Advancements in Navy and USMC Power Systems

Joint Service Power Expo 2007
C. Justin Govar, Daphne A. Fuentevilla, Julie A. Banner,
and Clinton S. Winchester
Naval Surface Warfare Center, Carderock
Systems & Materials for Power & Protection Branch
9500 MacArthur Blvd, Bethesda, MD
301-227-5394, Clint.Govar@navy.mil

Presentation Goals

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- Provide an overview of portable power technologies for current and near-term transition into Naval and USMC applications
- Support user selection of power sources through review of selected technology characteristics, including performance and safety

USMC Battery Applications

- State-of-Charge Indicators
- APU/UPS Applications
- Zn/Air Hybrid Battery System
- Magnesium Air Batteries
- Aerial Vehicle Batteries

State of Charge Indicator For Zn/Air Batteries

- Goal
  - To develop a state of charge (SOC) indicator for the BA8180 and future Marine Corps Zn/Air batteries.
- Key Parameters
  - Size and weight
  - Efficiency and power consumption
  - Cost
  - Accuracy
  - Environmental factors
- Companies
  - Yardney Technical Products
  - Global Technology Connection

SOC Indicators for Primary batteries

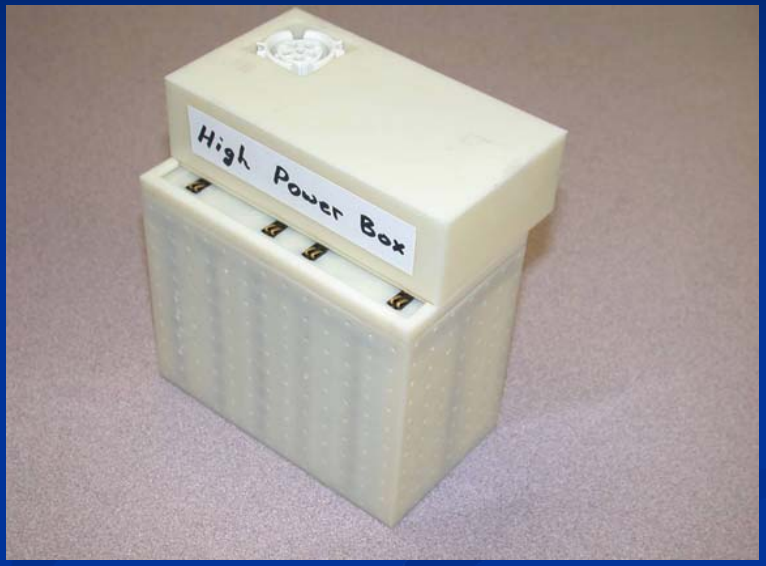
- Evaluating the SOC Indicators for BA5390A/U and the BA5590A/U
- Evaluation is done
- Currently in the approval process for the various Marine Corps Equipments
- Conclusions:
  - SOC does not effect the safety of the BA5390A/U
  - The BA5390A/U is susceptible to hard reversal conditions that can overcome its safety devices
  - SOC does not effect the safety of the BA5590A/U

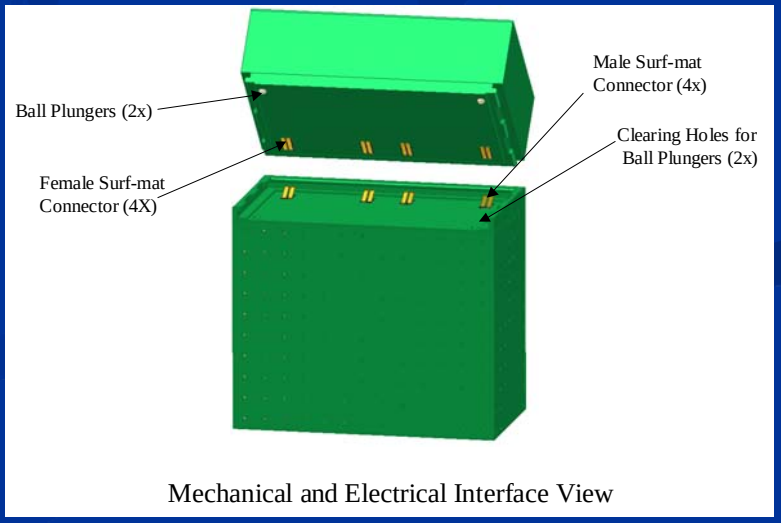
Marine Portable Power Unit

- Goal
  - To develop a APU/UPS system that utilizes the BB2590 as the energy storage device and can double as a battery charging station
- Key Parameters
  - 50lbs, single man portable
  - Uses and recharges the BB2590
  - Battery are hot-swappable while in use
  - 12VDC, 24VDC, 120VAC input and output
  - 1kW power output capability for 1 hour
- Companies
  - Space Hardware Optimization Technology
  - Acumentrics
  - AeroVironment

Zn/Air Hybrid Battery System

- 45% weight reduction (over 2 BA5590)
- 50% volume reduction (over 2 BA5590)
- Same size as BA5590
- 1.26kg
- 15Ah, 440Wh
- 350Wh/kg
- 100+Watt Capable
- Duel voltage 15V, 30V
- 62 hour run time on SINCGARS profile





