed to hydrogen embrittlement in high strength steel. Results may allow Corpus Christi Army Depot, TX, to optimize its maintenance processes.

The NDCEE has also applied its approach to process optimization and facility modernization to corrosion-prevention and control facilities. In the past, the NDCEE has collected baseline data on facility operations at several Marine Corps corrosion repair facilities. Based on this data, the NDCEE developed Standard Operating Procedures for the Marine Corps Corrosion Prevention and Control (CPAC) Program and identified areas where process upgrades, new equipment, and building modifications could increase program effectiveness and reduce costs. Aligning the operations at all CPAC locations provides an opportunity to implement best practices at all facilities, streamlining operations across the entire CPAC Program. During FY10 the NDCEE implemented the recommended upgrades at the Marine Corps Base Hawaii Corrosion Repair Facility (MCBH CRF) at Kaneohe Bay, HI, including installation of a more efficient blast booth with automated media recovery and extension of the existing paint booth adding drive through capability. These improvements, along with a planned storage/curing area, will increase production throughput at the MCBH CRF and align capabilities with other CRFs throughout the Marine Corps.

SUPPORTING GREEN PROCUREMENT AND LIFECYCLE CONSIDERATIONS IN ACQUISITION

While companies are developing new environmentally-friendly alternatives to existing products in the DoD supply chain, the cost and performance of these new products must be evaluated to quantify potential mission impacts. The NDCEE works with DoD stakeholders to identify new, environmentally-friendly products, calculate total lifecycle costs, and compare performance. Our efforts lead to the increased use of “green” products across DoD as well as an overall improvement in the incorporation of ESOHE considerations throughout the acquisition lifecycle.

In FY10, the NDCEE continued to facilitate the adoption of bio-based products for military applications. The Farm Security and Rural Investment Act of 2002 established the BioPreferred Program, which requires all Federal agencies to establish a preferred procurement program for bio-based products. The DoD has been buying and using bio-based products for several years but utilization has been limited due to a lack of lifecycle cost data and performance information aligned with DoD specifications and standards. To date, the NDCEE team has evaluated over 500 bio-based hydraulic and metalworking fluids, lubricants, greases, fuel additives, cleaners and parts washing solutions, and corrosion preventatives—including more than 200 products in FY10. In addition, the NDCEE conducted product demonstrations of two bio-based penetrating lubricants and several sorbent products provided by five different manufacturers. These products were demonstrated at Fort Jackson, South Carolina Army National Guard, Joint Base Charleston, and Naval Weapons Station Charleston. Penetrating lubricants were also demonstrated inside the Pentagon’s maintenance shop. By collecting and evaluating data on commercially available bio-based products in a Green Products Database, the NDCEE is increasing the utilization of bio-based products for military applications.

The NDCEE is also supporting a robust military supply chain by identifying critical materials for production of military munitions and alternatives to those materials in collaboration with the Organic Materials Technology Branch at the U.S. Army Research, Development, and Engineering Command (ARDEC). The NDCEE evaluated more than 100 critical materials used in the production of almost all munitions and identified 39 for which potential alternatives are available. Validating the performance of those alternatives, a future activity, would provide increased flexibility in the supply chain. A key aspect of the NDCEE’s support was identifying those munitions that would potentially be the most affected by supply chain issues. Finding alternatives for mission critical materials will help to ensure a steady supply of ammunition for the warfighter.



Reducing future ESOHE issues with weapon systems is also a vital DoD focus. In FY10, the NDCEE worked with the Chemical and Material Risk Management Directorate within the Office of the Secretary of Defense to develop a framework for systematically addressing potential ESOHE issues—for example, noise levels that require hearing protection and lead to hearing loss—in defense acquisition. The NDCEE team performed a gap analysis which identified why hidden ESOHE costs may be overlooked during defense acquisition. We then developed a new framework to address the gaps based on the analysis that incorporates a lifecycle assessment approach. This will serve as a critical tool for identifying and quantifying the real cost of weapon system components and where the greatest ESOHE impacts occur over the lifecycle of the system. Knowing the full lifecycle costs of a weapon system can help DoD decision makers avoid unplanned cost escalation within acquisition programs because of ESOHE considerations. It may also make future weapon systems safer for warfighters to use and maintain and reduce DoD’s energy and water needs.



