Panama City Engineers Develop Tools to Reduce Energy Consumption

Focus is on Forward-Deployed Marine Corps Combat Operations Centers

NAVAL SURFACE WARFARE Center Panama City Division (NSWC PCD) engineers are developing tools to enable U.S. Marine Expeditionary Forces (MEF) to more accurately predict energy consumption needs and reduce energy consumption before boots hit the ground.

NSWC PCD's Expeditionary Energy Evaluation and Integration (E3I) team of engineers were asked by the Marine Corps Systems Command (MARCORSYCOM) to find ways to reduce energy consumption of Marine Corps Combat Operations Centers (COC). MARCORSYCOM acquires and provides lifecycle support of ground weapon and information technology systems that U.S. Marines rely on to fight and win.

tions provided by the vendors of those shelters. The E3I engineers thought there was a better way. The first problem to be addressed was the prediction of the shelter heat transfer. Researchers sought to understand how shelters absorb heat and then how best to reduce the heat absorbed.

In July 2012, Gorin visited the National Renewable Energy Laboratory (NREL), located in Golden, Colorado, to determine if they may be able to help. What he found was a heat transfer model being used for building evaluations, but would it work for shelters? They decided to give it a try. NREL conducted the modeling and NSWC

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Together, leaders from MARCORSYCOM and NSWC PCD analyzed the COCs where almost 70 percent of all the energy was being used to heat and cool the shelters.

"Shelters could be anything that Marines live in, including tents, plywood buildings, or other temporary housing," said NSWC PCD E3I Team Lead and Senior Systems Engineer Steve Gorin. "In this case, we are talking about military style tents."

Additionally, all previous predictions of the energy usage of the shelters were based on specifications or calcula-

PCD conducted the validation testing. Not only did the model work, but it proved to be very accurate—predicting the correct temperature inside the tent within one degree Celsius.

Given the shelter modeling, a large part of the energy consumption (70 percent) could be accurately modeled. But how about the other 30 percent? The engineers determined the power consumption of a wide range of equipment used inside a shelter, such as computers, lights, displays, printers, shredders or communication equipment could be easily measured but they were concerned

NSWC PCD's expeditionary energy compound runs completely on solar power and uses fossil fuels as needed. A commercial-off-the-shelf water fountain offers researchers potable water captured from moisture in the air. Sensors are placed inside and outside the tents to capture radiant barrier and heat readings.

Ron Newsome

about the heat output of the equipment. Any heat output by the equipment required additional air conditioning. Two E3I team members, Dr. Tanisha Booker and Dr. Lee Fry, came up with a solution—measure the heat output with a calorimeter.

A calorimeter is an instrument used for measuring the quantity of heat absorbed or released by matter when it undergoes a chemical reaction or physical change. In this case, it was a well-insulated box in which a piece of equipment (computer, light, etc.) was placed and turned on and temperatures of air flowing in and out of the box was measured so that the heat generated by the equipment could be calculated. After a search however, Booker and Fry couldn't find a calorimeter that would allow the equipment to be measured. So they designed and built one.

The Basics About the National Renewable Energy Laboratory

NREL IS THE U.S. Department of Energy's primary national laboratory for renewable energy and energy efficiency research and development. NREL develops renewable energy and energy efficiency technologies and practices, advances related science and engineering, and transfers knowledge and innovations to address the nation's energy and environmental goals. The laboratory's emphasis is on a comprehensive energy approach that encompasses the relationship among key systems including:

- Fuel production
- Transportation
- The built environment
- Electricity generation and delivery

For more information, visit www.nrel.gov.

Gorin's team has built an expeditionary energy compound in Panama City, Florida, run entirely by solar power that incorporates energy technologies that has the potential to further improve field tactics.

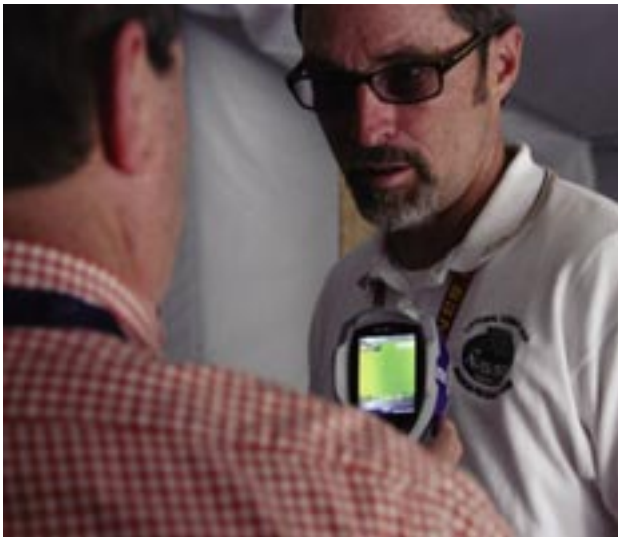
"We measured the heat output in a laboratory environment using a calorimeter that we created. We measured pieces of equipment within a shelter that might be used in an operational environment, such as computers, monitors, and lights," said Gorin.

The goal was to reduce energy consumption. Since heat and cooling of the shelter was where the majority of the energy was being consumed, improving the energy efficiency of the shelter seemed like a good place to start. Since the shelter model is bound by the Laws of Physics, physics-based variables such as shelter material, colors, radiant barriers, air vents, shades, and air infiltration rates can be varied to determine their effects.

