

# Standardizing Space Cells

Brad Reed, Associate Fellow, AIAA

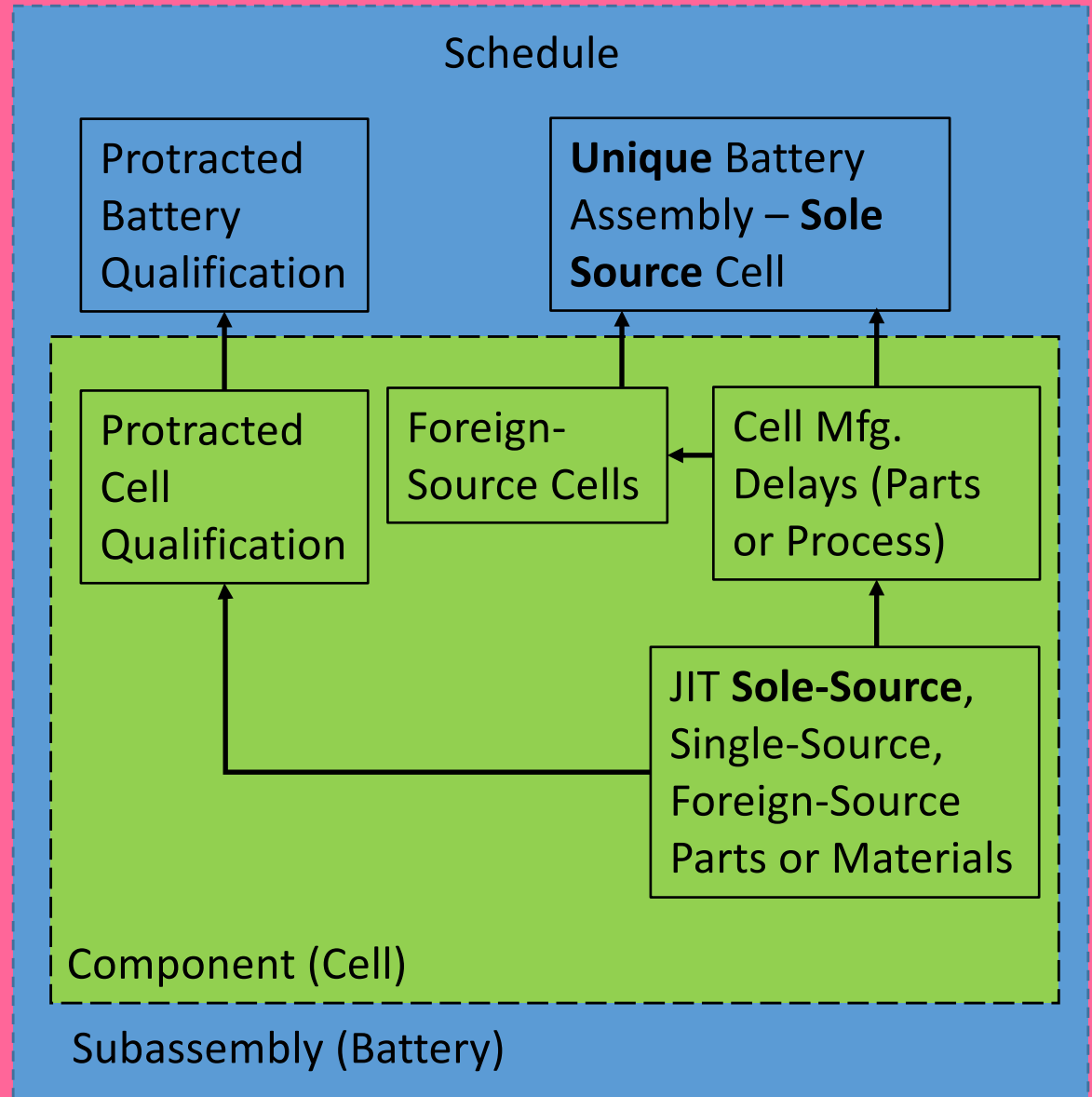
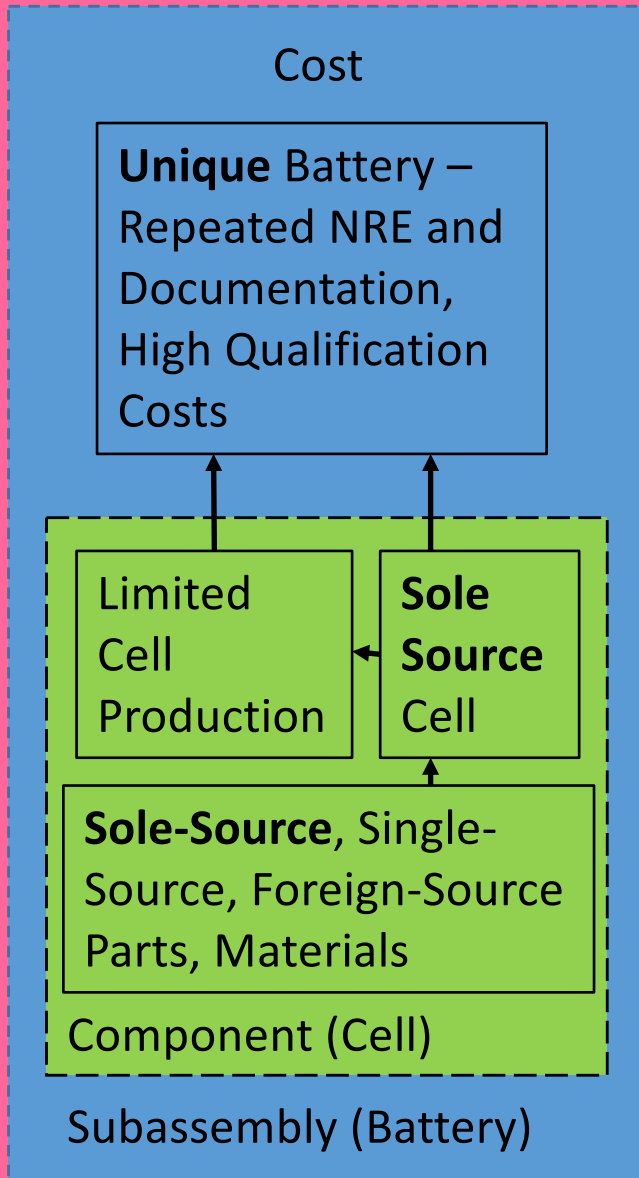
**NASA Aerospace Battery Workshop, November 16, 2016**

