MAY 2015

E2E

Energy to the Edge

Equipment Assessment

U.S. Army Rapid Equipping Force

Report Documentation Page

Form Approved
OMB No. 0704-0188

1. REPORT DATE	2. REPORT TYPE	3. DATES COVERED
01 MAY 2015	**Summary**	**01 JAN 2014 - 01 MAR 2015**

4. TITLE AND SUBTITLE
E2E Energy to Edge Equipment Assessment U.S. Army Rapid Equipping Force

5a. CONTRACT NUMBER
SP0700-99-D301/SUB1220202

5b. GRANT NUMBER

5c. PROGRAM ELEMENT NUMBER

6. AUTHOR(S)
Barbara Brygider, Brandon Bloodworth, Joe Barniak, Doug Fisher, Michael Funderburk, Jonas Bateman, Cory Reed

5d. PROJECT NUMBER

5e. TASK NUMBER

5f. WORK UNIT NUMBER

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
Barbaricum, LLC 819 7th Street

8. PERFORMING ORGANIZATION REPORT NUMBER

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)
U.S. Army Rapid Equipping Force 10236 Burbeck Rd Fort Belvoir, VA 22060

10. SPONSOR/MONITOR'S ACRONYM(S)
REF

11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release, distribution unlimited

13. SUPPLEMENTARY NOTES
The original document contains color images.

14. ABSTRACT
The REF procured, deployed and assessed hybrid alternative and renewable energy systems and energy efficient shelter systems as part of the Energy to the Edge (E2E) program and expanded the program to support Soldiers in Africa and South America and demonstrate various configurations at test sites in the US. Hybrid power systems were successfully operated in a wide variety of locations supporting a range of capabilities including surveillance, aerostats, aircraft landing, weather systems, entry control points, and tactical operations centers. Energy efficient shelters and systems provided improved living conditions for the Soldiers. Both Heavy and Lite Camp basing configurations provided warfighters with the comforts of garrison living in a tactical environment. REF operational energy efforts have demonstrated the effectiveness of hybrid power and energy efficient shelters. Feedback from Soldiers and Operational Energy Advisors has helped inform the defense community of the suitability and value of these hybrid power systems and alternative basing configurations.

15. SUBJECT TERMS
Rapid Equipping Force, Operational Energy, hybrid energy, commercial-off-the-shelf (COTS), power, energy, Heavy Camps, Lite Camps, contingency basing

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT	b. ABSTRACT	c. THIS PAGE			
unclassified	**unclassified**	**unclassified**	**SAR**	**86**	

Abstract

The Rapid Equipping Force (REF) procured, deployed and assessed hybrid alternative and renewable energy systems as part of the Energy to the Edge (E2E) program. The initial E2E program was expanded beyond Afghanistan to support Soldiers in Africa and Central America and to demonstrate various configurations including energy efficient shelters and systems at test sites in the Continental United States (CONUS). Hybrid power systems were successfully operated in a wide variety of locations supporting a range of capabilities including surveillance, aerostats, aircraft landing support, weather stations, entry control points (ECPs), and tactical operations centers (TOCs).

Energy efficient shelters and systems provided improved quality of life for Soldiers. The basing configurations provided Warfighters with the comforts of garrison living in a tactical environment. REF operational energy efforts have demonstrated the effectiveness of hybrid power and energy-efficient shelters and systems. Feedback from Soldiers and Operational Energy (OE) Advisors/Trainers has helped inform the defense community of the suitability and value of hybrid power systems and alternative basing configuration.

Contents

1.0 Executive Summary ____ 6

2.0 Purpose ____ 6

3.0 Findings & Recommendations ____ 12

4.0 Conclusion ____ 20

5.0 Appendixes ____ 23

- Scorpion Hunter Energy System ____ 24
- Hybrid Energy System (T-Series 910) ____ 27
- 3kW Hybrid Energy System (SS400) ____ 30
- Forward Operating Renewable Generator Model 440/510 (FORGE 440/510) ____ 34
- 1KW Flex Fuel Generator ____ 37
- Wearable Advanced Soldier Power (WASP) X-90 ____ 40
- Load Demand Start Stop (LDSS) System ____ 42
- Heavy Camp Shelter – Dining Facility ____ 46
- Heavy Camp Shelter – Hygiene Facility ____ 49
- Heavy Camp Shelter - Kitchen ____ 52
- Heavy Camp Shelter - Billets ____ 55
- Heavy Camp Shelter – CP/Admin ____ 58
- Air-to-Water ____ 61
- SHOWER WATER REUSE SYSTEM (SWRS) ____ 64
- Generator ECU Trailer (GET) ____ 67
- Lite Camp Radome Tent ____ 70
- Lite Camp Billet Tent (307 Model) ____ 72
- Lite Camp Shower Facility ____ 75
- Lite Camp TOC Tent (HEX Dome) ____ 78
- Single Phase Efficient ECU (1.5 Ton Model) ____ 81

6.0 Acronyms ____ 84

U.S. Army Rapid Equipping Force

1.0 Executive Summary

SPIRAL II EQUIPMENT ASSESSMENT EXECUTIVE SUMMARY

The Army Rapid Equipping Force (REF) bridges the divide across requirements, science and technology, prototyping, acquisition, and logistics to provide capabilities to the Warfighter in 180 days or less. In 2012, the REF initiated the Energy to the Edge (E2E) program to reduce operational energy in the Afghanistan battlespace. The focus was on "the Edge"—those remote locations where Soldiers live, train, plan, and launch operations. The key component of the E2E program is Operational Energy (OE) Advisors/Trainers, which supports Soldiers in locations that are hard to reach, and where fuel deliveries are difficult and often treacherous. OE Advisors/Trainers not only assessed sites and implemented equipment solutions, but also trained power and energy concepts. We found that if Soldiers were not trained on the equipment, it would not be used.

The success of the initial E2E program at Forward Operating Bases (FOBs), Combat Outposts (COPs), and Village Stability Platforms (VSPs) in Afghanistan, resulted in the program expanding to also deploy OE Advisors/Trainers and additional capabilities to locations in Africa and Central America. Additionally, various equipment configurations were utilized by troops at training and demonstration events in the Continental United States (CONUS), including the Army Expeditionary Warfare Experiment (AEWE) at Fort Benning, the Network Integration Evaluation (NIE) at Fort Bliss and the Effective Energy for Expeditionary Operations Limited Objective Experiment (E2X LOE) at Fort Eustis.

The REF initially procured various equipment solutions known as "Spiral I," and a follow-on procurement, "Spiral II." Information on Spiral I was provided in the "Spiral I Equipment Assessment" Report completed in April 2012 and the "Energy to the Edge (E2E)" Report completed in March 2014. The U.S. Army Material Systems Analysis Activity (AMSAA) collected data at NIE and documented findings in the "Analysis of the REF E2E Renewable/Alternative Energy Solutions" published in February 2014. These reports, as well as operational feedback by Soldiers and OE Advisors/Trainers, resulted in identifying improvements that were implemented in the follow-on Spiral II procurement. This report documents the findings of Spiral II equipment deployments and demonstrations. While the assessment findings are summarized below, the individual assessments can be found in the Appendixes.

Hands on training with power management system for the TALS.

This report is divided into large hybrid systems, providing power in the 10kW (kilowatts) to 35kW range, medium systems from 3kW to 10kW and small hybrid systems with power capabilities below 3kW. After hybrid power systems, basing configurations and various energy-efficient shelters with integrated water and power systems are discussed.

Hybrid power systems were successfully operated in a wide variety of locations supporting a range of capabilities including surveillance, aerostats, aircraft landing, weather stations, entry control points (ECPs), and tactical operations centers (TOCs). As a result of the successful integration with hybrid power, several Program Managers (PMs) have included hybrid power in Program of Records (PORs). For example, the Product Manager (PdM) Electro-Optics/Infrared Payloads (EOIR) will field a hybrid power system with future RAID systems and the U.S. Army

Unmanned Aircraft Systems Project Office is considering a similar system for the Tactical Automatic Landing System (TALS). Hybrid systems reduced fuel demand, improved operational availability, and had more applications when integrated with a military Tactical Quiet Generator (TQG). Small hybrid systems worked well for Soldier power during dismounted operations and warm basing. Troops were able to reduce the number of batteries they carried because systems could be charged away from base operations. Beyond fuel savings, units are seeing an expansion in operational capability in terms of providing power generation to systems that can now be placed outside of an area where power is unavailable. This allows systems to operate for longer periods of time without refueling, thus extending mission duration.

Energy-efficient shelters and systems provided improved living conditions for Soldiers. Basing configurations provided Warfighters with the comforts of garrison living in a tactical environment. In addition to shelters that protected from the elements, structures were allocated for dining, hygiene, laundry, and billeting, as well as the TOC. While the containerized living of the Heavy Camps were an improvement over traditional tent structures, Material and Handling Equipment (MHE) was required for setup and movement of the Rigid Wall Camps (RWCs). These systems may work best at enduring base locations. The Heavy Camps were demonstrated at CONUS locations and some subcomponents need additional demonstration. Additional analyses are ongoing in operational environments. Lite Camps used soft-sided structures designed for better mobility and are in use in Africa and Central American military operations.

"The dramatic increase in safety that this base saw is due in large part to all the efforts that the REF put forth here (providing a hybrid power solution for remotely positioned RAID towers). You made a substantial contribution to the NKAIA Force Protection Group that I'll always remember."

- CPT Stephen Caldwell, U.S. Army

This picture was taken on Qasaba mountain at the base of a recently installed RAID Tower. This aerial view depicts where rockets attacks were being launched between the summit and the FOB.

2.0 Purpose

SPIRAL II EQUIPMENT ASSESSMENTS PURPOSE

The REF procured, trained, deployed and assessed hybrid alternative and renewable energy systems and energy-efficient shelter systems in an effort called "Energy to the Edge (E2E)." OE Advisors/Trainers traveled to FOBs, COPs, and VSPs in Afghanistan, Africa, and Honduras as well as to test and training sites at Fort Benning, Fort Bliss, and Fort Eustis to implement material solutions for improving energy security.

Training Soldiers on hybrid power equipment.

Table 1. Locations Where Systems Are Deployed.

EQUIPMENT	CENTCOM	USAFRICOM	SOUTHCOM	RSOI Fort Eustis	NIE FORT BLISS, TX	AEWE FORT BENNING, GA
Scorpion Hunter					1	1
T-Series 910	6	6	4			
SS400	12	11	3			
FORGE 440 & 510	10	6	3			1
1kW Flex Fuel	10	57	3			1
WASP	56					
LDSS	2*	1*		1	1	1
Dining Facility		2*			1	1
Hygiene Center		2*			1	1
Kitchen		2*			1	1
Billets		2*			1	1
TOC & ADMIN		2*			1	1
Air-to-Water					2	
SWRS					1	1
GET Trailer		6	4	1		
Radome		6	4	1		
307 Billet		6	4	1		
Shower Facility		6	4	1		
HEX Dome 6		6	4	1		
1.5 Ton ECU		30				

* awaiting installation

KEY	HEAVY HYBRID	MEDIUM HYBRID	SMALL HYBRID	Heavy CampS	LITE CAMPS

Systems Evaluated: Hybrids

The Scorpian Hunter, T-Series 910, SS400 and FORGE energy systems were hybrid technologies that combined military TQGs with commercial solar panels, batteries, and inverters. The FORGE Spiral I variant and WASP were renewable systems that did not have a generator. The SS400, T-Series 910, FORGE 440/510, and WASP were improvements of the Spiral I designs S360, H-Series, FORGE 400, and SPACES, respectively. These general improvements were:

1. **Efficiency** - Solar panels were improved to increase solar collection and additional batteries were added for improved efficiency.
2. **Mobility -** Solar panels were reduced in size to improve packaging, which improved mobility.
3. **Power Distribution** - Cables were added to allow better distribution of the power.
4. **TQG Battery Charging** - In some hybrid systems, a NATO slave was added to connect to the battery bank to keep the TQG battery charged (SS400, T-Series 910, and FORGE).

