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An update on CERDEC fuel cell technology research, development, and demonstration is provided.
Presentation Outline

Army Power Division & CERDEC Fuel Cell Team Missions

Sensor & Soldier Power
- Potential Benefits
- Recent Test Results

Man Portable Power
- Potential Benefits
- Recent Test Results

Demonstrations & Exercises
- Aberdeen Test Center
- Joint Readiness Training Center, Ft. Polk
- West Point Military Academy
To conduct research, development, and system engineering leading to the most cost-effective power, energy, and environmental technologies to support Army’s soldier, portable, and mobile applications.

**ATO D.CER.2008.08**

**Power for Dismounted Soldier**
- Half-Sized BA5590 Li/CFx Battery
- Half-Sized BA5590 Li-Air Battery
- Soldier Conformal Rechargeable Battery
- Soldier Hybrid Methanol Fuel Cell Power Source
- Soldier Hybrid Fuel Cell Power Source
- Portable Hybrid Power Sources & Chargers, JP-8 fueled

**ATO R.LG.2009.01**

**Mobile Power**
- Transitional Hybrid Power Source, Log-fueled
- Waste Heat Recovery
- Power Centric Mobility applications
CERDEC Fuel Cell Team

Our Mission

To Rapidly Develop & Transition Suitable Fuel Cell Technologies to Applications where they are Most Needed

Sensors
< 5 W

Soldier Power
5 – 100 W

Man Portable
100 – 500 W

TECHNOLOGY DRIVEN. WARFIGHTER FOCUSED.
Fuel Cells for Sensor and Soldier Power

Current Programs
&
Recent Lab Testing Results
Potential Benefit – Sensor and Soldier Power

- Longer runtimes than current batteries for comparable form factors
- Logistic advantages related to handling and lifecycle costs
- Cheaper than current batteries for comparable power needs
Potential Benefit – Sensor and Soldier Power

Cost Comparison for Operating Batteries vs. Fuel Cells

- Battery Cost
- Fuel Cell System Cost

Cost (Dollars) vs. # of Batteries/ Fuel Cartridges
25W Starting Mission Weight vs Mission Hours

- Ultracell
- AMI
- BA5590
- BA5390
Sensor and Soldier Power
(100 mW - 100 W)

Fuel Technology

- Direct Methanol
- Reformed Methanol
- Chemical Hydrides
- SOFC
- Bio-Fuels

Current Efforts

- SFC (Smart Fuel Cell)
- UNF (University of North Florida)
- Samsung
- UltraCell (High Power Micro Fuel Cells)
- General Atomics
- Jadoo Power
- AMI (Adaptive Materials Inc.)
- FIU (Tennessee Tech University)
- Akarmin
In Development with CERDEC and DARPA

Rated 25W continuous
Reformed Methanol Fuel Cell (RMFC)
Fuel: 67% Methanol / 33% Water

**Dimensions:** 9.3" x 5.3" x 1.8"
**Start Up Time:** 20 min.

**System Dry Weight:** 1.2 kg
**Fuel Cartridge Weight:** 0.3 kg

**25W Mission Energy Density:**
24-hr 230 Whr/kg
72-hr 360 Whr/kg
Progression from XX25

Rated 55W continuous (110W Peak)
Reformed Methanol Fuel Cell (RMFC)
Fuel: 67% Methanol / 33% Water

Dimensions: 13” x 8” x 4”
Start Up Time: 25 min / Hybridized

System Dry Weight: 2.7 kg
System Efficiency: 26.0%

55W Mission Energy Density:
24 hr 265 Whr/kg*
72-hr 410 Whr/kg*

* Calculated based on initial data only
AMIle60 60W SOFC

Developed with CERDEC and DARPA

Rated 60W continuous (100 W Peak)
Solid Oxide Fuel Cell (SOFC)
Fuel: Commercial Propane Canisters

Dimensions: 10.25" x 9" x 4"
Start Up Time: 15min.

System Dry Weight: 2.8 kg
System Efficiency: 18.0 %

60W Mission Energy Density:
24 hr  400 Whr/kg
72-hr  760 Whr/kg
Fuel Cells for Man Portable Power

Current Programs
&
Recent Lab Testing Results
Auxiliary Power/ Battery Charging

- Bridge power gap between batteries and generators
- Greater efficiencies than TQGs and vehicle power
- Reduced noise and heat signatures
- Enables remote, portable battery charging capability where other power sources are not practical
- Low emissions
Man Portable Power (100 W – 500 W)

Fuel Technology

- Direct Methanol
- Reformed Methanol
- Ammonia Borane
- Sodium Borohydride
- SOFC

Current Efforts

- INI
- Protonex
- Spectrum Brands
- Rayovac
- Ultralife
- Lynntech

Technology Driven. Warfighter Focused.
Protonex P-125a SOFC

Developed with CERDEC & ARO

Rated 100W continuous
Solid Oxide Fuel Cell (SOFC)
Fuel: 100% Pure Propane

Dimensions: 14” x 6.75” x 3.75”
Start Up Time: 50 minutes

System Dry Weight: 6.9 kg
Fuel Cartridge Weight: 0.8 kg

Fuel Consumption: 38g/hr
System Efficiency: 18.6 %
Recent Exercises
&
Demonstrations
Ballistic Testing:

*Determine Fuel Cell and Cartridge Safety*

.50 Cal Incendiary Rounds

Targets:

*Fuel Cells in Operational Configuration*
*Propane Canisters*
*Methanol Cartridges*

Results:

*Benign Release of Fuel from Containers*
*No Incident on Fuel Cell Systems*
Purpose:
Utilize the UltraCell XX25 RMFC as a Remote Power Source for Dismounted Soldier Applications

Feedback:
Users enjoy Hotswapable Capabilities
“…Good Mission Extender”

Environmental Conditions
Temp: 70-100°F
Humidity: 60-100%
Purpose:

Conduct a Human Factors Analysis on the UltraCell XX25 RMFC

Test Factors:

- Ergonomics
- Ease of use
- Ability to Read Display (Fuel, Error Codes, etc.)

Testing Results:

Phase 1: August – December 2009 (Classroom)
Phase 2: Summer 2010 (Field Demo)
Conclusions

- Fuel Cells have shown great potential for meeting the increased energy needs of the dismounted soldier
- Many current systems have increased reliability and ruggedness moving from TRL 5/6 to 6/7
- No one technology has shown it will be the sole solution for the military – both fuel and fuel cell need to be safe and user acceptable
- Test and evaluation of fuel cell power systems plays a vital role in assessing the state of technology and transitioning to the procurement stage
Thank You!

Questions?