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MILITARY POWER SUPPLY UNITS DEVELOPMENT PROSPECTS ON THE COMBAT OPERATIONS EXPERIENCE BASIS

The goal of this article is specification of requirements to sources of the electric energy, used in armed forces, consideration of their condition and the assessment of prospects of progress of army electric supply units on the combat operations experience basis.

Keywords: *independent power sources, military power supply units, prospects of development of electrotechnical means.*

Preface

Problem. Last years, Ukrainian armed forces consumed more than 20 000 tons of fuel in military operations [1]. At the same time that military demand for energy is growing, global and battlefield energy supplies are under pressure. At the operational and tactical level, fuel logistics have proven vulnerable to attack in recent conflicts. As long as Ukrainian armed forces rely on large volumes of energy, particularly petroleum-based fuels, the vulnerability and volatility of supplies will continue to raise risks and cost for the armed forces.

In US forces operational energy is defined by statute as the energy required for training, moving, and sustaining military forces, weapons, and equipment for military operations. Operational energy typically accounts for 75 percent of all energy used by the Department of Defense. Since the beginning of Operation Iraqi Freedom/Operation Enduring Freedom, the Department of Defense has initiated numerous studies, assessments, technology demonstrations, and reports that have made recommendations on how to improve operational energy use in expeditionary environments [2].

Analysis of recent researches and publications. In 2010, the Department of Defense established the special office to strengthen the energy security of U.S. military operations. The mission of the office is to help the military services and combatant commands improve military capabilities, cut costs, and lower operational and strategic risk through better energy accounting, planning, management, and innovation [3].

In 2011, the Army included achieve energy security and sustainability objectives in the 2012 Army Campaign Plan [4].

In May 2011, the US Army Rapid Equipping Force (REF), a introduced its Energy to the Edge initiative, focusing on operational energy requirements for small units operating at the tactical edge [5]. This effort evolved into the current Net-Zero to the Edge initiative as the REF quickly identified common challenges and opportunities associated with water, waste and energy.

Objective of the article. The goal of this article is specification of requirements to sources of the electric energy, used in Armed forces, consideration of their condition and the assessment of prospects of progress of army electric supply units on the combat operations experience basis.

Statement of the main material

The focus of the armed forces is on Army units operating at the tactical edge – remote, often austere locations beyond routine logistical support reach.

From 2006 to 2008, US Army Rapid Equipping Force identified and incubated several hybrid power and energy demand reduction solutions, a number of which have matured and have been deployed by the Army [6].

*Transportable Hybrid Electric Power Station (THEPS)***:** an prototype 5 kW ruggedized hybrid power system that utilizes both renewable and traditional energy sources: wind turbines, solar panels, diesel generators and batteries in order to provide both continuous and back-up power. While the system proved effective in reducing fuel consumption, it was not ideal for harsh combat conditions.

*Hybrid Electric Station – K Crossing***:** The hybrid electric station demonstration was to decrease energy dependence on the local Kuwaiti power grid. The system was designed to provide 22 kW back into the utility grid. The hybrid electric station can provide renewable power that can be combined with conventional fossil fuel power to enhance mission capability while providing constant reliable power.

Tactical Garbage to Energy Refinery (TGER): TGER converted roughly 2,000 pounds of solid waste – paper, plastic, packaging and food waste – into approximately 800 kWh of electricity via a standard 60-kilowatt diesel generator in Camp Victory, Iraq for a 90-day operational assessment. The in-theater assessment determined that the system required too many man-hours to operate and maintain.

Tactical Electrical Solar System (TESS): This portable Hybrid power systems comprised of two 50W solar

panels and storage capacity in a 100 amp-hour absorbed glass mat battery with four 12V DC receptacles. The entire system weighs 85 lbs and is equipped with a 120V 60Hz AC component.

In May 2011, the US Army Rapid Equipping Force launched its Energy to the Edge initiative [7].

The primary objective of the Energy to the Edge initiative has been to identify and fulfill the operational energy gaps at the tactical edge-defined as units located beyond a Battle Space Owner's routine logistical support reach, without requiring additional ground or aerial resupply operations. A secondary objective is to provide meaningful and measurable analyses that support the U.S. Army's policy and procurement decisions.