Systems Evaluated: Shelter and Support Systems

The shelter systems evaluated were Heavy Camps and Lite Camps. The heavy and lite configurations correspond to the type of shelter either rigid or soft wall. Heavy Camps used RWC expandable containerized systems. The RWC is based on the Energy-Efficient Shelter System (E2S2). The RWC provides shelters for sleep, personal hygiene needs, food service operations, routine operational tasks, and can serve as TOCs. The RWC utilizes power management and water re-use technology to reduce energy and water consumption. It incorporates the latest technology in mobile shelter design and construction to increase energy efficiency, reduce weight and increase mobility. The camp can be transported by land, sea or air intermodal systems. For storage and transport, the RWC contains most of its components inside the stowed E2S2 shelters. The E2S2 shelter is 20’ x 8’ when stowed and expands to 20’ x 20’ when deployed. Tricon containers are used for general storage and transportation of additional equipment, primarily power, and water management systems, including cabling, hoses and support equipment.

The Heavy Camps have the Load Demand Start Stop (LDSS) power management system, kitchen and laundry facility. The Heavy Camps support billeting and TOC/ Admin functions. The Lite Camps use various tent configurations such as the 307, HEX Dome, and Radome did not have kitchen or laundry facilities. The Lite Camps supported billeting, TOC/Admin, shower, and latrine functions.

Shelter support systems included the LDSS, Air-to-Water, Shower Water Reuse System (SWRS), Generator and Environmental Control Trailer (GET) and a 1.5 Ton Environmental Control Unit (ECU).

Table 2. Equipment Capabilities.

PRODUCT	CAPABILITY	CATEGORY	SPIRAL I
Scorpion Hunter	18kW of Power	Hybrid	
T-Series 910	4.8kW of Power	Hybrid	H-Series
SS400	4.2kW of Power	Hybrid	SS360
FORGE 440 & 510	2.4 kW of Power	Hybrid	Forge 400
1kW Flex Fuel	700 watts of Power	Hybrid	Qinetic JP-8
WASP	132 Watts Battery Power	Hybrid	SPACES
LDSS	Power Management	Heavy Camps	
Dining Facility	DFAC	Heavy Camps	
Hygiene Center	Hygiene & Laundry	Heavy Camps	
Kitchen	Prepare Meals	Heavy Camps	
Billets	Living Space	Heavy Camps	
TOC & ADMIN	Mission Command	Heavy Camps	
Air-to-Water	Potable Water	Heavy Camps	
SWRS	Recycle Gray Water	Heavy Camps	
GET Trailer	Power Supply	Lite Camps	
Radome	Mission Command	Lite Camps	
307 Billet	Living Space	Lite Camps	
Shower Facility	Living Space	Lite Camps	
HEX Dome 6	TOC	Lite Camps	
1.5 Ton ECU	Heating/Cooling	Lite Camps	

KEY	HEAVY HYBRIDS	MEDIUM HYBRIDS	SMALL HYBRIDS	Heavy CampS	LITE CAMPS

U.S. Army Rapid Equipping Force

3.0 Findings

& Recommendations

SPIRAL II EQUIPMENT ASSESSMENTS FINDINGS AND RECOMMENDATIONS

Findings: Large and Medium Hybrid Power Systems

Hybrid power systems (3kW to 30kW) were successfully operated in a wide variety of locations supporting multiple capabilities. Matching the large, and medium hybrid systems with the proper equipment improved operations. Hybrids were used to power surveillance, aerostats, aircraft landing, weather stations, ECPs, and TOCs. Hybrid power systems had more applications when integrated with a military TQG. The Scorpion Hunter, T-Series 910, SS400, and FORGE 440/550 augmented the TQG to provide power from solar energy resulting in reduced generator operation. While there were cases where TQGs did not turn on, a generator provided power in periods where there was little or no sun for extended periods of time. In summary, the benefits of large hybrid systems:

- Reduced generator run time resulting in less refueling,
- Increased system availability,
- Prevented power outages,
- Increased operational readiness,
- Reduced power interruptions,
- Reduced generator maintenance,
- Increased power surety,
- Provided continued operations when the prime power source failed,
- Prevented disruptions to operations, and
- Provided clean power waveforms for sensitive electronics.

Individual Systems

Scorpion Hunter – A Plug-and-Play configuration that supported larger power demands (TOC and Admin shelters) and was easy to set up. The system did require a forklift to move the two containers.

T-Series 910 – A trailer mounted solar, battery and TQG configuration that had increased mobility due to the trailer. This system was used to operate weather stations, ECPs, Containerized Weapon System (CWS) in Afghanistan, and used to power Lite Camps in Africa. Two vehicles are required to transport the entire system and could be improved if combined into one trailer.

SS400 – A smaller sized system that can be sling loaded and is scalable by adding additional solar panels or batteries. The SS400 was used in a wide range of systems (RAID, weather stations, TOC Un-interrupted Power Supply (UPS), REAP, TALS, and Lite Camps) in multiple theaters of operation. Minor modifications to the inverter are recommended to improve the design.

FORGE 440/510 – A man portable modular system that can fit a wide range of applications. It was configured with a 3kW TQG to power the CWS, TOC UPS, and Mortar Fire Control Systems (MFCS). Lithium batteries were used which reduce weight while improving energy density. The system was used to power kitchens, mortar fire control and dining areas in Afghanistan, as well as providing power to Lite Camps in USSOUTHCOM and USAFRICOM.

Findings: Small Power Systems

Smaller hybrid systems (3kW and below) such as the 1kW Flex Fuel and WASP supported troops during dismounted operations and warm basing. Warfighters used the WASP to charge tactical radios and personal electronic devices powered by batteries. The result reduced the need to carry replacement batteries of different sizes and types. The WASP has the added benefit to capture energy from diverse sources such as solar, vehicle and grid power. The 1kW Flex Fuel is a small man portable generator that provided reliable mission support to Special Operations Forces (SOF) troops in Africa. It was used to power the Global Rapid Response Intelligence Package (GRRIP), warm basing at Camp Clark and used to support the elections in Afghanistan. It can also be used indoors and operate on any combustible liquid or gas. In summary, the benefits of small hybrid systems:

- Increased system availability,
- Reduced the need to carry multiple spare batteries,
- Increased operational readiness,
- Provided portable power generation, and
- Increased mobility.

Individual Systems

Flex Fuel Generator – A portable multi-fueled generator that was small and light at 30 lbs without fuel. The system could be operated indoors and provided immediate functionality. It was very useful to operate on any fuel, but the ether required to start the system can be difficult to find and resupply.

WASP – A battery-charging system that can harvest power from multiple sources including solar, fuel cell, vehicle and grid power. The system was used widely in Afghanistan for individual Soldier power. One noted limitation was that it was unable to supply power to laptop computers due to the inverter's limitations. A pure sine wave inverter is required, and was procured by the OE Advisors/Trainers to enable use with laptops.

Recommendations: Hybrid Power System

Feedback from Warfighters on the systems was positive. Hybrid power systems provided measurable benefits such as reduced fuel and reduced generator maintenance. The requirements for logistics and maintenance personnel was reduced as a result. There were favorable impacts that cannot be quantified such as increased operational availability and clean power. Beyond the fuel savings and increase in combat power, units are seeing an expansion in operational capability in terms of providing spot power generation to Command, Control, Communications, Computers, Intelligence, Surveillance AND Reconnaissance (C4ISR), force protection, and Mission Command systems that can now be placed outside of an area where prime power is unavailable at the tactical edge. Addtionally these systems can be operated for longer periods of time without refueling.

Hybrid systems work best when matched to the correct system, but not all hybrid systems work well in all cases. Systems in the 10kW range and below are suited well for hybrid applications, due to better mobility. The larger the power demand, the more solar panels and/or batteries are required, which reduces mobility.

1. Improvements need to be made in solar panel collection to make them lighter and more efficient.
2. Batteries should be improved and better matched to improve energy storage and reduce weight.

3. Inverters should be improved to eliminate power loss when converting power from the generators and the batteries.
4. Systems need to be deployed in other climates, including cold weather locations like Alaska, to fully assess operational use.
5. Water systems should be included to determine the benefits of hybrid power on water systems, as well as the ability to reduce logistics for water replenishment.
6. Inverters/rectifiers should be improved to provide more flexible power conversion, including conversion from local power grids.

Findings: Shelter and Support Systems

Overall, all shelter systems were an improvement over the traditional canvas tent structures. For the Heavy Camps, the containerized solutions both improved and reduced mobility. While the inter-modular design made the E2S2 easy to move as a system, they were heavy and required material handling equipment (MHE) for movement. These camps work best at locations that are more enduring. The limitation on the RWS shelters was the need for MHE for loading and emplacement. An additional concern was that if sand and debris made it into the floor joints, they became difficult to collapse.

While the Heavy Camps showed promise with troops, additional analysis is ongoing. The Lite Camps were mobile and easy to erect. While the concept of reusing water has many benefits in reducing logistics, the SWRS did not operate well and required significant training. Many of the SWRS issues can be attributed to quality control problems and that the system was not operated as designed to support the recommended 600 personnel. The Air-to-Water system was not tested at a location where there was enough water to extract from the atmosphere. The GET was a good concept, but the ECU was oversized for use with Lite Camps. While the LDSS had several operational problems that were not fully resolved, the camp never lost power.

Individual Systems: Heavy Camps

LDSS – A power management system that used the military TQGs. The system automatically started and stopped generators based on power demand. While the system did reduce fuel use, there were several operational issues due to Electro Magnetic Interference (EMI) which resulted in communication problems in the

controller that must be resolved by the system developer. Additionally, the system had a large footprint and had to be moved by flatbed trucks.

Shelter – Dining Facility – A containerized shelter to accommodate tables and chairs for up to 40 personnel that connected to the kitchen shelter. The shelter was set up in 30 minutes with the table and chairs taking an additional 45 minutes.

Shelter – Hygiene Facility - A containerized shelter equipped with latrines, showers, and laundry. For storage and transport, panels were stored inside the E2S2 shelters. This system could be used in conjunction with the SWRS.

Shelter – Kitchen – A containerized shelter with cooking, cleaning and serving equipment to support a company, which could connect to the dining facility. The configuration could be setup and ready to cook in 90 minutes.

Shelter - Billets - A shelter that can hold 16 beds, completely stored and stowed in the E2S2 configuration. Power outlets are included with no need to run additional wiring.

Shelter – CP/ ADMN - A shelter that can serve as a Command Post (CP) or other function, and could be set up in 30 minutes.

Air-to-Water – A system that harvests water from the humidity in the air and is advertised to produce 120 gallons of clean drinking water per day. However, the system was demonstrated at NIE in Texas where humidity was less than the 25% required. Recommend this system be used in a different environment to fully access operational capability.

SWRS – A self-contained water treatment system to treat and reuse gray water from showers and laundry. The system had multiple problems due to manufacturing and quality control issues, as well as not having enough users to fully exploit the system. Because of this lack of use, it would have to be restarted repeatedly, which required 45 minutes to be operational. Recommend this system be given additional testing at the 600 personnel level for further assessment.