# Enterprise-Level Battery Cost/Schedule Issues Due to Cell Production Delays

- Enterprise Level: Global
  - Space Program Cost Delays for All Countries/Governments (\$B)
  - Human Cost of Delayed Assets
- Enterprise Level: Prime Contractor
  - Multiple levels of cost while spacecraft/satellite production sits idle due to mission-specific designs (\$M)

# Power Subsystem Impacts - Enterprise Perspective

## Risks



Assembly (Energy Storage)

# Systems Level Cost Issues for Large Space Batteries

- **Program Office Costs Due to Schedule Delays**
- **Prime Contractor Costs for Specialty Engineering:  
No Large Standardized Cells (50-75 A-h)**
- **Costs of Qualification**
- **Sole-Source, Single-Source, and Foreign-Source  
Cost Risks to Production**
- **Cell Manufacturer Costs: No Commoditization**

# Commoditization: Standardizing Li-ion Cell Sizes for Large Missions (NASA, USAF, Commercial)

- State of Practice (Small Missions)
  - 18650: Approximately the size of a “AA” cell, up to 3 A-h capacity
  - 26650: Approximately the size of a “C” cell, up to 6 A-h capacity
- **Goal: Commercial off the Shelf (COTS) Cell for Large Missions: Approximately 6.8” x 3.2” x 2” with up to 75 A-h capacity**