The US Army Rapid Equipping Force has equipped units through two separate principal directions [8]. Principal direction I focused on power generation to support fixed, mobile and dismounted operations, whereas principal direction II focused on energy efficiency measures to reduce demand at both expeditionary and enduring outposts.

Solutions principal direction I supplied eleven new or modified solutions to the deployed forces in Afghanistan. Solutions fell into three capability categories:

– soldier power: solutions that support dismounted operations;

– expeditionary power: solutions that provide mission power outside the combat outpost;

– outpost power: solutions that provide power for fixed site operations.

Soldier Worn Integrated Power Equipment System (SWIPES). SWIPES is a modular power distribution system that is designed for use with a conformal battery. For commonly used handheld communications, SWIPES utilizes modular lightweight load-carrying equipment pouch mounted chargers to maintain a high level of charge (80%) within an standart battery. SWIPES also provides direct power to various devices, including GPS units, radios, and Shot Detection Systems. This approach reduces the need for carrying spare batteries for each peripheral on multi-day missions. SWIPES comprises a conformal battery – a rugged battery pack that provides 150 watt-hours at 5 amps while weighing less than 2.5 lbs. It's thin and flexible design allows for safe operation and conforms to a soldier's front, back, or side ballistic plates. While feedback across the Army has been very positive for this solution, demonstrating a battery load reduction of 33%, the benefit is only realized when dismounted operations exceed 72 hours.

Rucksack Enhanced Portable Power System (REPPS). REPPS is a lightweight, portable power system capable of recharging batteries and/or acting as a continuous power source. It required 5 to 7 hours to charge a standard military lithium-ion rechargeable BB2590 battery.

Solar Power Adaptor for Communication & Electronics Systems (SPACES). SPACES is the Marine Corps version of REPPS. It was selected based on a high level of positive feedback from the in-theater operational assessment. Unlike the Marine Battalion, which trained with the systems for several months before deployment, Army units were issued REPPS while already deployed in theater and did not trust the SPACES solutions.

Squad Power Manager (SPM). SPM is a lightweight, portable power management system that can provide device power or battery charging for up to four devices, including multiband inter team radios, defense advanced GPS receivers, Toughbooks, and USB-powered equipment. It can use power from solar sources, AC, military/disposable batteries, and NATO/cigarette adapters. The ability to scavenge power from multiple sources was well received by users.

Small Hybrid Power Generator. To take advantage of available sunlight as a free energy resource and to reduce generator run-time, US Army selected three different hybrid power generation solutions: a 1.8 kW, 3 kW, and a 5kW output solution.

The 1.8 kW solution was a completely modular solution with ten 1 kWh storage modules, three 360 W solar arrays and a power manager to control a connected 3 kW tactical quiet generator (TQG). It was a predecessor to the original TESS effort and had participated in numerous demonstrations.

The 3 kW system was similarly integrated with three modules: a power module with 3.8 kWh storage, an AC module that managed AC outputs and inputs, and a DC module that managed all DC inputs and outputs including 1.2 kW of solar PV panels. The 3 kW system was selected because of its history in both Iraq and Afghanistan supporting strategic missions.

The 5kW system forms a tightly integrated system that is mounted on a light tactical trailer. It connects to a 5 kW TQG and includes 1.2 kW solar arrays and 28 kWh of battery storage. The 5kW system was down-selected and deployed by the Marine Corps.

All of the solutions performed well in theater and were effective in providing reliable power to mission critical systems. However, the outputs were too small to have a significant impact on the fuel consumption of the 200 – 300 kW Outposts.

Large Hybrid Power Generator. US Army procured two large hybrid solutions during the Principal direction I cycle. The first a 28.8 kW system that included 28 kW of rated photovoltaic (PV) panels, 192 kWh of energy storage integrated with a 35 kW commercial generator. The second system was never deployed due to operational testing challenges.

3 kW & 5 kW Tactical Quiet Generators with Auto-Start Kits. In order to take advantage of the hybrid power systems, the power management function of each system must have the ability to automatically turn the

generator off and on. The kits were very effective and contributed to 50% reduced run-time and associated maintenance.