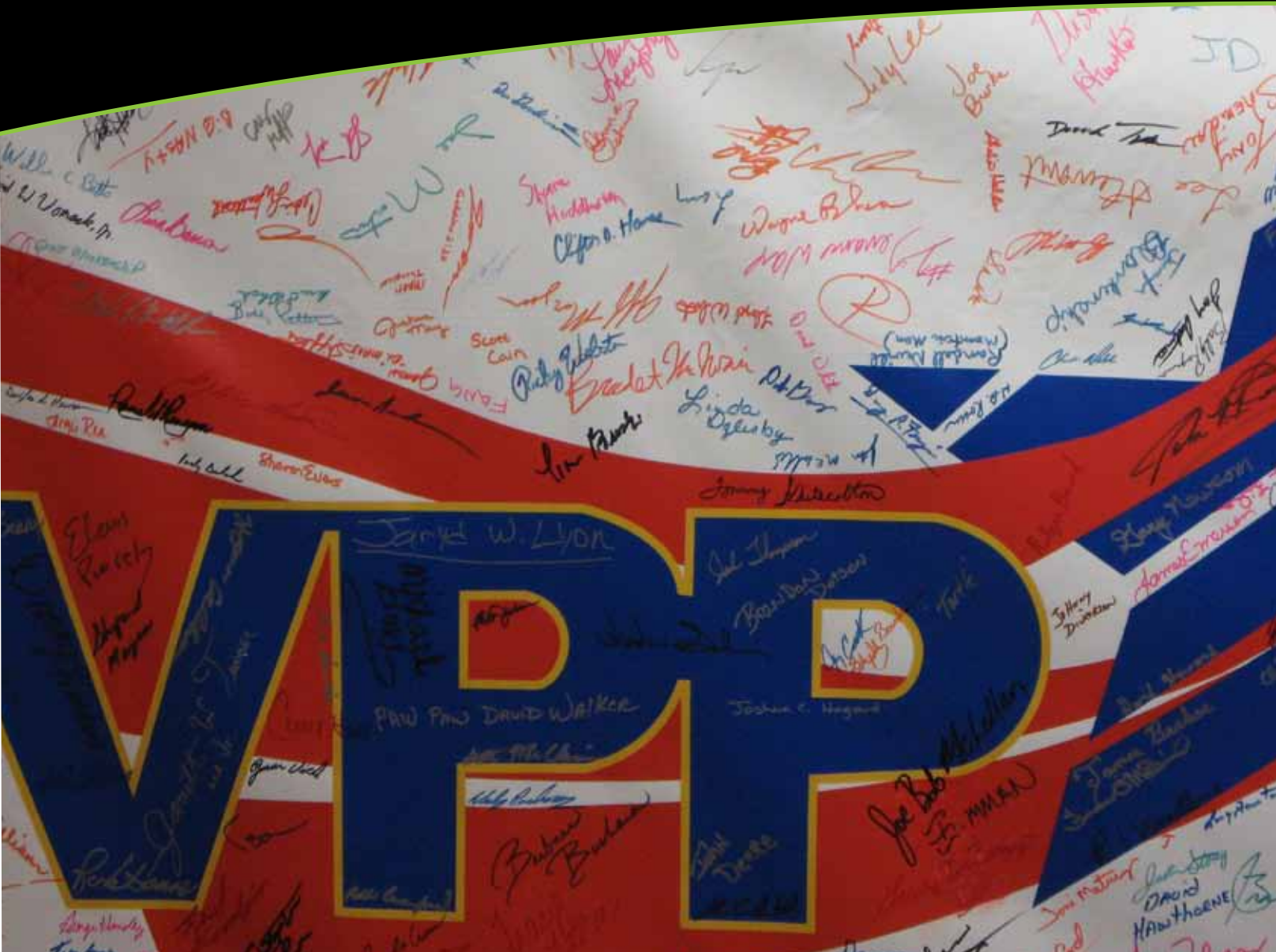
The NDCEE identified process and equipment improvements to optimize operations at corrosion prevention and control facilities like this one, representative of modifications being implemented at Marine Corps Base Kaneohe Bay, HI.
top left