Lite Camps

GET – A 35kW generator and eight Tons (four Tons per shelter) ECU mounted on a HMMWV capable trailer. The configuration was designed to support two 307 shelters and was deployed to USAFRICOM and USSOUTHCOM for use with the

Lite Camps. The system was oversized for two tents, yet did not have other distribution outlets to heat/cool additional tents.

Shelter - Radome - A soft shell dome tent that is supported by inflated air beams. The system was deployed to USAFRICOM and USSOUTHCOM. The shelter is lightweight and is easily set up. The intent of the Radome was to house radar or Satellite Communication (SATCOM) equipment. It could be used for personnel if a radiant barrier and HVAC are added.

Shelter – 307 Billet Tent – A soft shell modular tent that can house 12-16 personnel. A radiant barrier was included to help improve HVAC efficiency. A minimum of eight persons could erect the structure in 30-45 minutes. A limitation was that there was only a single breaker box to support the entire tent.

Shower Facility - An airbeam shelter was used to house the shower and hygiene components of the Lite Camp. The design included four showers, hot water heater, sump pump, three sinks, plumbing and gray and white water storage to support 45-50 personnel. Construction of this shelter was much more time consuming than the other Lite Camp structures (307, HEX Dome, and Radome).

HEX Dome – A soft shell dome used as a Command Post (CP) for up to 10 personnel. The system is very compact and easily transported by HMMWV. While the system can be erected in 60 minutes with six personnel, tear down requires multiple iterations taking between four to six hours each.

1.5 Ton ECU – A single-phased highly-efficient heat pump designed for smaller applications and used to replace the eight Ton ECUs. The smaller design with a handle cart could be moved by one Soldier, including the duct work, which was limited in use because it was only four feet and could not be reached in some areas.

Recommendations: Shelter and Support Systems

While the Heavy Camps showed promise, they require MHE and would work better for enduring locations. The Lite Camps consisted of several different tents, creating increased logistic support. The Lite Camp structures should be reviewed and streamlined into one or two structures. The SWRS needs to be used at a larger facility to determine the full capability. The Air-to-Water systems must be tested in an environment with at least 25% humidity to fully determine the system capability. Recommend additional testing for the LDSS to resolve communication and EMI issues.

U.S. Army Rapid Equipping Force

4.0 Conclusion

SPIRAL II EQUIPMENT ASSESSMENTS CONCLUSIONS

The REF E2E Report provided innovative solutions to reduce fuel demand by implementing hybrid, systems and using energy-efficient shelters and systems. The REF has the greatest impact on the Warfighter and the Army's needs when it partners with others to solve problems facing our military personnel. For several years the REF OE Advisors/Trainers have been working with units using RAID towers to reduce the logistics burden of fuel and increase the RAID systems' effectiveness and reliability. This work on a hybrid power solution for the RAID tower system was done in close collaboration with PM Electronic Optics/Infrared Payloads & Force Protection (EO/IR Payloads & FP). The RAID tower has become an increasingly important tool in providing security to deployed units. The visibility that it provides is making units safer and delivering security not possible thru other means.

In order to maximize the effectiveness of these RAID systems, units are positioning them on high ground outside of protected areas. Refueling and maintaining these remote systems requires forces to travel outside the wire on dangerous unimproved roads. As stated in Afghanistan by unit leadership, "the placement of these valuable ISR assets in remote locations would not be possible without the hybrid power solutions being provided by the REF."

"This power provided by the REF will solve a near impossible and costly power production situation for 3 weather stations for Joint Forces aircraft flying into [the airfield]... The system will also provide redundancy for this mission critical weather system that would have been unavailable before."

- 455 AEW Executive Officer

REF operational energy efforts have demonstrated the effectiveness of hybrid power at the Edge and Soldier feedback has helped inform the defense community of the suitability and value of these hybrid power systems. PM EO/IR Payloads & FP is currently reconfiguring the RAID tower for Armywide reset and it will be referred to as the Persistent Surveillance System-Ground (PSS-G). Based upon the extensive work and convincing results of the REF operational energy efforts, PM EO/IR Payloads & FP has decided to field the reset PSS-G with a complete hybrid energy system. This is one example of the REF working directly with Army Project and Product Managers to analyze their modernization and improvement requirements with the effect of incorporating energy operations. Another example under

consideration is the U.S. Army Unmanned Aircraft Systems Project Office reviewing results of the hybrid energy solution provided by the REF operational energy effort to power the TALS in very remote or inaccessible areas of Afghanistan and Iraq.

The efforts in energy-efficient shelters and systems found that modular basing systems such as the Heavy Camps and Lite Camps improved Soldiers' well-being by providing the comforts of garrison in a deployed environment. While the Heavy Camp configuration required MHE equipment, they provide options for enduring basing. The Lite Camps are more mobile and are in use by units in Africa and Central America.

OE Advisors/Trainers play a critical role in both assessing sites for possible hybrid systems, as well as installing and training the equipment. In cases where equipment was used by Soldiers that were not trained (due to the misalignment of the trained unit and deployed units equipment schedules) there were multiple issues with the use and acceptance of the equipment. OE Advisors/Trainers found that adding training significantly improved integration success. Training on power and energy concepts created an informed energy culture change within the Army.

Energy security will remain a priority throughout the Army and the entire Department of Defense, regardless of location, enemy, or operations. Documenting the findings from the OE Advisors/Trainers was critical to provide a body of information that can be used in developing requirements for future energy efficient systems, improving Warfighter doctrine and training, and planning combat operations. As technology improves and hybrid systems become more efficient and lighter, their use will increase across the military.

Data analysis of the equipment is ongoing and will be provided in a future report. The load demand and power is currently being recorded on the hybrid systems that are in theater. In reviewing the data, the OE Advisors/Trainers found a discrepancy in system performance. Working with the OE Advisors/Trainers, it was determined the solar panels were severely degraded, and had to work with vendors to replace the defective panels. Further analysis will be provided in a future report.

5.0 Appendixes

SCORPION HUNTER ENERGY SYSTEM

Background

The Milspray Scorpion Energy Hunter is a deployable hybrid energy system with an Intelligent Power Center, capable of harvesting solar power. The Scorpion Hunter system is flexible and adaptable; effectively harvesting solar power at any site. It has two Quadcons (4' x 8') and is modular and scalable to meet a variety of requirements. The system has been used in support of NIE at Ft. Bliss, and AEWE at Ft. Benning. The system consists of Photovoltaics (PV), energy storage, and is connected to a 30kW Tactical Quiet Generator (TQG).

- **Power -** Provides 18kW of power using military 3-Phase 208v at 60 Hz. The system has one 2500W PV array per container (5,000W total).
- **Packaging** - (2) Quadcon containers and a 30kW TQG modified with an auto-start kit.
- **Energy Storage** - (48) lead acid batteries (12 VDC @183Ah), provides 105kWh of battery storage.

Capability Deployment

AOR LOCATION	APPLICATIONS	SUPPORTED CAPABILITIES
NIE Ft. Bliss, TX	1	Powering TOC and ADMIN shelter
AEWE Ft. Benning, GA	1	Powering TOC and ADMIN shelter

Demonstrated Capabilities

System positioning flexibility.

Powering TOC and ADMIN shelter.

Providing power for classroom training.

Equipment Assessments

a. Benefits:

- The Scorpion Hunter system provides 18kW of military 3-Phase 120/208v power and is the largest hybrid energy system in the E2E inventory (Generator, PV and energy storage).
- Very small footprint for the amount of power the system will generate. Provides 105kWh of energy storage.
- A plug-and-play system that is easy to setup, install and maintain.
- Ability to tie directly into the terminal lugs to meet multiple power needs.

b. Constraints/Limitations:

- The pigtail that connects the generator to the system is too short, limiting flexibility for setup.
- System requires a 10k fork lift to move the (2) ISO containers and the 30kW TQG.
- The system requires secondary distribution to effectively distribute and maximize power output.
- There is not a NATO slave connector included with the system.

c. Safety Issues:

- Several pinch points on the framework for the solar arrays.

d. System Recommendations:

- Longer pigtail to connect the TQG to the system.
- Should have two ladders with the system for setup.
- Provide secondary distribution, to include cabling.
- Install NATO slave connection to the system.

e. Recommendations for other applications:

- Use at ECP locations.
- Power multiple mission command and ISR platforms.

HYBRID ENERGY SYSTEM (T-SERIES 910)

Background

The Zerobase T-Series Hybrid Energy System is a trailer-mounted system of solar panels, lead acid batteries and a military tactical quiet generator (TQG). The system can be configured with a 5kW or 10kW TQG, depending on the requirements. The T-Series is a mobile system that can be used to power various military applications and platforms. The T-Series is an upgrade over the H-Series that was part of Spiral I. The product improvement focused on the following areas:

- **Power -** Output is single phase 120v or split-phase 240v.
- **Power & Energy** - System provides 4.8kW and system could be congifured to provide 3-Phase 120/208v.
- **Packaging -** Adding two trailers (either 5kW or 10kW gen mounted on a trailer) and the T-Series trailer.

Capability Deployment

AOR LOCATION	APPLICATIONS	SUPPORTED CAPABILITIES
USAFRICOM	6	Lite Camp
USCENTCOM	6	Weather Station & ECP
USSOUTHCOM	4	Lite Camp

Demonstrated Capabilities

Training USAF personnel at North Weather.

T-Series powering the CWS.

Equipment Assessment

a. Benefits:

- There is a built in data collection package that can measure Solar—AC output/AC input.
- The system is very mobile.
- There are two power configurations - single-phase 120v and split phase 240v.
- The system can be quickly installed and setup and uses a fairly small footprint.

b. Constraints/Limitations:

- Based on data analysis in September 2014, the OE Advisors/Trainers discovered that some of solar panels were not supplying power. The OE Advisors/Trainers worked with the vendors to provide new panels.
- The cables are too short (solar leashes, AC input & auto start) and both the cables and connectors are not durable enough.
- The doors on T-trailer open down and do not shield water, causeing water to get into the compartments.
- The solar panel cases warp in the weather and the handles are not durable. There is also no way to tie down the panels once installed on the ground.
- While the system is mobile, two vehicles are needed to transport the entire system.
- Connectors on the solar panels stick up and are vulnerable to breakage.
- The main breaker is a 3-pole 20 amp breaker that should be upgraded.
- The hitch/tongue/stand (front leg with wheel and crank) is not nearly durable enough.

c. Safety Issues:

- None observed.

d. Recommendations:

- More durable and longer cables (leashes, AC input, and auto-start).
- More durable connectors (metal not plastic).
- Re-design storage compartment to prevent water damage.
- The solar panel cases would benefit from a better design and composition, as well as determining a method to secure cases to the ground (employment).
- Right-size the main breaker to meet rated output specifications.
- Combine into one trailer if possible.

e. Recommendations for other applications:

- The system can be used for UPS applications and could power ECP (10kW) and TOC.

3KW HYBRID ENERGY SYSTEM (SOLAR STIK 400)

Background

The Solar Stik 400 (SS400) 3kW Hybrid Energy System is a system that evolved from the Solar Stik 360 (SS360) assessed in Spiral I. It consists of solar panels, batteries and a 3kW Tactical Quiet Generator (TQG). The SS400 3kW Hybrid Energy System is concurrently deployed in Afghanistan, Honduras, Hawaii, Niger, and Mauritania. In support of military operations, feedback from OE Advisors/Trainers and end users of the SS360, lead to the development of the SS400 3kW Hybrid Energy System for E2E Spiral II. A Breeze Kit was added in one application to collect wind power. The product improvement focused on the following areas:

- **Power & Energy** - A larger inverter enabled a greater power and energy output from 1.8kW to 4kW continuous. A "Y" cable was added to increase combined power output from the battery bank from 2.4kW to 4.8kW. PV output was increased within the same footprint from 360W to 400W per mast.
- **Packaging** - PV panel width reduced for easier emplacement.
- **Generator Battery Charging** - A NATO slave cable was added to connect to the battery bank, keeping the generator battery charged, and increased overall capability.

