61st Annual NDIA Fuze Conference

Small Thermal Battery for High Spin Environments

San Diego, California, CA

May 15-17, 2018

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A Gun Launch Thermal Battery

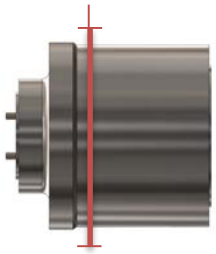
- **Primary Reserve Gun Launch Thermal Battery**
  - *One Time Use – Not Rechargeable (This electrochemistry can be charged)*
  - *Assembled in a Dormant State*
  - *Primer Activated*

- **Characteristics that Make Thermal Batteries Ideal Power Sources for Weapon Systems**
  - *Long Shelf Life (Up to 30 Years)*
  - *No Maintenance Required*
  - *High Power Density*
  - *Rapid Discharge*
  - *Wide Operating Temperature Range*
  - *No Self Discharge*
  - *Low Life Cycle Cost*
  - *Fast Activation (under 60 ms for gun launch)*
  - *Extremely Rugged*
  - *No Out-gassing*
  - *High Reliability (4 - 9's)*
  - *No External Heating Required*
  - *Flexibility in Design (Multiple Voltage Sections in Parallel or in Series)*

Powering 57mm Smart Munitions

- **EAS thermal batteries now power cutting edge gun launch munitions**
- **Currently flying in a Navy MK Format Smart Projectile**
- **Powering a 24 volt system @ a nominal 50 watt load with power excursions reaching more than 100 watts.**
- **Battery life exceeds typical round flight times with exceptional margins, operating for more than 20 seconds.**

40 mm (1.60 in) Diameter



EAS Thermal Battery Powering Smart Round

57 mm (2.24 in) Diameter

MK Navy Style Round

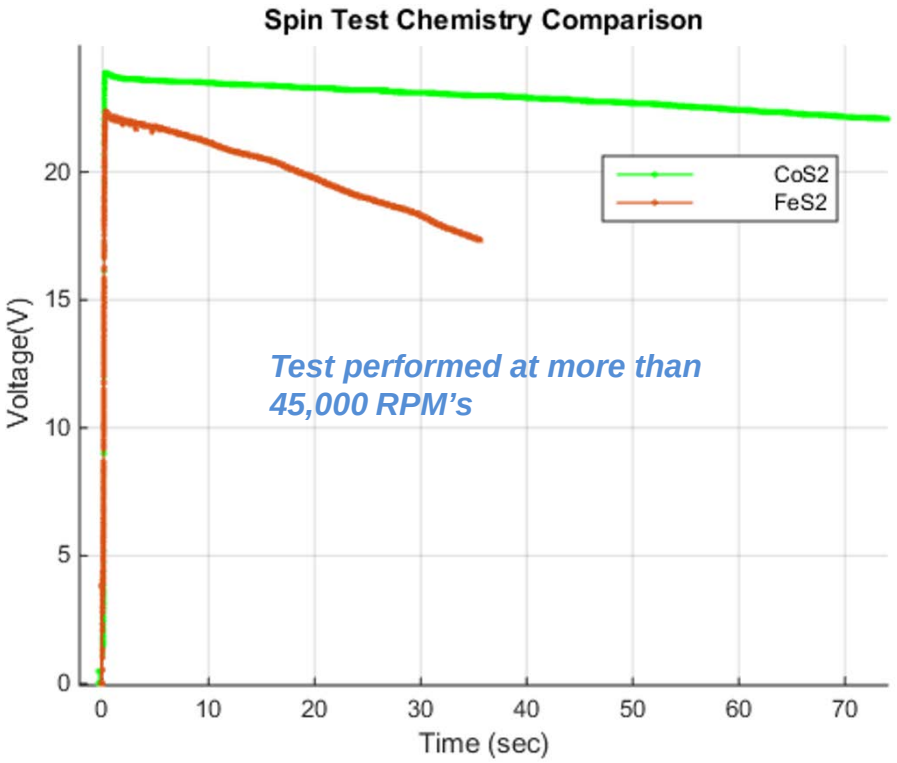
EnerSys. Power/Full Solutions™

Extreme Environments

- **Set Back Acceleration**
  - *Continued Operation during applied forces over 35,000 g's*
- **Angular Acceleration**
  - *Continued Operation during applied angular acceleration over 1M rad/sec²*
- **Angular Deceleration**
  - *Continued Operation during applied angular deceleration over -2M rad/sec²*

A Highly Rugged Design, Built to Survive Some of the Harshest Man Made Environments

EAS Cobalt Disulfide Cathode Technology



- **Traditional Cathode Electrochemistry active material, FeS_2, does not perform well under high spin conditions.**

  Voltage noise and higher impedances (overall) plague this chemistry when subjected to high spin environments

- **In a one-to-one spin test comparison, EnerSys Advanced Systems' CoS_2 technology outperforms in impedance, voltage, and capacity - providing more than double the mission capability**

More than Double the Mission Capability when using CoS_2 over the Conventional FeS_2

Gun Launch Thermal Battery Enhancements

With many years of experience and various design iterations, EAS has produced a unique battery that eliminates extreme performance degradation from high spin environments.