The NDCEE continues to validate the performance of bio-based products such as corrosion preventatives, industrial and multipurpose cleaners, penetrating lubricants, and sorbents in military applications, increasing their use across the DoD.
top right

The NDCEE evaluated more than 100 critical materials used in military munitions to identify potential alternatives—increasing flexibility in the military supply chain and maintaining a ready supply of ammunition.

PROTECTING MILITARY AND CIVILIAN PERSONNEL

To improve readiness, protect the DoD's military and civilian personnel, and reduce the \$3 billion annual cost of preventable mishaps, the Secretary of Defense established the DSOC and challenged the services to reduce preventable mishaps by 75%. The DoD is also actively participating in the Occupational Safety and Health Administration's (OSHA) VPP to foster a safety culture and continually improve workplace health and safety at DoD installations. In FY10, the NDCEE continued to support DSOC and other mission critical readiness initiatives by evaluating mishap data, demonstrating and validating technologies, and developing and implementing training programs. Under the NDCEE, the VPP CX also continued to support DoD installations in obtaining VPP Star recognition by developing and disseminating tools to streamline the recognition process and by providing hands-on coaching and support.



REDUCING MISSION-RELATED INJURIES

Improvised explosive devices (IEDs) continue to be a major threat to warfighters in theater as insurgents target military vehicles. Designers have responded by providing additional armor; however, they often lack the data they need on specific blast parameters and effects. The NDCEE developed a proof-of-concept Vehicle Blast Data Recorder (VBDR) for ground combat vehicles by leveraging commercial-off-the-shelf (COTS) technologies, custom-designed materials, and custom-built blast protection. The VBDR is similar to an aircraft black box and captures real-time data that allows blast investigators to reconstruct the blast or crash event, with information such as directional G-force, humidity, temperature, GPS and video. To protect the VBDR, the NDCEE developed a shock isolation system for the electrical components. Concepts for enclosing the system and attaching it to a vehicle were modeled to provide an explicit dynamic simulation of shock loads, followed by prototype testing on a shock test fixture that incorporated a drop tower and simulated the pyroshock of an IED blast. The shock test exposed the VBDR to greater than 6,000 gravitational force (g), which is greater than 20% above specification. The information also has applications for vehicle design and survivability engineers, first responders, and the medical community and may ultimately lead to improved blast mitigation technologies and the more effective treatment of IED-associated occupant injuries.

While IEDs cause many mission-related ground mishaps, controlled flight into terrain (CFIT) is the leading cause of helicopter accidents and crew fatalities in the U.S. Army and Air Force. CFIT accidents have killed approximately 200 people and destroyed nearly 150 helicopters over the past two decades. CFIT occurs when helicopter pilots and crew lose visual awareness of their surroundings. The NDCEE evaluated Rotary Wing Terrain Awareness (RWTa) human interface tools to prevent helicopter crashes and is working with the DSOC to militarize commercially-available

IEDs cause powerful and devastating explosions as military vehicles pass over or near them. The NDCEE developed a vehicle blast data recorder to help fully characterize the effects of IEDs and improve survivability.

top left

Controlled flight into terrain when visual awareness is compromised, is a leading cause of helicopter fatalities. The NDCEE is demonstrating COTS technologies to increase terrain awareness in helicopter flight crews and reduce preventable aviation mishaps.

top right

Commanders at 20 sites where VPP has been implemented are reporting an average total case incident rate reduction of 69% and a total annual cost savings of \$1.7 million due to an improved safety culture.

opposite page



systems to reduce CFIT accidents. Demonstrations with approximately 20 pilots at three test sites on UH-60 and UH-1 helicopters have shown that RWTA devices can prevent CFIT accidents and save lives by increasing situational awareness of terrain, weather, and traffic conditions. If adopted fleet-wide, the RWTA technology could save \$38 million and five lives a year with full payback achieved in four years after initial investment.