Capability Deployment

AOR LOCATION	APPLICATIONS	SUPPORTED CAPABILITIES
USCENTCOM	12	RAID Tower, Weather Station, TOC UPS, REAP, TALS
USPACOM	1	Company Level Water Purification
USAFRICOM	11	Power Surety for NetZero Camp (Lite Camps) TS & HOA
USSOUTHCOM	3	Power Surety for NetZero Camp (Lite Camps)

Demonstrated Capabilities

SHIPKA installation with Breeze Kits to capture wind power.

Powering RAID Tower at Morehead South.

Powering REAP aerostat system.

Equipment Assessments

a. Benefits:

- Shipping configuration is significantly smaller compared to the SS360. This allows for more efficient inter-theater movement. The smaller shipping configuration for intra-theater movements is critical when using sling-loaded and/or fixed-wing delivery.
- Peak power capability of 5kW allows greater flexibility in equipment applications.
- NATO slave cable - keeps the generator battery powered and can be utilized as another means to provide output power (increased capability and flexibility).
- Scalable – the system can easily be augmented with additional batteries and/or solar panels to increase capability.
- Batteries – Lead acid or lithium variations based on requirements.
- Ability to sling load the system.

b. Constraints/Limitations of the SS400:

- Based on data analysis in September 2014, the OE Advisors/Trainers discovered that some of the solar panels were not supplying power. The OE Advisors/Trainers worked with the vendors to provide new panels.
- The inverter has stopped inverting due to power surges from generator.
- The inverter light is on when it is inverting power, however when the system goes to sleep to reduce the parasitic load, the inverter is still operating. When this happens, the inverter light turns off, causing Soldiers to think the system is not working properly. The system needs to stay awake at all times.
- The Proverter has two duplex GFCI outlets. The GFCI outlets continually trip whenever the plugs are used. The outlets aren't used and require the cover to be open, making the system susceptible to weather damage.
- The data collection package requires a dedicated LAN line, which isn't supported in most, if not all tactical environments.

- The rubber mallet that is included as part of the system, will not drive stakes to secure the masts into ground. The system needs a real hammer.

c. Constraints/Limitations of the 3kW TQG:

- The relay in the TQG generator fails and the generator will not charge automatically. Every 3kW TQG generator fielded in Afghanistan has had the relay replaced at least once. (PM MEP is aware of this issue).
- The generator door switch fails and generator will not start automatically. This is due to vibration of the generator over time, which flexes the metal supporting the switch.
- The E-Stop on the generator doesn't work. The wiring harness for auto-start is bypassing the E-Stop.
- Male ends get damaged and bent easily. Plug is a lock type, but vibrates out. Hard wiring straight into the generator has shown to reduce further damage.

d. Safety Issues:

- None observed.

e. System Recommendations:

- Install a ground lug on P.R.O. Verter™ for installation without a generator.
- Add Hubbell type male & female connectors for increased capability and to support varying applications.
- The current NATO cable is 5' long, however at a minimum it should be at least 15' long to allow more flexibility of system emplacement.
- Add Breeze Kits where wind power is available.

f. Recommendations for other applications:

- The system has worked well with multiple applications and has been integrated with Mission Command, ISR, and FP platforms.
- Assess data to determine viability of wind power.

FORWARD OPERATING RENEWABLE GENERATOR MODEL 440/510 (FORGE 440/510)

Background

The ZeroBase Forward Operating Renewable Generator (FORGE) solar power system is a man portable modular system that is expandable in output, generation and storage to fit a range of application requirements. The 440 is a single-phase 120v power and the 510 is a split-phase 240v.

- **Power** - 1,800W at 150v of Solar Intake providing 120 VAC/60 Hz, 20 amp/2,400W of power to the load. Additional generators can be added to provide power adjustable between 800W, 1500W, and 3000W. Simple plug ports allows user to select between the plug port (1) 120 VAC 20 amp, (1) 120/240 VAC 50 amp.
- **Packaging -** (3) each (AC module, DC module, and battery module). All-Weather Pelican case type boxes and six each portable solar panels.
- **System -** Can be configured with a 3kW TQG.
- **Generator Battery Charging** - Lithium-ion Ferrous Phosphate (LFP), (2) 3.9kWh, 3000 Cycles or 10 Years at 90% DoD, 208 lbs/94.3 kg.

Capability Deployment

AOR LOCATION	APPLICATIONS	SUPPORTED CAPABILITIES
USAFRICOM	6	Lite Camp
USCENTCOM	10*	Mobile Kitchen, Dining Building, Mortar Fire Control
USSOUTHCOM	4	Power Surety for NetZero Camp (Lite Camps)

* six awaiting installation

Demonstrated Capabilities

System portability & flexibility.

Powering MKT and dining building.

U.S.N. SeaBees Training with the FORGE.

Equipment Assessments

a. Benefits:

- The FORGE hybrid power systems utilize LFP batteries, which gives the system significantly increased energy density for its size and weight, compared to lead acid batteries.
- FORGE can be paired for use with generators with a rated power of 1-3kW providing flexibility in application.
- This hybrid system has a very small footprint that makes it easy for the Warfighter to transport and emplace.

b. Constraints/Limitations:

- There is no way to secure the solar panels to the ground aside from weighing the travel case down with rocks or sand bags.
- FORGE has shown issues operating at temperature above 110°F. Need to ensure filters for the fans are cleaned and cleared of dust before resetting the system.
- Solar panels become less efficient at high temperatures, losing as much as 11% at 120°F temperature.
- AC power distribution becomes less efficient at high temperatures, losing as much as 10% at maximum temperature.

c. Safety Issues:

- Refer to the National Fire Protection Act's Web site at http://www.nfpa.org for more information on lithium batteries.

d. System Recommendations:

- Lower the temperature setting for the cooling fan when inverting power.
- Use a main breaker with a higher threshold to enable 2.4kW peak output in order to prevent power tripping.
- Include energy storage case for applications where greater storage is required.

e. Recommendations for other applications:

- Other off-grid spot power ISR platforms (like the REAP or force protection camera systems) would benefit from the FORGE 440/510.
- This system could be used as UPS, functioning as a flyaway hybrid system for critical mission command systems supporting a unit that may need to jump to other locations as mission dictates.
- Integration with lethal force protection systems like the Containerized Weapon System (CWS) would also be applicable.

1KW FLEX FUEL GENERATOR

Background

The IntelliGen Flex Fuel Generator is a multi-fuel generator used for military and off-grid applications. The generator provides tactical Soldier power for Squad/ Platoon level missions to support military forward operating bases (FOB), combat outposts (COP), observation posts (OP), and expeditionary missions such as mounted, dismounted and/or cold/warm basing. It uses liquid and compressed fuels. The generator uses diesel, gasoline, propane, methanol and isopropanol. The generator weighs about 35 lbs fueled, making it easy to transport. The unit provides 1000W peak and roughly 700W nominal power. It can operate in very harsh climates from between -20°C to 60°C. This generator evolved from a Spiral I 1kW generator, which could only operate on clean JP 8.

Capability Deployment

LOCATION	APPLICATIONS	SUPPORTED CAPABILITIES
USAFRICOM	57	Mission Support & SOF Capability Set
USCENTCOM	10	Mission Support, GRRIP & Warm Basing
USPACOM	1	Mission Support
USSOUTHCOM	3	Power Surety for NetZero Camp (Lite Camps)

Demonstrated Capabilities

Integrating the INI with the GRRIP.

Soldiers at a JCOP receiving training.

Equipment Assessments

a. Benefits:

- The Flex Fuel Generator is small and light weight (30 lbs. dry) and is one person portable.
- Utilizes multiple fuel sources, to include diesel variants. Will burn any combustible liquid or gas.
- The system features a low noise signature.
- Can be operated both outdoors and indoors using a ventilation hose.
- The Flex Fuel has immediate functionality upon startup and comes packed in a Pelican case with service parts, tools and oil.
- Ability to function in extremely hot and cold climates.
- Capable of providing AC and DC power.
- Unit comes with a carbon monoxide detector.
- Ability to integrate with current inventory of hybrid energy systems.

b. Constraints/Limitations:

- Challenging to add oil and is easy to overfill.
- The pull cord breaks easily and must be sent back to manufacturer to repair/replace.
- Ether is required to start the system. It is difficult to resupply. The ether hose connected to spray has a tendency to bind, and the nozzle assembly breaks easily.
- The spark plugs foul easily.

c. Safety Issues:

- None observed.

d. System Recommendations:

- A funnel should be included to make it easier to add oil.
- Overcome the need for ether or develop a more robust starting system.
- Add more consumables to the kit.

e. Recommendations for other applications:

- The small design makes this system ideal for mounted and dismounted patrols.
- The 82nd Airborne used the system for cold/warm basing and is applicable to air assault power.

WEARABLE ADVANCED SOLDIER POWER (WASP) X-90

Background

The ApECOR WASP X-90 is a Soldier Power solution that evolved from SPACES assessed in Spiral I. The WASP was designed to decrease battery-charging times and comes with wearable components for on-the-move operations. It is a Soldier Power hybrid system used to power tactical communications and recharge batteries. It consists of flexible solar panels (2) 80W, a variety of cables for charging different sources, and a capacitor designed with specific algorithms to charge a variety of battery types. In a networked application, it eliminates the need for the Warfighter to carry spare batteries and multiple battery types. All of the battery-operated devices on the Soldier are consolidated onto one network supported by a single "primary" DD2590 battery (provided). The WASP X-90 is currently deployed to Afghanistan and has been notably demonstrated with the Global Rapid Response Intelligence Package (GRRIP).

Capability Deployment

LOCATION	APPLICATIONS	SUPPORTED CAPABILITIES
USCENTCOM	79/32*	Battery Charging/ Radio power platform

*79 total in theater, 32 in storage.

Demonstrated Capabilities

WASP Flexible Solar Panels.

Packed for quick access.

Equipment Assessments

a. Benefits:

- The WASP allows the Warfighter to consolidate multiple electrical devices into one closed-loop circuit, eliminating the need to carry multiple battery types and spares reducing individual Soldier load.
- Units can use the WASP as a power platform for other types of communication devices directly if the right connector is available.
- The WASP allows for opportunity charging, which is the ability to harvest energy from other available sources. Warfighters can charge the WASP from sources as diverse as solar, fuel cell, vehicular, or even grid power making this a flexible option during extended operations.

b. Constraints/Limitations:

- The system does not have 12v to 120v inverter. This limits the WASPs ability to provide AC power to laptop computers.

c. Safety Issues:

- None observed.

d. System Recommendations:

- Add a small 12v - 120v pure sine wave inverter that can be used to plug in laptop computer.
- The system can also be used to provide power to the Harris radio thru a 2590v battery. While this is quite useful, units have requested the ability to actually charge the Harris radio batteries. A Harris battery stinger would be a beneficial addition.