Mechanical and Electrical Interface View

Emergency Battery System

- Magnesium/Air battery
- Three Different Systems
  - Basic – Soft rubber pack
  - Standard – Basic with hard case and fan cooled
  - Disposable – One time use
- 50Ah plates, 570g (dry)
- 400Wh/kg (dry), 228Wh/kg (wet)
- Takes ~ 500ml of salt water
- 20Watts, 6V
- 12V/24V DC/DC converter (88% Efficiency)
- BB2590 Charger adaptor

Metal Cell Batteries
(Still under evaluation)

Large Backup Power System

- Voltage = 12V
- Energy Density
  - 280Wh/kg (dry over 4 plates)
- Energy = 2200 Wh
- Power = 50W-100W
- Hydrogen inhibitor
- Size = 7”x10”x16”
- 35 pounds (Dry with salt)

InfraTech Battery
(Still under evaluation)

UAV Battery Designs

- Dragon Eye (2004 version): AeroVironment P/N 55616
  - 21 Saehan-Enertech li-ion polymer cells (1.9 Ah)
  - Nominal 25.9V, 5.7 Ah
  - NOSSA ltr 8020 Ser N311/936 of 16 Jun 04
- Dragon Eye (2005 version): AeroVironment P/N 55900
  - 18 LG Chem 18650 cells (2.2 Ah)
  - Nominal 21.6V, 6.6 Ah
  - NOSSA ltr 8020 Ser N841/179 of 31 Jan 06
- Raven (2007 version): AeroVironment P/N 54677
  - 12 Saehan-Enertech li-ion polymer cells (1.9 Ah)
  - Nominal 22.2V, 3.8 Ah
  - Still under approval process

Navy Power System Advancements

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- Focus on TRL Level 6-9
- Advancements in Fieldable Systems
- Examples

Technology Readiness Level (TRL)

9	**"Flight Proven" OT&E**
8	**"Flight Qualified" DT&E**
7	**System Prototype Demo in Operational Environment**
6	**System Demo in Relevant Environment**
5	'High Fidelity' Benchtop Integration
4	'Low Fidelity' Benchtop Integration
3	Component Development
2	Paper Study/Basic Principle
1	Concept

Current Navy Power Systems

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- Hit on a few of the recent Navy battery systems
  - Unmanned Ground Vehicles
  - Unmanned Underwater Vehicles
  - Manned Vehicles

Unmanned Ground Vehicles

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- Talon
  - EOD/IED disposal reconnaissance
  - Weight <150 lbs
  - Payload 100 lb
  - Water resistance to 90ft
  - Li-Ion Battery Pack
    - 70Whr
    - 42 Volts, 17.8 Amp-hours
    - 4.5 hour operation/charge
    - S9310 Approved

Unmanned Ground Vehicles

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- Toughbot
  - Remote Video and Audio Reconnaissance
  - 2.2 lbs
  - 100-300ft range
  - Li-polymer Battery Pack
    - 7.4V, 0.65 Ahr
    - ~1hr operating time
- Throwbot
  - Earlier version of Toughbot
  - Remote Video and Audio Reconnaissance
  - Tossable: Soda-can size, <1 kg
  - 100ft range
  - Li-polymer Battery Pack
    - 11V, 0.25Ahr

- Limited S9310 Approval

Unmanned Underwater Vehicles

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- 12 ¾” UUV
- SAMS
- “Tunnel”
- REMUS/SARV

REMUS 100 Power System

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- SAFT MP176065 based Li-Ion battery
  - Fully S9310 Approved & Tested
- Moli 18650 based Li-Ion battery
  - Preliminary S9310 Evaluation
  - Cell Capacity 2.2Ahr ⟶ 2.4Ahr

Battlespace Preparation Autonomous Underwater Vehicle (BPAUV)

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- Maps Ocean Floor, Hunts Mines
- Up to 2 x 3.6kWhr battery packs
- 120Ahr at 30V in 8S24P configuration

Solar Autonomous Underwater Vehicle (SAUV)

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- Autonomous UUV, Technology Testbed
  - Moli 18650 based Li-Ion 2kWhr Battery Pack
  - Solar panels recharge Li-Ion Battery while deployed
  - S9310 Limited Approval

Manned Vehicles

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- ProMare/MarlinSubs S201 2-Man Submarine
  - Technology Testbed
  - Currently Contractor Owned and Operated
  - Li-Ion Battery
    - Phosphate Cathode
    - Uses 18650 size cell
    - 150 kWatt-hour
  - S9310 evaluation in progress

Manned Vehicles

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- Joint Strike Fighter, F-35
  - Li-ion Power Supply
    - Start-up Power, Back-up Flight control
    - 270 V

Conclusions: Trends in Battery Development

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- Modularity
- Commercial off the shelf
- Specialty packages with COTS cells
  - Still have batteries that have odd shape factors or special locations
- Metal air chemistries
- Rechargeable batteries
- Larger battery systems
- Higher energy density
- Higher power density

Questions ?