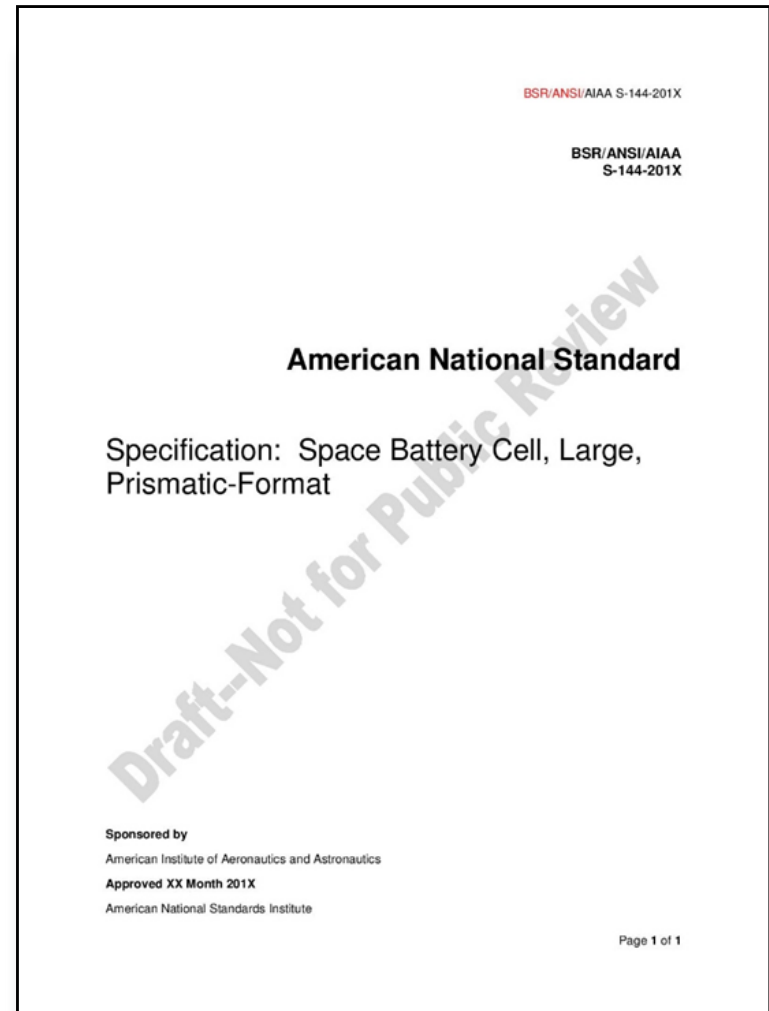


# Space Battery/Cell Commoditization

- April 2016: DLA Study indicated problems within the Prime Contractor/Battery/Cell supply chain
  - Study organizers encouraged by government, prime contractors, and cell manufacturers to help find solution
  - Design implementation of “common component” cell with standard outer cell dimensions is noted for 75 A-h cells
- May 2016: Seed document written for AIAA S-144-201X to standardize outer dimensions, qualification and acceptance testing, and data reporting for “common component” cell already built by multiple manufacturers
- June 2016: Editing of seed document performed by small steering committee of government and industry representatives.
- July 2016: Editing of steering committee document performed by larger working group, including range safety, DOT, and all other government and industry representatives.
- August 2016: Working group implements 8 of 9 pages of Aerospace Corporation proposed changes in document. Document submitted to AIAA. AIAA assembles CoS and obtains comments for final adjudication.
- September 22, 2016: Meet and greet of AIAA Committee on Standards members for subject matter editing of AIAA S-144-201X.

# AIAA Li-ion Space Cell Commoditization Committee on Standards (CoS): AIAA S-144- 201X

- AIAA CoS Includes Over 30 Organizations
  - Government Customers
  - Prime Contractors
  - Battery Assemblers
  - Cell Manufacturers
  - Range Safety (East and West)
- 10-year old “Standard” cell design (approximately 6.5”x3”x2”) produced by Saft, EaglePicher, Yardney, and Quallion
- Issue: Stockpiles of heritage NCA, LCO and MCMB may be exhausted in 3-4 years
- Solution: Two test programs being executed with “Standard” cell design using domestic precursor replacements NCA, LCO, and MCMB
- Tailorable standard to enable quicker new technology introduction
- AIAA S-144-201X under review