The engineers evaluated variances, one being how much air is being lost due to air gaps in the shelter assembly and the opening of the door flaps. What they discovered with a tracer gas test is that the rate of infiltration (of heat into the shelter) was 10 times greater with one door unzipped than when the tent was sealed. NREL modeled a shelter with a radiant barrier and the model predicted a 26 percent heating or air conditioning saving for a year with a radiant barrier than without a radiant barrier. Radiant barriers, or reflective barriers, inhibit heat transfer by thermal radiation. They are like the reflector that is used in your car to keep it cool. Further efforts are underway to determine other means to further reduce energy consumption.

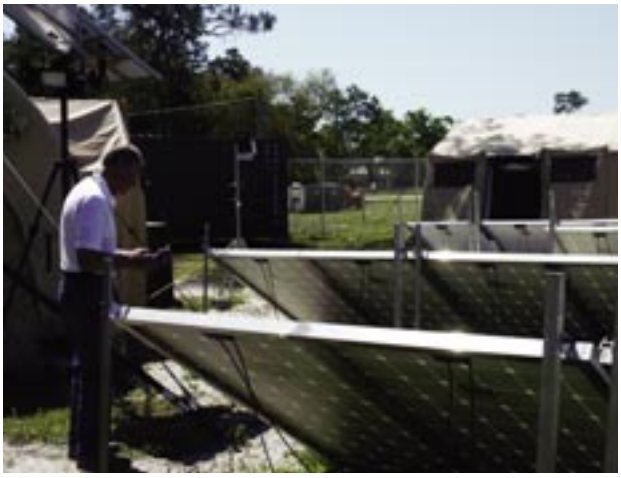
"This new computerized model allows users to incorporate shades, radiant barriers, and tent colors into the heat transfer calculations to determine the need for heating and air conditioning," said Gorin.

Sensors line two different Marine Corps CoC tents in NSWC PCD's expeditionary energy compound. These sensors measure the sun's heat absorption rates. The data are used to determine methods to deliver cooler, more cost-effective tents for MEFs.
Jacqui Barker



NSWC PCD engineers Bob Backus (left) and Ray Sheffield (right) use a handheld thermal imaging device to determine heat levels inside a tent being used for energy absorption and monitoring research conducted at NSWC PCD.

Jacqui Barker



NSWC PCD engineer Dr. Lee Frye uses a hand held thermal imaging device to determine heat output levels inside the Warfare Center's expeditionary energy compound.

Jacqui Barker

Lights in the expeditionary energy compound are powered by solar panels.

Jacqui Barker

Since the model utilizes a weather input file, it can predict tent temperatures anywhere in the world, thus allowing field units to predict supply needs before they deploy. Gorin said that the new algorithm and model have been shared with the U.S. Marine Corps and the U.S. Army for their consideration.

Gorin's E3I team has expanded their efforts now that they have a computerized model that allows them to predict energy consumption in theater. To date, Gorin's team has built an expeditionary energy compound in Panama City, Florida, run entirely by solar power that incorporates energy technologies that has the potential to further improve field tactics.

"We're also looking at hybrid energy systems that will enable the U.S. Marines and the Army to match their supplies to demand," he said. "Unlike your house where you only pay for the energy you consume, the military fires up a generator that frequently is lightly loaded and

The Basics About Naval Surface Warfare Center Panama City Division: Technical Center of Excellence for Littoral Warfare and Coastal Defense

THE TECHNICAL CENTER of Excellence for Littoral Warfare and Coastal Defense at NSWC PCD conducts research, development, test and evaluation, and in-service support of mine warfare systems, mines, naval special warfare systems, diving and life support systems, amphibious/expeditionary maneuver warfare systems, and other missions that occur primarily in coastal (littoral) regions.

NSWC PCD exists to understand the technical dimensions of warfighter requirements, to collaborate with industry, academia and other Warfare Centers to develop solutions and certify that safe and effective solutions are achieved. NSWC PCD engineers provide a bridge between the warfighter and the technical community, rapidly respond to the warfighter, provide objective advice to naval leadership, and make naval programs successful.

For more information, visit www.navsea.navy.mil/nswc/panamacity/pages/mission.aspx.

NSWC PCD's E3I team conducts expeditionary energy research to determine ways to reduce energy consumption by first understanding how shelters absorb heat. An example of a successful heat reduction experiment includes the use of an Ultra Lightweight Camouflage Net System over the top of a shelter tent.

wastes energy. The hybrid system's aim is to use the generators efficiently by turning the generators off when not needed and using stored or renewable power."

The NSWC PCD's E3I team is comprised of four engineers—Steve Gorin, Dr. Tanisha Booker, Dr. Lee Fry, and Steve Naud. The E3I team is also collaborating with NSWC Carderock engineer Eric Shields, and NSWC Crane Ken Burt to complete the Analysis of Alternatives for Hybrid Power Systems that will result in new power systems for the U.S. Marines. One of the hybrid solutions under consideration is a U.S. Army microgrid that utilizes six, 60-kilowatt generators that are switched on and off as needed. NSWC PCD is expected to receive one U.S. Army microgrid for project testing in the fall of 2013.

Read more about the U.S. Marine Corps Systems Command at www.marcorsyscom.marines.mil. ⚓

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