LOAD DEMAND START STOP (LDSS) SYSTEM

Background

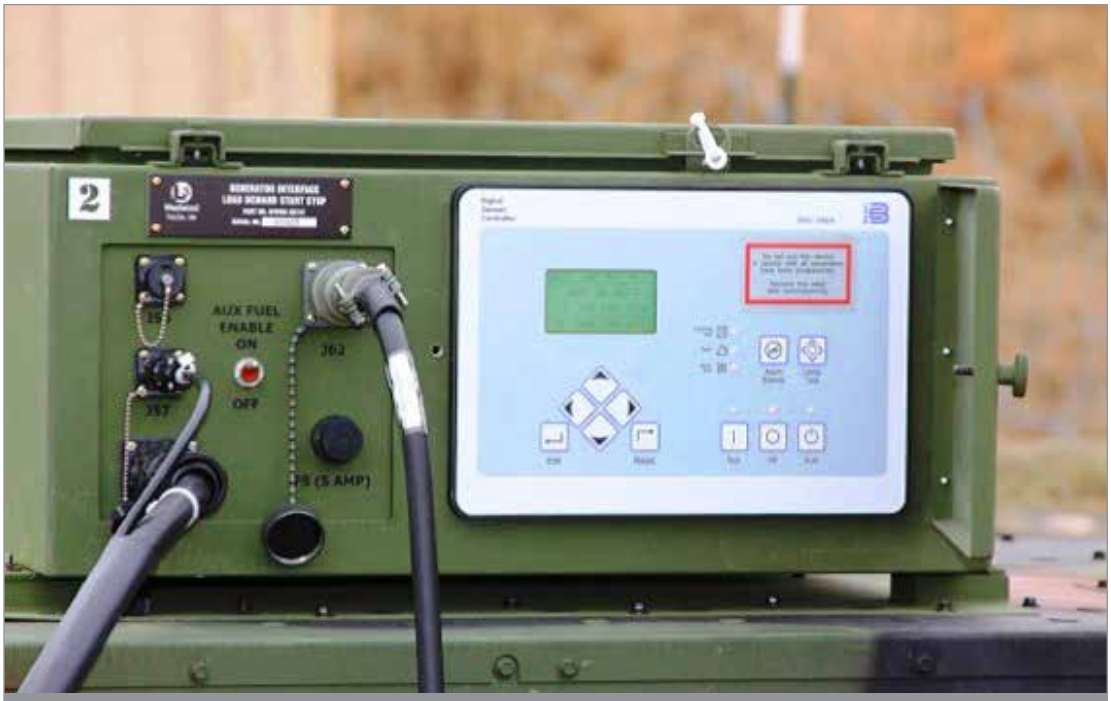
The Load Demand Start Stop (LDSS) System is L-3 Westwood's next-generation approach to power grid modernization and was designed to work in conjunction with 30kW and 60kW, B Model, and Tactical Quiet Generator (TQG) sets. The LDSS System can be utilized with as few as two TQG's or up to six TQG's (30kW, 60kW, or a combination of sizes) and can be adapted to work with other types of generator sets. The LDSS System adds power demand and load control in a grid configuration. Power applications range from 60kW to 180kW. The system was arranged as 90kW and 150kW configurations for the 50-man and 100-man Rigid Wall Camps (RWCs) respectively. Each system comes with a spare 30kW TQG for back-up. The 90kW configuration has four paralleled 30kW TQGs, four Eaton distribution modules, four L-3 Grid Personnel Protection Devices (GPPD) and four L-3 mounted start stop communication boxes. The 150kW configuration has six paralleled 30kW TQGs, six Eaton distribution modules, six L-3 GPPD, and six L-3 mounted start stop communication boxes.

Capability Deployment

AOR LOCATION	APPLICATIONS	SUPPORTED CAPABILITIES
NIE, Ft. Bliss, TX	1	150kW Configuration to power the ExCamp
AEWE, Ft. Benning, GA	1	150kW Configuration to power the ExCamp
7th TBX, Ft. Eustis, VA	1	90kW configuration to power Lite Camp (equipped)

Demonstrated Capabilities

LDSS configuration.



LDSS control panel.

LDSS providing power to the ExCamp at NIE.

Equipment Assessments

a. Benefits:

- The LDSS is a field-installable power grid management system designed to interface with the Army's MEP-805B and MEP-806B TQG in order to reduce fuel demand to variable loads.
- The system automatically starts and stops TQG's based on load requirements, and the system continuously monitors battery bank voltage.
- The LDSS system allows as few as two and up to six of the generator sets to operate on a common communication BUS.
- Following startup and initial loading of the first TQG, the remaining generator sets are started and stopped automatically by the LDSS system, based on overall system load.
- As the load increases, additional generators start automatically and synchronize to the BUS in order to meet the increased load demand.
- The power load is automatically shared equally between online generator sets. As load decreases, generator sets are automatically removed from the BUS, cooled down, then shut down and returned to standby mode.
- The LDSS provides load management for the existing military inventory of TQGs, with very little modification to the TQG (adding an auto-start capability) and controller boxes.
- System can utilize an external fuel source, ensuring that individual generators don't need to be fueled during operation.

b. Constraints/Limitations:

- The system requires a 10K forklift to move the six 30kW TQG's.
- The system needs to be moved by flatbed trucks.
- Space considerations need to be taken into account; the fuel bag as well as the footprint of the grid itself.
- An EMI issue in the distribution box is causing communication issues between start/stop controllers on separate generators.

c. Safety Issues:

- None observed.

d. System Recommendations:

- Recommend LDSS be used to power the RWC to achieve energy efficiency.
- More testing to verify communication issues are resolved.

e. Recommendations for other applications:

- LDSS can be used at any site where there are multiple TQGs, located within close proximity of each other, to reduce fuel demand.

HEAVY CAMP SHELTER – DINING FACILITY

Background

The Spacemax Heavy Camp dining facility shelter evolved from the version 2 shelters assessed in Spiral I equipped for NIE and AEWE. This shelter can facilitate the feeding of a company plus and contains a vestibule to connect with the kitchen shelter so Soldiers remain indoors. For storage and transport, the shelters contain most of their components inside the stowed E2S2 shelters. The E2S2 shelter is 20' x 8' when stowed, and expands to 20' x 20' when deployed. The internal components include fold-out tables and chairs to accommodate approximately 40 individuals. All components are stored in the shelter for transport.

Capability Deployment

AOR LOCATION	APPLICATIONS	SUPPORTED CAPABILITIES
NIE Ft. Bliss, TX	1	ExCamp (Spiral I)
AEWE Ft. Benning, GA	1	ExCamp (Spiral I)
USAFRICOM	2	Proposed: ExCamp (Spiral II)

Demonstrated Capabilities

Kitchen and dining shelter at NIE.

Standard MILSPEC electrical hookup.

Equipment Assessments

a. Benefits:

- When not used to feed Soldiers, units have utilized this shelter for Morale, Welfare and Recreation (MWR) purposes.
- One shelter can be setup with four trained individuals in 30 minutes. Setting up tables and chairs takes an additional 45 minutes.
- The shelter has been upgraded from single-phase power to 3-Phase for better efficiency.
- The ECU mounts are built into this version versus the previous version where the mount had to be added after the shelter was setup.
- Connecting walls and the ceilings in place were improved from version 2 in Spiral I. Version 3 uses more robust latches to secure them.
- The addition of air-compressed cylinders used to support the walls reduced the weight required for raising and lowering. This also helps guide the latches in place better for a more secure/locked position, eliminating the requirement to have a raising pole as part of the setup tool kit.

b. Constraints/Limitations:

- Shelters require MHE for off-loading, emplacement, and loading, which if unavailable limits applicability.
- When shelters get sand or debris in the floor joints the walls become more difficult to collapse.
- A relatively level surface free from standing water is required.

c. Safety Issues:

- Pinch points are a concern when setting up.
- Shelters must be spaced properly so that the emplacement will not hinder the erection of the shelters.
- Shelters must be grounded, as this provides a path for electrical current, thus reducing the risk of electrical shock.

d. System Recommendations:

- A drain hole needs to be added to allow for water to drain when cleaning the floors.
- The Air Conditioners should be 3 phase instead of the current single phase.
- More durable handles should be added.

e. Recommendations for other applications:

- This shelter is essentially identical to the billets without beds. It can be configured as billets, CP/Admin, and aid station if properly equipped.
- This shelter and other Heavy Camp shelters should be assessed in an operational environment.
- The kitchen shelter could be used to support Defense Support of Civil Authority (DSCA) or Humanitarian Assistance and Disaster Relief (HA/DR) missions.

HEAVY CAMP SHELTER – HYGIENE FACILITY

Background

The Spacemax Heavy Camp hygiene facility shelter evolved from the version 2 shelters assessed in Spiral I equipped for NIE and AEWE. This shelter comes equipped with latrines, showers, and laundry machines. Additionally, it has bulk water for potable, gray, and black water storage. It can be used in conjunction with the Shower Water Reuse System (SWRS) to process gray and black water. For storage and transport, the shelters contain most of its components inside the stowed E2S2 shelters. The E2S2 shelter is 20' x 8' when stowed, and expands to 20' x 20' when deployed.

Capability Deployment

AOR LOCATION	APPLICATIONS	SUPPORTED CAPABILITIES
NIE Ft. Bliss, TX	1	ExCamp (Spiral I)
AEWE Ft. Benning, GA	1	ExCamp (Spiral I)
USAFRICOM	2	Proposed: ExCamp (Spiral II)

Demonstrated Capabilities

Standard MILSPEC electrical hookup for Hygiene Center.

Hygiene Center.

Hygiene Center pump system.

Equipment Assessments

a. Benefits:

- The hygiene center includes the following features and equipment: (5) shower stalls, (5) toilet stalls, (2) waterless urinals, (3) sink stands with (2) sinks each, and hot and cold water.
- (6) front-loading combination clothes washer/dryer units, (2) jet air hand dryers.
- For version 3 the washer and dryers were upgraded to energy-efficient models to reduce load demand. Also, the wash and dry time was reduced from six hours per load to less than two hours.
- Additionally, a higher efficiency flusher was added to the toilets to reduce water demand.
- The ECU mounts are built into this version versus the previous version where the mount had to be added after the shelter was setup.
- Wall and ceiling connections were improved from version 2 in Spiral I. version 3 uses more robust latches to secure them.

- The addition of air-compressed cylinders used to support the walls reduced the weight required for raising and lowering, which helped guide the latches in place for a more secure/locked position. This eliminated the requirement to have a raising pole as part of the setup tool kit.

b. Constraints/Limitations:

- Shelters require MHE for off loading, emplacement, and loading, which if unavailable limits applicability.
- When shelters get sand or debris in the floor joints the walls become more difficult to collapse.
- A relatively level surface free from standing water is required.

c. Safety Issues:

- Pinch points are a concern when setting up.
- Shelters must be spaced properly so that the emplacement will not hinder the erection of the shelters.
- Shelters must be grounded, as this provides a path for electrical current, thus reducing the risk of electrical shock.

d. System Recommendations:

- The Air Conditioners should be 3-Phase instead of single-phase.
- The washer and dryer needs to be more efficient (faster).
- Drain hole needed for elimination of standing water.
- An extra water valve or water source would be helpful in cleaning floors.

e. Recommendations for other applications:

- This shelter and other Heavy Camp shelters should be assessed in an operational environment.
- The kitchen shelter could be used to support Defense Support of Civil Authority (DSCA) or Humanitarian Assistance and Disaster Relief (HA/DR) missions.