# AIAA Committee on Standards Participants

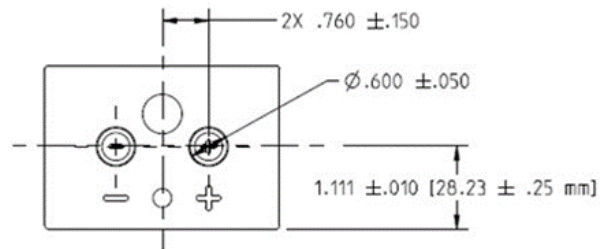
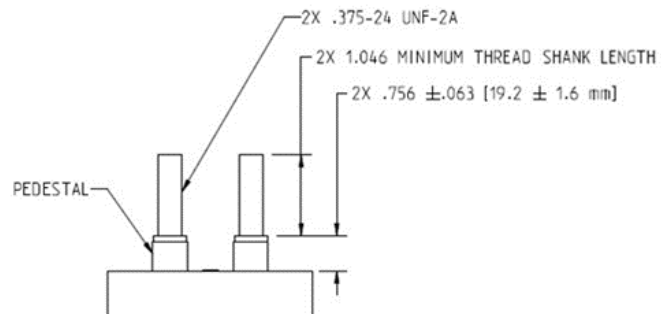
- Government
  - USAF Space and Missile Systems Center – AEHF, SBIRS, GPS, Launch Wing, Chief Engineer's Office, Chief Scientists Office
  - NASA – Glenn (ISS), Goddard (Space Science), Johnson (Planetary Missions), Marshall (Launch Vehicle)
  - NSWC Crane
  - Defense Logistics Agency
  - OGA
- Prime Contractors
  - Ball Aerospace, Boeing, Lockheed-Martin, Northrop-Grumman, Orbital/ATK, SpaceX
- Battery Assemblers
  - ABSL
- Cell Manufacturers
  - EaglePicher, GS Yuasa, Quallion, Saft, Yardney
- Range Safety
  - USAF Kennedy, NASA Kennedy, USAF Vandenburg, NASA Wallops
- FFRDCs, Consultants
  - Aerospace Corporation, Teledyne, Jet Propulsion Laboratory, Salim
- Academic
  - Kyushu Institute of Technology, Texas A&M



# COTS Cell

- 10-year-old “Standard” Cell Design
- Produced by Saft, EaglePicher, Yardney, and Quallion

Dimension	Nominal Measurement	Tolerance
Length	171.9 mm (6.768")	± 1.0 mm (.039")
Width	80.95 mm (3.187")	± .5 0 mm (.019")
Thickness	56.45 mm (2")	± .50 mm (.019")
Terminal Height Above Top of Cell	Up to 55.75 mm (2.222")	N/A
Fill Tube Height above Top of Cell	Up to 15.7 mm (.618")	N/A



# Stockpiles of Heritage NCA, LCO and MCMB Exhausted in 3-4 years

- USAF Title 3 domestic precursor replacements  
NCA, LCO, and MCMB
  - Under Test Since 2007
  - Currently Manufactured by Quallion/Energys (Santa Clarita, CA)
  - Currently Stockpiled by ongoing Defense Logistics Agency Program
- Two COTS cell test programs being executed
  - Government
  - Commercial
    - Lockheed-Martin
      - Sharing Qualification Data with all on AIAA CoS

# Standard AIAA S-144-201X: “Specification, Space Battery Cell, Large Format” Solutions

- Program Office Costs Due to Schedule Delays
  - **Reduces program office costs by providing COTS drop-in alternatives from multiple manufacturers**
- Prime Contractor Costs for Specialty Engineering: No Large Standardized Cells
  - **Minimizes customer costs by making batteries modular and scalable, reducing the need for changes in mission-specific battery design assembly, documentation, and requalification**
- Costs of Qualification
  - **Standardizes qualification and acceptance tests based on international requirements**
- Sole-Source, Single-Source, and Foreign-Source Cost Risks to Production
  - **Encourages dual-source parts to reduce sole-source, single-source, and foreign-source risks**
- Cell Manufacturer Costs: Commoditization
  - **Creates standardized reports and reporting formats, improving customer awareness of alternatives for new missions**
  - **Requires manufacturer transparency to resolve any issues that affect parts, materials, and processes, or form, fit, and function**
  - **Establishes one standardized cell in the 50-75 A-h range for large missions, developing an economy of scale for cell manufacturers**

# Summary

- AIAA Committee on Standards Formed to Address:
  - Program Office Costs Due to Schedule Delays
  - Prime Contractor Costs for Specialty Engineering: No Large Standardized Cells
  - Costs of Qualification
  - Sole-Source, Single-Source, and Foreign-Source Cost Risks to Production
  - Cell Manufacturer Costs: Commoditization
- AIAA S-144-201X Under Review
- **Proposed Standard to be Published in 2017**