Accidental mishaps also occur during military training. Training injuries not only reduce lost training time and increase clinic visits, hospitalizations, and medical evacuations, they reduce the fighting effectiveness of military units. For example, ankle sprains and strains often occur during airborne training when paratroopers



land on uneven terrain. The new T-11 parachute was designed to reduce injuries by reducing parachute descent rates by 25% and impact energy by 40%; however, the actual effect on injury rate has not been quantified. Therefore, the NDCEE is evaluating the injury incidence of parachute jumps using the T-11 versus the baseline T-10 within the same or similar military units in an operational environment.

The NDCEE plans to evaluate 10,000 jumps using the new T-11 parachute before completing the analysis and providing recommendations.

According to two reports released in July 2009 by the Office of the DoD Inspector General, electrical hazards in theater have caused 18 electrocutions and a number of shocks and related fires since 2003. The most prevalent fatal hazards involved contact with power lines and maintenance use with generators and power washers. The DSOC Installations and Industrial Operations Task Force worked with the NDCEE to create a multi-service, multi-agency working group through the DoD Electrical Safety Initiative to research key data and best practices to mitigate electrical hazards utilizing Service Safety Centers, safety and occupational health professionals, community leaders, and electrical subject matter experts. The working group conducted a thorough review of all mishap scenarios to determine the types of electrical hazards and root causal factors existing within DoD. The NDCEE performed a gap analysis of the standards and the existing programs which led to recommendations to improve policies, procedures, engineering controls, personal protective equipment, and training.

FOSTERING A SAFETY CULTURE IN THE DOD WORKPLACE

Since the VPP CX was established: 38 sites within the DoD have earned VPP Star status; the Air Force has committed to 100% VPP conformance across all installations, gaining its first 8 Stars at an aggressive pace; the Navy has 13 Star sites, with the newest recommendation for Star status going to the Naval Surface Warfare Center—Carderock Division—Ship Systems Engineering Station (SSES), Philadelphia; Illesheim Health Clinic, Germany and the U.S. Army Health Clinic, Livorno Italy have volunteered to seek Army VPP Star recognition as part of Army strategy to implement VPP across all medical commands, including those in Europe; and the Army National Guard is actively piloting VPP implementation at sites across all 54 states and territories. Further, the Defense Logistics Agency (DLA) has requested additional VPP support to advise all of its sites on their journey toward Star status, and VPP CX personnel are directly supporting Washington Headquarter Service’s efforts to achieve Star recognition for the Pentagon.

In addition to the successes supported under the VPP CX, the NDCEE is supporting additional endeavors to promote a safe culture by advancing best practices and promoting the use of new technologies including: immersive, stereoscopic 3D safety training; a scheduling tool to reduce fatigue-related mishaps; an industrial hygiene handheld tool; and anti-vibration power hand tools.

FY10 represented the fourth year of developing and implementing 3D safety training across the DoD. The NDCEE developed advanced interactive delivery tools to make safety training more realistic, enjoyable, and ultimately more effective. High-impact safety training videos offer life-like simulations of safe and unsafe worker attitudes, choices, and consequences. The newest training combines immersive 3D stereoscopic visual images with enhanced audio through a light-weight, adjustable, head mount display. It creates a learning environment with mind-body integration, cognitive restructuring, and a heightened emotional response, similar to learning through “real-life” experience. This tool persuades the trainee to establish a “present moment” consciousness with consideration and appreciation for future consequences. A self-serve kiosk was just installed in the Pentagon annex providing training for individuals, and a mobile Playback on Demand console was installed in the Pentagon library for training groups as large as 12 people.