HEAVY CAMP SHELTER - KITCHEN

Background

The Spacemax Heavy Camp kitchen shelter evolved from the version 2 shelters assessed in Spiral I equipped for NIE and AEWE. The kitchen comes organic with enough cooking, cleaning, and serving equipment to support a company plus size element, and is used in conjunction with the dining facility shelter, which is part of the Heavy Camp. For storage and transport, the shelters contain most of its components inside the stowed E2S2 shelters. The E2S2 shelter is 20' by 8' when stowed, and expands to 20 by 20 feet when deployed.

Capability Deployment

AOR LOCATION	APPLICATIONS	SUPPORTED CAPABILITIES
NIE Ft. Bliss, TX	1	ExCamp (Spiral I)
AEWE Ft. Benning, GA	1	ExCamp (Spiral I)
USAFRICOM	2	Proposed: ExCamp (Spiral II)

Demonstrated Capabilities

Soldiers prepare meals in a Heavy Camp shelter kitchen.

Standard MILSPEC connections for the power to the shelter from the LDSS.

Equipment Assessments

a. Benefits:

- The kitchen and dining shelters are expanded and setup in the same manner as the billeting shelters.
- This shelter can be setup with six trained individuals in 30 minutes. Setting up the cooking, serving, and cleaning components can take an additional 60 minutes.
- Internal components of the kitchen can support up to a company plus sized element and consists of: (1) griddle, (1) hand wash sink (1) ice machine, four insulated food warmers, (1) 10-quart tilt kettle, (4) insulated beverage dispensers, (1) convection oven, (3) serving tables, (1) cook-and-hold oven, (1) weapons rack (capacity: (6) rifles), (1) steam-and-hold oven, (2) banquet tables, (1) 20-cubic foot refrigerator, (4) benches, and (1) 3-well sanitation sinks.
- Addition of the griddle in the Spiral II kitchen increases types and quality of meals served.
- Cold food storage was increased from the kitchen equipped in Spiral I.
- Cam locks designed to secure the walls and ceilings were improved in the Spiral II kitchen.

b. Constraints/Limitations:

- Shelters require MHE for off-loading, emplacement, and loading, which if unavailable limits applicability.

- When shelters get sand or debris in the floor joints the walls become more difficult to collapse.
- A relatively level surface free from standing water is required. Some shelters experienced mold growth following excessive rain during evaluations at Fort Bliss, TX.
- The kitchen shelter is designed with drain holes to address standing water from cleaning and spillages, however there are too few.

c. Safety Issues:

- Pinch points are a concern when setting up.
- Shelters must be spaced properly so that emplacement will not hinder the erection of the shelters.
- Shelters must be grounded, as this provides a path for electrical current, thus reducing the risk of electrical shock.

d. System Recommendations:

- Air Conditioning needs to be 3-Phase instead of single-phase.
- Door handles need to be ruggedized.
- The refrigerator should be larger to accommodate more storage.
- Better storage of cooking utensils is needed – the current drawer breaks.
- Add a more extensive First Aid kit.
- An extra water source would be beneficial in cleaning and adding water.

e. Recommendations for other applications:

- This shelter and other Heavy Camp shelters should be assessed in an operational environment.
- The kitchen shelter could be used to support Defense Support of Civil Authority (DSCA) or Humanitarian Assistance and Disaster Relief (HA/DR) missions.

HEAVY CAMP SHELTER - BILLETS

Background

The Spacemax Heavy Camp Billet shelter evolved from the version 2 shelters assessed in Spiral I equipped for NIE and AEWE. This shelter can hold a maximum of 16 beds where as the Spiral I version could only hold 10. For storage and transport, the shelters contain most of its components inside the stowed E2S2 shelters. The E2S2 shelter is 20' x 8' when stowed, and expands to 20' x 20' when deployed. The internal configuration in terms of the number of beds of each shelter can be tailored based on mission requirements.

Capability Deployment

AOR LOCATION	APPLICATIONS	SUPPORTED CAPABILITIES
NIE Ft. Bliss, TX	1	ExCamp (Spiral I)
AEWE Ft. Benning, GA	1	ExCamp (Spiral I)
USAFRICOM	2	Proposed: ExCamp (Spiral II)

Demonstrated Capabilities

New and improved bunk bed system, complete with weapons rack, drawers, and improved mattress.

Aerial view of the ExCamp shelters.

View of the kitchen which provides all the amenities of a professional kitchen.

Equipment Assessments

a. Benefits:

- One shelter can be setup with four trained individuals in 30 minutes. Setting up beds (depending on the number/configuration) can take an additional 45 minutes.
- Each shelter contains up to (8) bunk beds (16 beds) with lockable storage for each.
- Shelters can be configured with less bedding to accommodate more living space.
- Power outlets are mounted on the walls with no need to run wires in the open.
- Each shelter is equipped with a single phase 120v ECU.
- System requires special tools to assist with the locking of the rigid walls (tools are provided with system).

- Each shelter has leveling feet and bubble levels to adjust for slightly uneven ground.
- Improvements to the quality of the doors and windows were made from the Spiral I version to address damage from excessive use.

b. Constraints/Limitations:

- Shelters require MHE for offloading, emplacement, and loading, which if unavailable limits applicability.
- When shelters get sand or debris in the floor joints the walls become more difficult to collapse.
- A relatively level surface free from standing water is required.

c. Safety Issues:

- Pinch points are a concern when setting up.
- Shelters must be spaced properly so that emplacement will not hinder the erection of the shelters.
- Shelters must be grounded, as this provides a path for electrical current, thus reducing the risk of electrical shock.

d. System Recommendations:

- Air Conditionaing needs to be 3-Phase instead of current single-phase design.
- Door handles need to be stronger.
- Add a drain hole to facilitate cleaning floors.

e. Recommendations for other applications:

- Shelters can be used for multiple purposes such as storage or CP/Admin if beds are removed.
- This shelter and other Heavy Camp shelters should be assessed in an operational environment.
- The kitchen shelter could be used to support Defense Support of Civil Authority (DSCA) or Humanitarian Assistance and Disaster Relief (HA/DR) missions.

HEAVY CAMP SHELTER – CP/ADMIN

Background

The Spacemax Heavy Camp CP/Admin shelter evolved from the version 2 shelters assessed in Spiral I equipped for NIE and AEWE. This shelter can facilitate Command Post (CP) or Combat Training Command Post (CTCP) operations. For storage and transport, the shelters contain most of its components inside the stowed E2S2 shelters. The E2S2 shelter is 20' x 8' when stowed, and expands to 20' x 20' when deployed. There are no internal components in terms of office equipment that are equipped with this shelter.

Capability Deployment

AOR LOCATION	APPLICATIONS	SUPPORTED CAPABILITIES
NIE Ft. Bliss, TX	1	ExCamp (Spiral I)
AEWE Ft. Benning, GA	1	ExCamp (Spiral I)
USAFRICOM	2	Proposed: ExCamp (Spiral II)

Demonstrated Capabilities

Inside the CP/ADMIN.

Equipment inside the CP/ADMIN.

Equipment Assessments

a. Benefits:

- Different from the CP/Admin shelter equipped in Spiral I, the Spiral II shelter comes as one shelter. This eliminates the need to join two shelters, reducing setup time.
- One shelter takes a minimum of four trained individuals and approximately 30 minutes to setup.
- The shelter has been upgraded from single-phase power to 3-Phase for better efficiency.
- The ECU mounts are built into this version versus the previous version, where the mount had to be added after the shelter was setup.
- Wall and ceiling connections were improved from version 2 in Spiral I. Version 3 uses more robust latches to secure them in place.
- The addition of air-compressed cylinders used to support the walls reduced the weight required for raising and lowering. This also helps guide the latches in place better for a more secure/locked position. This eliminated the requirement to have a raising pole as part of the setup tool kit.

- Based on feedback from Warfighters the door handles were made more durable to withstand heavy usage.
- Walls are capable of mounting flat screen TVs for digital battle tracking.

b. Constraints/Limitations:

- Shelters require MHE for offloading, emplacement, and loading, which if unavailable limits applicability.
- When shelters get sand or debris in the floor joints the walls become more difficult to collapse.
- A relatively level surface free from standing water is required.

c. Safety Issues:

- Pinch points are a concern when setting up.
- Shelters must be spaced properly apart so that the emplacement will not hinder erection of the shelters.
- Shelters must be grounded, as this provides a path for electrical current, thus reducing the risk of electrical shock.

d. System Recommendations:

- Better (sturdier) white boards should be added.
- Add drain to allow for cleaning.
- Update Air Conditioning to 3-Phase power.

e. Recommendations for other applications:

- This shelter is essentially identical to the billets without beds. It can be configured as billets, MWR, and aid station if properly equipped.
- This shelter and other Heavy Camp shelters should be assessed in an operational environment.
- The kitchen shelter could be used to support Defense Support of Civil Authority (DSCA) or Humanitarian Assistance and Disaster Relief (HA/DR) missions.

AIR-TO-WATER

Background

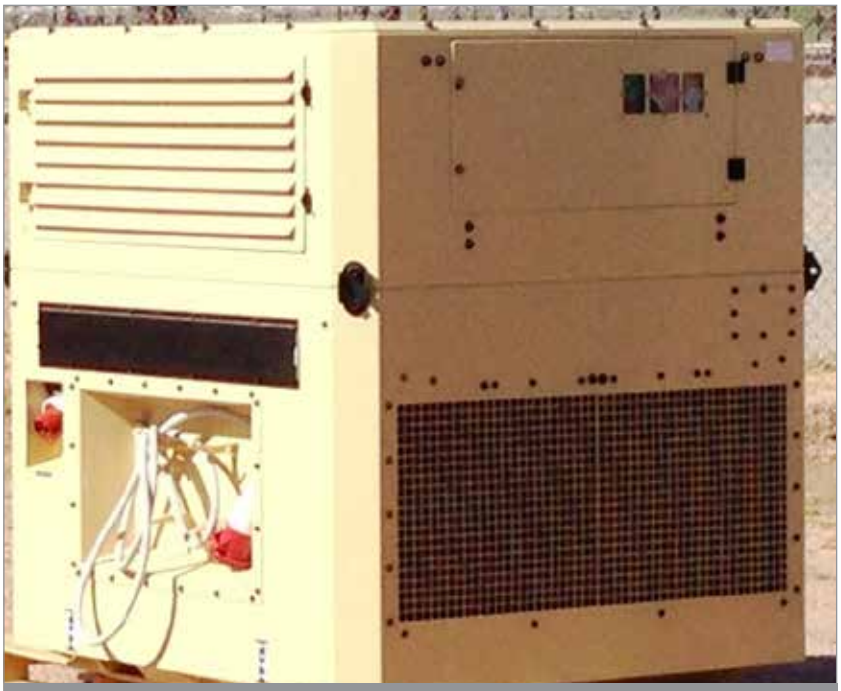
The Mistral GEN-350G Air-to-Water Generation Unit, harvests water from humidity in the air. The system is advertised to produce 120 gallons of clean cool drinking water per day at 25°C and 55% RH. This or similar capabilities were not previously assessed in Spiral I.

- **Power** - The main power connection is a 5 x 40 amp circuit breaker, recommended outlet connector for 208-240 VAC 3-Phase operation.
- **Packaging** - Cardboard covered on a single pallet for shipping.

Capability Deployment

AOR LOCATION	APPLICATIONS	SUPPORTED CAPABILITIES
NIE Ft. Bliss, TX	2	ExCamp

Demonstrated Capabilities



Mistral Air-to-Water system with power connectors.

