

Space and Missile Systems Center



Rapid Innovation Fund-EnerSys
Proposal AFLCMC17-11.e.-P-769

Qualify Zero Volt™ – The Highest
“Usable Energy” Space Battery Cell

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Advanced Systems &
Development

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Overview

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- EnerSys & RIF FY17 BAA Overview
- Objectives of the Project
- Scope of Work & Tech Approach
- AIAA S-144-201X Objectives
- SMC S&T (Portfolio Architecture Corps, Innovation Office) Objectives
- SMC EN (Atlas Corps) Objectives
- Msn Area (Production Core) Objectives
- SMC Execution Plan/Next Steps



EnerSys & USAF FY'17 RIF BAA Program Overview

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- Background: ~\$250M/4 Services competing (w/ 12 other AF orgs) for the best RIFs
- SMC had 59 RIF white papers submitted to OSD addressing PEO-Space Requirements
- Four projects selected for funding to address high-impact needs
- Vendor proposal one of top 4 selected to “Qualify Zero Volt™ Technology”
- \$2.8M awarded to characterize and qualify new battery cell chemistry from a TRL 5.5ish to TRL 7



NSS Objectives of the Project

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- Characterize new chemistry
- Demonstrate new cell qualification standard AIAA S-144-201X for large and small cells
- Encourage establishment and adoption of an open standard cell compatible with NSS missions
- Compare qual performance of different-sized cells of same chemistry for apps in NSS Missions
- Exercise and evaluate industry consensus test criteria for cell qualification in NSS
- Transition Technology



Scope of Work for EnerSys

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- Characterize 72Ah/18650 Zero Volt™ Title III Chemistry
- Qualify 72Ah/18650 Zero Volt™ Title III cells to AIAA S-144-201X
- Provide AIAA S-144-201X qualification reports to SMC
- Test common configuration battery consistent with a SMC mission profile & begin life testing
- Commence qualification on a SMC type asset battery using SMC S-017



SOW for EnerSys con't (Tech Approach)

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- Zero Volt™ Technology Cells undergo destructive and non-destructive tests
- Parallel Testing path to minimize overall qual schedule meeting 6 month reqm't
- Validate required pre/post launch safety & performance attributes for SMC programs



AIAA-S-144-201X Objectives

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- Improve transparency of Qualification and Characterization Requirements for Space Qualified Batteries
- Enable modular/scalable batteries & min customer costs by reducing need for changes in msn-specific battery design, assembly, doc, & requal
- Encourage dual-source parts to reduce sole-source, single-source, and foreign-source risks
- Relieve government of requirement to maintain battery standards
- Document traceability to SMC's battery standards
 - SMC S-007
 - SMC S-016
 - SMC S-017
 - SMC S-018
- Traces compliance with 23 requirements documents
- Reduces reliance on subject matter expert's interpretation

RIF activity evaluates industry consensus approach



AIAA S-144-201X Qualification Report Data

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- General information
- Number of years on Calendar Life Test (LEO, MEO, HEO, GEO where applicable).
- Dates of all launches in LEO, GEO, and/or MEO
- Battery cell design description
- Drawing information
- Indication whether qualification passed or failed on the first try
- Qualification/Acceptance Test Procedures
- Chemistry
- Cell Capacity
- Cell Electrical Specifications



AIAA S-144-201X Qualification Report Data (cont'd)

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- Cell Mechanical Properties
- Temperature Range
- Pressure
- Graphs
- Tables
- Additional Data
- Acceptance Report
- Cell Formation Data Report
- In-Process Inspections and Tests
- Electronic copy of raw test data



SMC/ST's S&T Objectives

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- Characterize new chemistry
 - Destructive Testing
 - Additional Cell Testing
 - Non Destructive Testing
- Hardware Deliverables
 - 100 18650 Cells of Advanced Chemistry for Flight Experiments/Demo
 - 1 2P12S Battery (for SMC POR)



Destructive Testing

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- Internal pressure to which the cell housing/structure can withstand and contain
- Mass and torque that can be applied to the terminals
- Effects of cell mishandling (dropping)
- Effects of loss of charge control (overcharge conditions)
- Effects of loss of bus voltage control/load management control (over-discharge)
- Loss of thermal control exposing the Zero Volt™ cells to extreme high/low temperature conditions



Additional Cell Characterization Tests

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- Extended low temperature survival test at 0 Volts
- Extended high temperature survival test at 0V
- Recharge current limits after low temperature exposure at 0V
- Maximum charge rate at low and high temperatures at 0V
- Maximum discharge rate from 100% SoC at low and high temperatures



Non-Destructive Testing

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- Consistency of cell manufacture
- Verification of cell manufacturer's stated performance
- Verification of cells to a consensus set of environmental worst-case requirements
- Characterization of cell performance



SMC/EN Objectives

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- Ensure new chemistry will function properly in National Security Space applications
- Understand EnerSys/ABSL's commercial qual approach in relation to SMC standards
 - AIAA S-144-201X qualification reports to SMC EN
 - EN to accomplish a compatibility analysis to understand possible gaps & aid prgrm risk determination
- Review results of qualification for potential program insertion/transition



PEO Production Core Objectives

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- Enhanced Military Capability
 - Smaller spacecraft or spacecraft with higher mission capability using the same bus structure
 - Reduced mass satellites due to reduction of battery mass and dead bus hardware elimination
 - Satellites that are hardened to dead bus failure issue
- Reduces Costs
 - Conserving satellites that currently cannot recover from “dead bus” conditions
 - Using up to 50% less battery cells
 - Paying reduced launch costs due to battery mass reduction
 - Implementing a large-format “standard sized” battery cell for the first time in space history to reduce integration costs at the battery level
- Accelerated Military Development Capability
 - Status of specially-engineered devices to that of a commodity
- Transition Technology



SMC Execution/Next Steps

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- Test Readiness Review
 - Ensure that test regime will meet SMC objectives of the program
- SMC S&T/EN/GP Analyze Characterization and Qualification Reports
 - Identify NSS Applications
- Limited Period of Performance
 - RIF Project limited to 2 years however fully competed
 - Initiate but unable to complete full battery qualification
 - Partnership with major prime integrating contractor
 - Transition project to SMC or OGA
- AIAA Battery Standard
 - After the cell-level AIAA S-144-201X is released, industry consensus battery-level standards can be pursued, w/ experience gained from this RIF
- Utilize 100 18650 battery cells, & one 2P12S Battery for SMC &/or NSS assets



Questions!?

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