While training can encourage safe practices, fatigue can interfere with those practices. According to the Air National Guard (ANG), the cost of fatigue-related mishaps to the Air Force alone is approximately \$54 million per year. Long-term shift workers report greater stress, relationship issues, and physical ailments, and are twice as likely to fall



asleep behind the wheel when fatigued. The NDCEE modified the successful FlyAwake tool, used to optimize flight schedules to mitigate fatigue in joint aviation operations, to create the WorkAwake application. WorkAwake is a scheduling tool that minimizes fatigue-related mishaps by using individual sleep history to identify specific people most likely to be alert even when the mission calls for additional or replacement personnel. This DSOC, ANG, and Navy initiative is developing a viable solution to assess and mitigate schedule-driven fatigue in shift work personnel, including Air Traffic Controllers, Navy shipboard personnel, space mission personnel, security forces, maintenance personnel, and the medical community.

Industrial hygiene (IH) baseline assessments, conducted under the VPP CX, provide data used by VPP teams to address workplace health and safety issues to meet VPP Star requirements. To facilitate electronic data collection and streamline the health hazard identification process during baseline assessments, the NDCEE developed an IH handheld tool. Following its initial development, the IH tool was demonstrated and validated at the Army Aviation Support Facility at Fort Indiantown Gap, PA and at Crane Army Ammunition Activity, Crane, IN. After proving its value in the initial demonstrations, the NDCEE used the tool to conduct baseline assessments at 28 diverse facilities for the U.S. Army Corps of Engineers. At every facility, the tool was proven effective—ultimately streamlining the VPP application process and driving down the number of occupational health exposures and related costs.

The safety culture in the procurement community is also expanding and promoting health-related cost considerations when evaluating products. The DSOC partnered with the National Institute for Occupational Safety and Health (NIOSH) and the DoD Ergonomics Working Group to improve anti-vibration power hand tool availability, reducing personnel exposure to crippling



The WorkAwake tool mitigates schedule-driven fatigue in DoD shift workers even when the mission calls for additional or replacement personnel.
top left

The NDCEE developed and demonstrated expanded delivery methods for 3D Training and produced additional safety videos on General Pentagon Safety; Fire Safety, Egress & Evacuation; Slips, Trips and Falls; and Office Safety
top right

hand-arm vibration and noise exposure. The NDCEE performed a hand tool analysis and created procurement guidelines for power hand tools for Federal and DoD acquisition authorities. The Government Services Agency (GSA) expressed an interest in assigning National Stock Numbers (NSNs) for ergonomic power tools from a variety of categories, such as grinders, chipping hammers, needle guns, and drills. The DLA facilitated assignment of 52 NSNs for new protective items as well as the first procurement guidance for low vibration tools and certified anti-vibration gloves.

MITIGATING OFF DUTY HIGH RISK FACTORS

Off duty, recreational, and sports activities can affect mission readiness when injuries lead to lost work days or fatalities. For example, traffic fatalities are the leading non-battle mishap category across the services, with the cost estimated to be \$104 million for fatalities DoD-wide in 2008. The NDCEE analyzed incident trends using several methods to understand root causes and counter high-risk behaviors in personal motor vehicle (PMV) and sports activities.

Motorcycle accidents are a leading cause of non-combat injury and death. A combination of fast, powerful bikes and young, inexperienced riders with a warrior ethos has led to serious injuries and fatalities. The NDCEE is supporting the DSOC through two initiatives to better understand risk perceptions and educate service members in motorcycle safety. A series of focus groups was conducted in FY10 to collect information on motorcycle activity within the military. The focus groups identified mitigation efforts most effective against barriers in technology, education, enforcement, and guidance. Other efforts to drive down motorcycle incidents included the development and distribution of popular traffic-safety “Quickseries” flip-book reference guides to military service riders. More than 57,000 flip books were delivered to multiple military branches as a tool to enhance traffic-safety awareness.