Equipment Assessments

a. Benefits:

- The system was not able to produce water due to arid conditions at Fort Bliss, TX. However, the system was added to the power supply for the ExCamp and did provide a load on the LDSS.
- System is “plug and play” to any 3-Phased 208-240V power.
- The Air-to-Water has an internal 55 gallon water tank that is monitored continuously.
- The Air-to-Water system dispenses water at chilled and ambient temperatures from internal or externally connected dispensing unit.
- Advertised: The Air-to-Water will produces 120 gallons of fresh, clean and cooled drinking water.

b. Constraints/Limitations:

- The system requires MHE, which based on availability could limit the integration or use in austere environments.
- Water output spigot does not have a MILSPEC connector and requires a standard hose that needs to be sterilized for potability.
- System requires at least 25% humidity in order to produce water.
- System cannot operate below 40°C.
- If powered by the Low Demand Start Stop (LDSS) power system, a special 60 amp cable is needed so it can be wired to the LDSS DM Box.

c. Safety Issues:

- There are several pinch points on the framework.
- The system currently does not produce water that has been certified as potable for military use.

d. System Recommendations:

- Further testing and evaluations are required in order to recommend system upgrades or modifications.
- Water needs to be tested and certified as potable.

e. Recommendations for other applications:

- System needs to be tested in an environment with 25% humidity or more either at AEWE or in an operational environment such as in the USSOUTHCOM AOR where other E2E solutions have been equipped.

SHOWER WATER REUSE SYSTEM (SWRS)

Background

The primary mission for the Sotera Shower Water Reuse System (SWRS) is to treat and reuse gray water from showers, laundry units and the sinks in the Hygiene Complex. The SWRS requires connection to a potable water source, the shower wastewater system and the camp wastewater system. The minimum clearance is 40' x 30' around the SWRS, the 3k-wastewater tank, the diverter box, and the interconnecting hoses.

- **Power** – 208 VAC 3-phase 50 or 60 Hz.
- **Packaging** – (1) 8x8 ISO Container per each SWRS system.
- **System** - Sized for a 600-max camp.

Capability Deployment

AOR LOCATION	APPLICATIONS	SUPPORTED CAPABILITIES
AEWE, Ft. Benning, GA	1	ExCamp
NIE, Ft.Bliss, TX	1	ExCamp

Demonstrated Capabilities

SWRS deployed on site at NIE.

3K blivet of blackwater.

SWRS showing a full gray water bag (on bottom left) waiting to be processed back to the source water bag (on top right).

Equipment Assessments

a. Benefits:

- The SWRS is a fully self-contained water purification system. Gray water is treated for reuse, while black water is diverted to a different storage bag.
- SWRS can be used wherever it can be setup to accept input of wastewater not exceeding 10 gallons per minute (GPM).
- Once the system is in operation a full time operator is not needed. The operator is needed only during system setup and to add chemicals every four hours.
- The SWRS provides reused water that meets or exceeds the Tri-Service Field Water Quality Standards for long term use.
- SWRS can treat up to 12,000 gallons of water in a 20-hour period (10,000 reusable).

b. Constraints/Limitations:

- The SWRS requires a 10K fork lift to move the ISO container.

- It takes 45 minutes for the system to be fully operational.
- The system requires chemicals (bleach) for water treatment and needs to be monitored frequently. Chemicals need to be added roughly every four days.
- Level ground is needed for container emplacement and it should be free from standing water.
- The system at NIE has only operated properly for 24 hours through multiple events.
- The system at AEWE came with multiple manufacturer deficiencies (incorrect wiring, valves, and setting).
- The SWRS requires thorough cleaning and proper shutdown procedures to stow and set back up.
- Requires significant in-depth training.

c. Safety Issues:

- Common electrical knowledge and situational awareness is recommended for setup.
- Avoid skin contact with gray water (wastewater) and chemicals.

d. Recommendations:

- Additional Soldier testing on the system is needed. Using the system as it was designed with a 600-max capacity will fully exploit the system.
- Add two T-valves (this will keep air from getting into the system, which sounds an alarm and puts the system in stand-by mode).
- Additional training provided by the manufacturer would be beneficial.
- The manufacturer needs to troubleshoot the system at NIE.

e. Recommendations for other applications:

- Use with any BN sized camp (600 personnel).

GENERATOR ECU TRAILER (GET)

Background

The HDT GET Trailer is a 35kW generator mounted on a HMMWV capable trailer. The generator comes equipped with automatic 10kW and 5kW load banks to prevent wet stacking and two 60 amp ports for power distribution. The trailer is also equipped with an 8 Ton ECU complete with two output ports. At 80% power output, the GET will produce 24kW distributed. The heating and cooling elements require 17kW and 12kW respectively. Based on the current configuration (GET supports (2) 307 Shelters), the remaining power of 7kW or 12kW is available for distribution between the two tents (3.5kW or 6kW per tent).

Capability Deployment

AOR LOCATION	APPLICATIONS	SUPPORTED CAPABILITIES
USAFRICOM	6	ExCamps and C2
USSOUTHCOM	4	Billeting and Forward
Ft. Eustis	1	Billeting for RSOI operations

Demonstrated Capabilities

GET Trailer system showing airflow ducts on the left side and control panel on the right side.

Equipment Assessments

a. Benefits:

- Trailer makes equipment easy to use and adds maneuverability to Lite Camp. The GET can be used to power and condition any tent shelter as long as it has the portholes.
- Generator comes equipped with 100 amp shore port for connecting with other generators if power distribution needs are lower than output potential.
- ECU is capable of easily cooling two shelters at once (limited by the output). It will cool two of the 307 billet shelters or any shelter that is smaller in size.
- Load banks can be disconnected to prevent wasted fuel – this is optimal if the load is tested and the user knows that load banks will not be necessary.
- Multiple (2) 60 amp ports facilitate segregated power distribution systems.

b. Constraints/Limitations:

- Generator is oversized for most needs of the Lite Camp. This means load banks often run when ECU is not connected.
- Because of size of the generator, it can often be used to distribute power throughout the camp.
- The ECU has only two outputs to condition tents and is rated at 8 Tons distributed (4 Tons per tent). The 307 tents have air inputs on each end however, the ECU can only input air on one end, creating uneven air temperatures in the same tent.
- Length of ECU hoses makes distribution to multiple shelters difficult.
- Multiple units have had trouble with air in the fuel lines on delivery.
- The trailer has a Military Standard Tongue, which requires a HMMWV or larger to transport. This can constrain mobility if in an environment where non-tactical vehicles are the primary means of transportation.

c. Safety issues:

- None observed.

d. System Recommendations:

- Equip the GET with (4) 2 Ton ECUs that can be packaged with the trailer for shipping purposes. Removing the generator would add the additional space for another ECU, but another trailer would be needed to move the ECU. The two Ton ECUs can then be distributed more efficiently by conditioning both sides of a tent or paired with other shelters (Radome, HEX Dome, etc.).

e. Recommendations for other applications:

- This generator system would be ideal for a larger camp or more permanent shelters.
- If delivered with 100 amp cabling, shore cables could connect with other GET units and more efficiently Right-size the generator's capacity.

LITE CAMP RADOME TENT

Background

The HDT Base-X Radome is a soft shell dome shelter, which was procured as a component of the NetZero Lite Camp. The Radome shelter is supported by inflated airbeams and has no metal or carbon fiber support. Radome shelters were concurrently deployed in Honduras, Niger, and Mauritania as part of the E2E SPIRAL II program.

Capability Deployment

AOR LOCATION	APPLICATIONS	SUPPORTED CAPABILITIES
USAFRICOM	6	ExCamps and C2
USSOUTHCOM	4	Billeting and FARP
Ft. Eustis	1	Billeting for RSOI operations

Demonstrated Capabilities

Radome shelter component of Lite Camp in Africa.

Equipment Assessment

a. Benefits:

- The Radome is compact and relatively lightweight when packed. It can be transported via HMMWV and/or medium sized pickup (Non-Tactical Vehicle (NTV)).
- The Radome is simple to setup and tear down and is staged much faster than shelters with solid frames.
- Risk of shelter failure is minimal – frame inflation can be measured with included pressure gauge. Re-inflation takes a minimal amount of time.

b. Constraints/Limitations:

- Shelter does not come equipped with lights, power strip, furniture, or flooring, limiting its usability as an occupied shelter.
- Shelter is delivered with air compressor and vacuum, but the vacuum is underpowered for teardown of the shelter. This makes it difficult to strike the camp quickly.
- Shelter does not have a radiant barrier and is not airtight, which makes the use of the HVAC ineffective in cooling the shelter.
- Rigid air beams are solid to the touch and reinforced, but are vulnerable to puncture by sharp objects or projectiles.

c. Safety Issues:

- None observed.

d. System Recommendations:

- Ship Radome with larger vacuum to speed deflation.
- Equip the Radome with lights and power strips. If equipped it could be used as a Command Post (CP) at Initial Operating Capability (IOC).

e. Recommendations for other applications:

- Primary use for Radome has been as a medical tent. Other applications could include a single use office or expeditionary Command Post (CP).

LITE CAMP BILLET TENT (307 MODEL)

Background

The HDT Base-X 307 is a soft shell billet shelter, which was procured as a component of the NetZero Lite Camp. The 307 shelter can house 12-16 personnel and is equipped with a radiant barrier, which reduces power usage when cooling the shelter. 307 shelters are currently deployed in Honduras, Niger, and Mauritania as part of the E2E Spiral II program.

Capability Deployment

AOR LOCATION	APPLICATIONS	SUPPORTED CAPABILITIES
USAFRICOM	6	ExCamps and C2
USSOUTHCOM	4	Billeting and FARP
Fort Eustis, VA	1	Billeting for RSOI operations

Demonstrated Capabilities

Interior of billet tent.

Deployed System.

Equipment Assessments

a. Benefits:

- The 307 billet is compact and relatively lightweight when packed. It can be transported via HMMWV and/or medium size pickup (Non-Tactical Vehicle (NTV)).
- The addition of the radiant barrier makes the shelter more efficient with an increased R-value over the current POR that lacks this capability.
- Ridged flooring is simple to install, is quicker than installing the floor on the HEX Dome, protects from low standing water, and provides a level surface for tables, chairs, and other equipment.
- Setup and tear down requires a minimum of eight trained individuals and takes approximately 30-45 minutes, which includes the flooring and lighting.
- Once radiant barrier liner is inserted, the process of subsequent setups is faster because it can be left in place when taking the shelter down versus separating and packing individually.
- Cables for lighting and outlets are located behind the internal barrier creating less clutter and eliminating tripping hazards.

b. Constraints/Limitations:

- All power for the shelter comes through a single breaker box; this can overload if too many components are hooked up.
- Shelter support beams and legs seem weakened upon subsequent setups.
- Radiant barrier tears easily if pressure is applied in the wrong place.
- The spare parts kit comes with spare rods, supports, wire, etc. However it is limited; specialized tools necessary to make repairs are included.

- 60 amp cabling is short and limits where the shelter can be setup in relation to the power generation.
- Camouflage netting on shelters is very difficult to install on top of shelter after staging. Installing netting prior to staging makes the shelter significantly heavier and adds difficulty to the installation process.

c. Safety Issues:

- Pinch points are a concern when unpacking, raising, lowering, and packing.

d. System Recommendations:

- Weak point at intersection of support beams should be reinforced to prevent breakdowns.
- The spare parts kit should include additional supplies to include specialized tools.
- Increase the 60 amp cabling to 100' to allow flexibility of where the shelter is setup in relation to the power generation.

e. Recommendations for other applications:

- 307 shelter is modular and can be used in conjunction with other shelters – i.e. to add an office to the Hex Dome shelter or combine two 307s for a large classroom/storage.
- 307 shelter could be used as hygiene complex with added components from the Alaska Shower/Latrine.