Principal direction II Solutions. Principal direction II Solutions focused on providing expeditionary camps and enduring camps with integrated efficiency solutions for energy and water needs, including product improvements from Principal direction I.

Light Expeditionary Camps. Soft skinned turnkey camps can support up to 50 Soldiers and enablers. The camp is equipped with insulated liners, sunshades, energy efficient environmental control units and improved hybrid energy solutions.

Enduring Camps. The camps have insulated shelters, a 90 kW–150 kW tactical micro-grid, a grey water re-use system, water efficient hygiene facility, and an energy efficient kitchen. The camps were well received by the soldiers and preliminary data suggests significant fuel savings when compared to current techniques and practices in deployed operations

14.8 kW Hybrid Power Generator (with 80 kWh storage). Unlike the larger 28.8 kW system, the new Hybrid systems rely on batteries and generators (as opposed to PV panels) as the primary power source. This configuration requires a smaller footprint and is significantly lighter.

Product/Capability Improvements from Principal direction I. As part of both the Light and Enduring Camps, US Army selected some of the suitable and effective solutions from the Principal direction I effort. They included:

– Small Hybrid Power Generators with improved form, size, and performance.

– Improved Multi-fuel 1 kW Generator.

– Integrated Warrior System that distributes both power and data.

So the primary objectives of the Net-Zero to the Edge initiative are to [9]:

1. Provide Commanders at the tactical edge increased operational flexibility by reducing reliance on resupply operations.

2. Provide suitable, sustainable and reliable power to meet the demand of mission critical systems.

3. Reduce water and waste transport requirements and reduce soldier load during dismounted operations.

Advantages of the Net-Zero to the Edge initiative:

– solutions can be tailored to the specific missions and conditions at the site;

– the end-user actually experiences the challenges and understands the benefits of this solutions. The actual operator and supervisor attend the training;

– the Operational energy advisor gets to observe first hand end-user acceptance and suitability issues.

Disadvantages of the Net-Zero to the Edge initiative:

– units at the edge are typically overtaxed with a number of missions and tasks. Caring, feeding, and supervising additional un-armed personnel requires support from the Unit;

– while equipment and personnel can predictably move to theater, intra-theater movement is entirely unpredictable. Enemy activity, weather, and maintenance issues can delay movement to an austere location by weeks.

Summary

Improving the Army's Operational Energy Posture will increase mission effectiveness by enhancing or preserving adaptability, versatility, flexibility and sustainability, reducing costs and preserving future choice. Smart energy wins the fight. Providing energy alternative capabilities and interoperability builds flexibility and resilience through increased ability to respond to changes in operational demands, and greater ability to adapt to changes in the operational environment. Integrating operational energy strategies into the Army's culture, processes and systems promote adaptive and innovative leaders for a flexible and agile force of decisive action. The Army needs enough power and energy in the right form, at the right place and the right time to conduct modern military operations.

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ПЕРСПЕКТИВИ РОЗВИТКУ ВІЙСЬКОВИХ ДЖЕРЕЛ ЕЛЕКТРИЧНОЇ ЕНЕРГІЇ З УРАХУВАННЯМ ДОСВІДУ ВЕДЕННЯ БОЙОВИХ ДІЙ

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Метою статті є уточнення вимог до джерел електричної енергії, що використовуються в збройних силах, аналіз їх стану та оцінювання перспектив розвитку військових джерел електричної енергії з урахуванням досвіду ведення бойових дій.

Ключові слова: *автономні джерела електричної енергії, військові електростанції та електроагрегати, перспективи розвитку електротехнічних засобів.*

ПЕРСПЕКТИВЫ РАЗВИТИЯ ВОЙСКОВЫХ ИСТОЧНИКОВ ЭЛЕКТРИЧЕСКОЙ ЭНЕРГИИ С УЧЕТОМ ОПЫТА ВЕДЕНИЯ БОЕВЫХ ДЕЙСТВИЙ

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Целью статьи является уточнение требований к источникам электрической энергии, используемых в вооруженных силах, анализ их состояния и оценивание перспектив развития войсковых источников электрической энергии с учетом опыта ведения боевых действий.

Ключевые слова: *автономные источники электрической энергии, войсковые электростанции и электроагрегаты, перспективы развития электротехнических средств.*