Navy commanders now have a method of identifying high-risk drivers through the Driver History Profile Pilot Program (DHP3)—a reporting system to monitor off-base driving violations, suspensions, and revocations. All services have benefited from a similar program, the Travel Risk Prevention System (TRiPS), developed under a previous DSOC initiative, which performed analysis of travel risks associated with specific bases, equipping commanders to initiate appropriate countermeasures. DHP3 reduces costs by targeting high-risk drivers for in-depth safety training, sparing the general population from the additional time commitment. This targeted training approach could save the Navy up to \$44 million, based on the cost-benefit analysis.

Sports related injuries are another major off duty concern among military personnel, especially cadets and midshipmen at service academies. DSOC’s Sports and Recreational Injury Prevention Working Group under the Military Training Task Force sponsored an initiative to make injury prevention a priority from Day One in the military. The three easy-to-use modules of the Sports Injury Portal provide institution-wide injury surveillance and reporting for various stakeholders, such as medical staff, intercollegiate athletic personnel, and academy leadership. Key features are automatic demographic field population from student information systems, replacement of the cadet/midshipman medical excusal process, and additional illness tracking. This portal has been optimized for the United States Military Academy at West Point and current testing and implementation is near completion at the United States Air Force Academy.

CAPTURING A COMPREHENSIVE VIEW OF MISHAPS ACROSS SERVICES

The NDCEE created the Human Factors Analysis and Classification System (HFACS) Online Training Program to improve the consistency of data collected during mishaps investigation and reporting. All Services use the DoD HFACS for a myriad of mishap investigations, including aviation, PMV, and industrial incidents. However, ambiguities in the application of the DoD HFACS taxonomy by investigators complicate analysis and reduces data reliability. The web-based courseware standardizes taxonomy usage – leading to more accurate trend analysis and hazard identification. Implementing real-time intervention strategies based on an accurate assessment of an organization’s climate, human factors, and safety perception trends will increase the DoD’s operational readiness and save costs associated with incident response and recovery.

◀ *Motorcycle training classes are one tool that the DoD uses to reduce riding mishaps.*

THE WAY AHEAD



The Secretary of Defense is leading the charge for improved efficiencies and reducing preventable mishaps, and the NDCEE’s mission falls in line with these sustainability and readiness challenges. In direct support of the DoD’s proactive implementation of the Strategic Sustainability Performance Plan for EO 13514, the NDCEE will continue to support initiatives in net zero energy, water, and waste across military installations and operating environments in FY11. For example, the NDCEE brings a high-level of understanding of the challenges and innovative technical solutions that will be utilized in the creation of a Renewable Energy Project Plan Strategy for the Army. Similar support will be provided to the Air Force in demonstrating an enterprise-level energy management dashboard. To meet new EPA regulations designed to drastically reduce pollution in the Chesapeake Bay watershed, the NDCEE is building a model for determining Federal facility water load allocations. Finally, the NDCEE will demonstrate a waste-to-energy system to address the needs of FOBs and potential technologies to recover and recycle off-specification fuels for the Navy.

Other FY11 NDCEE activities will ensure warfighter readiness by demonstrating new safety and personnel protection technologies and continuing to address ESOHE aspects in the defense acquisition lifecycle. For example, in support of the DSOC, the NDCEE will demonstrate a technology to increase helicopter pilot situational awareness in brownout conditions, particularly in arid combat zones. We will also provide direct support to the warfighter by designing, developing, and demonstrating a blast-mitigating protection seat which can be integrated into the next generation of Army ground vehicles for increased survivability.

Going forward, the NDCEE will continue to play a vital role supporting the DoD’s journey toward sustainable military installations, ESOHE solutions for weapon systems and maintenance operations, and the health and safety of military and civilian personnel. Visit the NDCEE web site for more exciting updates on new tasks, technologies, and recent developments.

FOR ADDITIONAL INFORMATION, PLEASE VISIT WWW.NDCEE.CTC.COM



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