LITE CAMP SHOWER FACILITY

Background

The Shower Facility structure is an Alaska Structures Small Shelter System with shower and hygiene components, which were procured as a component of the NetZero Lite Camp. There is a metal skeleton that provides the frame for the shelter and is equipped with four expandable showers, a hot water heater, a sump pump, three sinks, plumbing, white and gray water storage bladders, and a 2.5 Ton ECU (3-Phase). This configuration supports approximately 45-50 personnel. The internal components that make up the shower facility are modular and designed to fit into any Alaska Small Shelter System. These shelters and shower facility components were concurrently deployed in Honduras, Niger, and Mauritania as part of the E2E Spiral II program.

Capability Deployment

AOR LOCATION	APPLICATIONS	SUPPORTED CAPABILITIES
USAFRICOM	6	ExCamps and C2/Deployable C2
USSOUTHCOM	4	Forward C2 and Refueling
Fort Eustis, VA	1	Expeditionary Watercraft C2

Demonstrated Capabilities

OE Advisor/Trainers explaining hygiene station.

Soldiers running water lines to shower facilty.

Equipment Assessments

a. Benefits:

- The Alaska Small Shelter System is sturdy when completed and the radiant barrier keeps shelter cool even without the use of the ECU.
- All component pieces are clearly marked and color coded, making setup more user friendly.
- These shelters are common throughout the Army and many Soldiers are familiar with the setup and tear down process.
- The shower facility takes eight hours to train and six fully trained personnel approximately four hours to setup.
- Shelter is watertight and well insulated to maintain internal temperature and keep water out.

b. Constraints/Limitations:

- Construction of shelter is much more time consuming than other Lite Camp shelters such as the 307 Billets, HEX Dome and Radome.
- Shelter setup is difficult without the use of a ladder (minimum of 8' recommended), which is not included in the shelter tool kit.
- Shower support legs are held up by both pin locks and channel locks. The channel locks have been shown to fail, causing the shower box to partially collapse.
- The boxes containing the shelter are not easily man portable and cannot be transported conveniently without the use of a small forklift or pallet jack.
- Using Alaskan shelter for four showers and sink unit is not an optimal use of space; all configurations leave significant wasted area. The internal shower and hygiene components take up approximately 50% of the allocated space inside the shelter, which leaves unused space.

c. Safety Issues:

- Channel locks holding up top portion of shower units are difficult to tighten, leaving showers at risk of collapse.

d. System Recommendations:

- Replace channel locks in shower system with pin locks, which hold support legs more effectively and reduce risk of collapse.
- Recommend equipping a smaller structure that accommodates the internal shower and hygiene components with minimal unused space. This will also reduce the overall size of the shower facility packed for transportation (size and weight) and when setup.

e. Recommendations for other applications:

- This shelter is better used for a more semi-permanent camp.
- The shelter by itself can be used for Billets, CP, storage, etc.

LITE CAMP TOC TENT (HEX DOME)

Background

The HDT Base-X HEX Dome is a soft shell dome shelter, which was procured as a component of the NetZero Lite Camp. The HEX Dome shelter can be used as a Command Post, which can accomodate up to 10 people working comfortably within. The HEX Dome also comes equipped with an audiovisual system. HEX Dome shelters are currently deployed in Honduras, Niger, and Mauritania as part of the E2E Spiral II program.

Capability Deployment

AOR LOCATION	APPLICATIONS	SUPPORTED CAPABILITIES
USAFRICOM	6	ExCamps and C2/Deployable C2
USSOUTHCOM	4	Forward C2 and FARP
Ft. Eustis, VA	1	C2 platform for RSOI operations

Demonstrated Capabilities

Setup of HEX Dome.

Inside a HEX Dome.

Equipment Assessments

a. Benefits:

- The HEX Dome is compact and relatively lightweight when packed. It can be transported via HMMWV and/or medium size pickup (Non-Tactical Vehicle (NTV)).
- The addition of the radiant barrier makes the shelter more efficient with an increased R-value over the current POR that lacks this capability.
- Ridged flooring is simple to install, protects from low standing water, and provides a level surface for tables, chairs, and other equipment.
- Setup and tear down requires six to eight trained individuals and takes approximately 60 minutes and includes the flooring, lighting, and audiovisual equipment.
- Once radiant barrier liner is inserted, the process of subsequent setups is sped up because it can be left in place when taking the shelter down versus separating and packing individually.
- Cables for lighting and outlets are located behind the internal barrier creating less clutter and eliminating tripping hazards.
- The shelter comes with organic audiovisual equipment.

b. Constraints/Limitations:

- All power for shelter comes through single breaker box; this can overload if too many components are hooked up.
- This shelter has a different setup and tear down process from other shelters (307 and shower facility), which requires multiple iterations to avoid damage to components from minimally trained personnel. At a minimum, training takes multiple iterations of four to six hours each.
- Shelter support beams and legs seem weakened upon subsequent setups.
- Radiant barrier tears easily if pressure is applied in wrong place.
- The spare parts kit comes with limited amounts of spare rods, supports, wire, etc.. Specialized tools to make repairs are not included.

- 60 amp cabling is short and limits where the shelter can be setup in relation to power generation.
- Camouflage netting on shelters is very difficult to install on top of shelter after staging. Installing netting prior to staging makes the shelter significantly heavier and adds difficulty to the installation process.

c. Safety Issues:

- Pinch points are a concern when unpacking, raising, lowering, and packing.

d. System Recommendations:

- Weak point at intersection of support beams should be reinforced to prevent breakdowns.
- The spare parts kit should include additional supplies to include the specialized tools.
- Increase the 60 amp cabling to 100' to allow flexibility of where shelter is setup in relation to power generation.

e. Recommendations for other applications:

- HEX Dome shelter in its most appropriate as a Command Post. Could potentially be used as a Billeting shelter if necessary.

SINGLE PHASE EFFICIENT ECU (1.5 TON MODEL)

Background

The HDT 1.5 Ton Environmental Control Unit (ECU) is a single-phase, high-efficiency compressor heat pump. This capability was added to the Lite Camps that were harvested from Operation Enduring Freedom (OEF) and were going to sites in Africa that didn't have power and ECU capability available. The 1.5 Ton ECUs were designed to replace the 8 Ton ECUs that come organic to the generator ECU trailer (GET) as the primary ECUs for the Lite Camp to reduce power consumption.

Capability Deployment

AOR LOCATION	APPLICATIONS	SUPPORTED CAPABILITIES
USAFRICOM	5	ExCamps

Demonstrated Capabilities

HDT 1.5 Ton with SAAB Baracuda cover providing cool temperatures for the TOC/CP Tent.

Portable and efficient HDT 1.5 Ton ECU.

Equipment Assessments

a. Benefits:

- Small design with handle cart type wheels that can be moved by one Soldier.
- Efficient compressor operates on single-phase that can be plugged in as an additional component to 120 VAC distribution outlets.
- Draws approximately 15 amps during high cool, with power consumption of <2kW; makes it one of the most efficient military ECUs available.
- Easily operated tethered remote with large dial.
- Duct work included with the ECU.
- Two-stage start-up with fans activity first, followed by the compressor, thus leads to smaller in-rush of power when system is turned on.
- Monitors temperature and turns compressor on and off as necessary, dependent on dial setting.

b. Constraints/Limitations:

- Tethered remote cable located too close to fan and can get caught in fan.
- RF feedback on the ground tripped GFCI protected outlets.
- Power cord is short and requires prior planning to ensure distribution box is close enough for hook-up.
- Cart's wheels are small and pose problems causing a high center of gravity which makes it difficult to move system over rough terrain.
- Ductwork included is only 4' long and may have trouble reaching some ECU inputs for larger tents.
- Copper coolant line runs along steel floor of the system causing metal to metal contact that has shown to cause wear and even holes in the coolant line when line hauled over long distances in rough/austere terrain.

c. Safety Issues:

- Safety issue identified when bypassing the ground as a field fix for the RF feedback problem listed above. Not a long-term solution.

d. System Recommendations:

- Tether remote line should be shrouded from contact with fan.
- Copper coolant line should have non-metallic buffer from system housing.
- Include damping diode to power cable to reduce RF feedback from the ground.
- Include larger wheels and/or concave base to allow better movement over rough terrain.

e. Recommendations for other applications:

- This ECU can be used in many applications from rigid wall camps, B-Huts, and tents for efficient cooling of shelters. Tent applications may require thermal and/or radiant barriers for effective cooling.

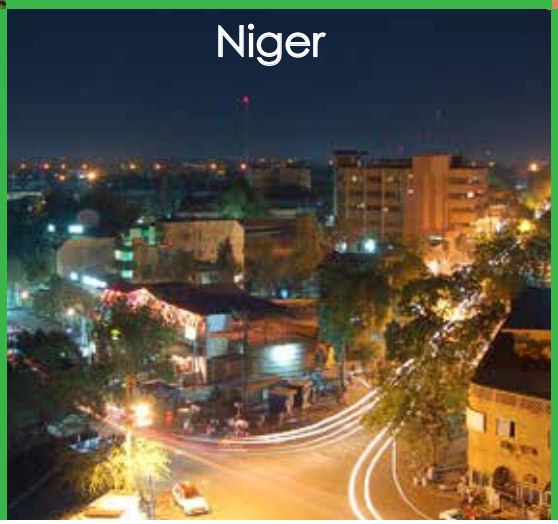
6.0 Acronyms

ACRONYMS

AEWE	Army Expeditionary Warrior Experiments
AMSAA	Army Material Systems Analysis Activity
C4ISR	Command, Control, Communications, Computers, Intelligence, Surveillance and Reconnaissance
CONUS	Continental United States
COP	Combat Outpost
COTS	Commercial Off the Shelf
CP	Command Post
CWS	Containerized Weapon System
DSCA	Defense Support of Civil Authority
DoD	Department of Defense
E2E	Energy to the Edge
E2X LOE	Effective Energy for Expeditionary Operations Limited Objective Experiment
ECP	Entry Control Point
ECU	Environmental Control Unit
EO/IR	Electro Optics/Infrared Payloads
EMI	Electronic Magnetic Interference
ExCamp	Expeditionary Camp
FOB	Forward Operating Base
FORGE	Forward Operating Renewable Generator
FP	Force Protection
GET	Generator ECU Trailer
GRRIP	Global Rapid Response Intelligence Package
GOTS	Government-Off-the-Shelf
HA/DR	Humanitarian Assistance and Disaster Relief
kW	Kilowatt
kWh	Kilowatt-hour
LDSS	Load Demand Start Stop
MFC	Mortar Fire Control
MHE	Material Handling Equipment
MILSPEC	Military Specification
MWR	Morale, Welfare and Recreation
NIE	Network Integration Evaluation

OE	Operational Energy
OEF	Operation Enduring Freedom
OP	Observation Post
PM	Program Manager
PdM	Product Manager
PM MEP	Program Manager Mobile Electric Power
POR	Program of Record
REF	Rapid Equipping Force
RWC	Rigid Wall Camp
SATCOM	Satellite Communication Equipment
SOF	Special Operations Forces
SWRS	Shower Water Reuse System
TALS	Tactical Automatic Landing System
TOC	Tactical Operations Center
TQG	Tactical Quite Generator
UPS	Un-Interrupted Power Supply
USFOR-A	United States Forces – Afghanistan
v	Volt
VSP	Village Stability Platform
W	Watt
WASP	Wearable Advanced Soldier Power

U.S. Army Rapid Equipping Force



Barbaricum LLC

819 7th St NW Washington, DC 20001

202.393.0873

barbaricum.com