- ***The internal wrapping pattern, in combination with advanced insulation materials, ensures a rugged design tempered to survive intense G loads and acceleration forces.***

- ***The primer activation system employs a striker method anvil which is activated under specific gun launch environments ~ making the batteries safe to handle in the event they are dropped.***

- ***A unique lead routing design mechanically immobilized in a propriety blend of epoxy and hardeners, enables strain relief during some of the harshest environments.***

- ***Custom tailoring of the primer assembly allows for various no fire/all fire scenarios to be met.***

- ***Electrical Isolators are strategically placed in the battery to not only serve as electrical isolators but also to contribute to an already internal rugged core.***

Experience in Gun Fired Systems

EnerSys Advanced Systems has demonstrated performance in gun launched systems with both high power density thermal batteries and high energy density liquid reserve batteries.

Thermal Batteries for Cannon & Artillery Applications

Liquid Reserve Cells and Batteries for Small & Medium Caliber Rounds, Artillery & Mortar Projectiles

EnerSys
Power/Full Solutions™

EAS Battery Design Capabilities

EnerSys Advanced Systems battery design and analysis capabilities ensure that the battery is designed to meet program performance requirements, including the most extreme environmental requirements.

Customer Inputs

DWG Templates

Material Properties

MATLAB

MatLab Outputs

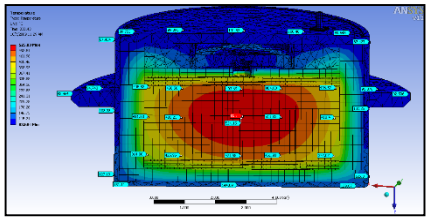
Drive Works Xpress SW

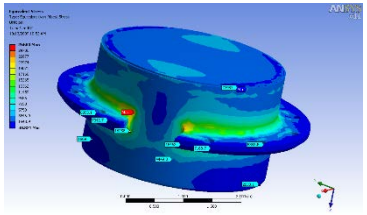
Parametric Model Output

ANSYS

FEA Model Output

High Fidelity modeling to support simplified thermal model. Supports mechanical stress analysis requirements from the customer. Identifies areas for potential risk: thermal runaway, high impedance, stress risers.





Using a combination of the latest software packages, EAS can generate thermal and mechanical models to reduce cost and time to PDR.

EnerSys Power/Full Solutions™

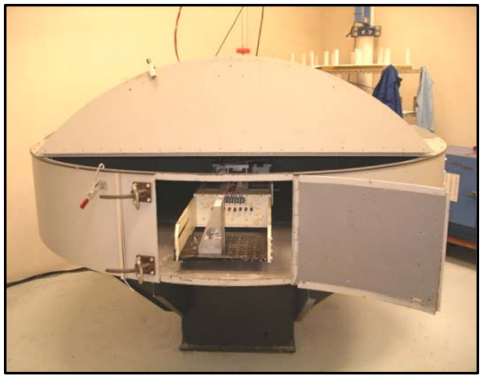
EAS Battery Test Capabilities

High-g Shock Tower
(simulate gun-fire conditions)

Temperature Cycling

Temperature Conditioning

Acceleration Table w/ Slip Rings

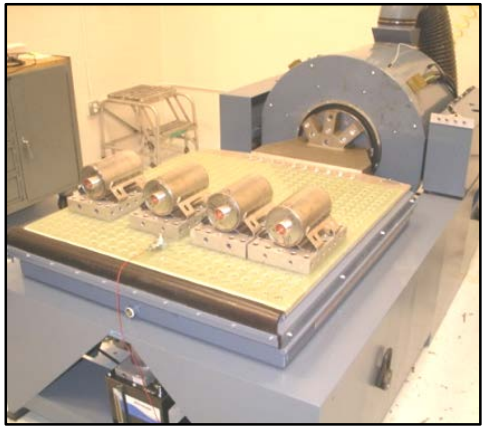


Salt Fog Chamber

Programmable Testers and
High-Speed Data Acquisition

Altitude Chamber

Vibration Tables / Slip Plates



Capabilities Support Full Range of Product Development, Qualification and Lot Acceptance Test Requirements
- **96 kW Programmable Load Not Shown**

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Powering the Smart Weapon

Our experienced team of thermal battery engineers at EAS Tampa are ready to discuss your specifications and how we can start powering your smart weapons!