xEMU Lite Development Plan

EVA Technology Workshop 2017

October 17, 2017

Liana Rodriggs
Advanced EVA Development Project Manager
Agenda

- History of EVA Technology Development efforts
- xEMU Lite Flight Demonstration Hardware Development Plan
History of EVA Technology Development Efforts
History of EVA Technology Development

• Since 2007, there has been a continuous effort by NASA to develop EVA technologies to enable future exploration missions
  – Incorporating lessons learned from 30+ years of EMU operations
  – Designing for the different environments of the potential destinations
  – Developing hardware that enables scientific exploration and supports the operational concepts of the potential destinations

• Development has occurred under several NASA programs but the team and overall development plan have remained essentially the same
History of EVA Technology Development

• 2007-2010: Exploration Technology Development Program (ETDP) focused on technologies for a lunar mission
  – Performed a PLSS schematic trade study to determine the combination of life support technologies that would best meet exploration mission needs
  – Advanced new system-enabling PLSS component technologies such as the Suit Water Membrane Evaporator (SWME) and Rapid Cycle Amine (RCA)
  – Began work on lunar-focused PGS technologies including bearings, Thermal Micrometeoroid Garment (TMG), and gloves
History of EVA Technology Development

• 2010-2011: Enabling Technology Development and Demonstration (ETDD) had the goal of developing and demonstrating prototype systems to support exploration goals
  – Continued EVA efforts from ETDP with the addition of SE&I activities
  – Integrated components into systems
  – Culminated in building and testing PLSS 1.0 and Z-1

PLSS 1.0 Breadboard

Z-1 Prototype Suit
History of EVA Technology Development

• 2011-2016: Advanced Exploration Systems (AES) and Space Technology Mission Directorate (STMD)
  – Focused on maturing component technologies, integrating them into prototype systems, and demonstrating them in testing
  – Culminated in building and testing PLSS 2.0 and Z-2
History of EVA Technology Development

- **2016-2017: ISS Program**
  - Continued to advance the TRL of EVA Suit technologies with the goal of developing a NASA reference concept with the capability to support missions at ISS and cis-lunar space
  - Focused near-term development on a “Lite” version of the xEMU, which defers some capabilities
  - Assembled and conducted an electrical live loads test of the xPLSS
  - Performed 19 NBL runs with Z-2

![xPLSS Electrical Live Loads Configuration](image1)

![Z-2 Ingressing the Airlock in the NBL](image2)

![Z-2 Foot Restraint Evaluation in the NBL](image3)
xEMU Lite
Flight Demonstration Hardware
Development Plan
Transition to Flight Hardware Development

• The technologies developed over the last 10 years are now being pulled into a flight hardware development effort

• Starting in FY18, the project objective is the development of the xEMU Lite for a flight demonstration on ISS
  – Demonstrate core suit capabilities needed for the full xEMU for exploration missions

• The in-house NASA Advanced EVA Development team that has been performing EVA technology development will design the xEMU Lite and build a single flight demonstration unit
  – NASA will be procuring components and will perform the role of system integrator
Project Organization

ISS Program

EVA Office

Advanced EVA Development Project
Manager: Liana Rodriggs

Systems Engineering & Integration
Lead: Ben Greene

Pressure Garment Subsystem
Lead: Amy Ross
Deputy: Richard Rhodes

Portable Life Support Subsystem
Lead: Colin Campbell
Deputy: Carly Meginnis

Safety & Mission Assurance
Lead: Terri Castillo

Informatics Subsystem
Lead: Chris Gerty
Deputy: Lucas Kinion
xEMU Lite Architecture

- The xEMU Lite is a subset of the fully outfitted xEMU, with non-critical capabilities deferred.
- Details of the architecture are captured in the Architecture Description Document.
- The Product Breakdown Structure identifies and organizes the hardware and software deliverables for the project.
## xEMU Lite vs xEMU

### xEMU Lite ISS Demonstration

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<tr>
<th>Feature</th>
<th>xEMU Lite</th>
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<td>Operating Pressure</td>
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<td>Design Environment</td>
<td>LEO, Microgravity</td>
<td>Deep Space Microgravity, Surface</td>
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<td>Mobility</td>
<td>Upper Torso + Min. Lower Torso</td>
<td>Upper Torso + Full Lower Torso</td>
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<td>Crew Autonomy</td>
<td>Scarred for future upgrade</td>
<td>Graphical Display</td>
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### xEMU Deep Space EVA
- For
  - Gateway and Mars Transit
xEMU Lite Development Assumptions

• 3 complete hardware iterations will be built
  – Design Verification Test (DVT) prototype – pre-qualification testing
  – Qualification unit
  – Flight unit
• The flight demo will be performed with a single xEMU Lite suit
• Flight demonstration objectives and a concept of operations will be developed prior to SRR
  – Dual suit operations with EMU
  – Multiple EVA’s over a period of time
• Goal is to design the xEMU Lite to meet as many of the xEMU requirements as feasible within cost and schedule constraints, but it will be certified for a demo, not for full EMU replacement or xEMU (ex. Life requirements)
  – Details are being worked out in preparation for the project Systems Requirement Review (SRR)
• Work is underway to determine best approach to interface xEMU Lite with the ISS airlock
  – Permanent vs. temporary approaches are being considered
### Tentative Schedule

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<th>xEMU Lite Milestones</th>
<th>FY18</th>
<th>FY19</th>
<th>FY20</th>
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<td>SRR</td>
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<td>DVT Build/Test</td>
<td>CDR</td>
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- Project-level System Requirements Review (SRR) in January 2018
- PLSS Subsystem design TIM in late spring 2018
  - Informal peer review
- PGS Subsystem design TIM in fall of 2018
  - Informal peer review
- Project-level Preliminary Design Review (PDR) in mid-2019
  - Initial assumption is that we will have a series of component PDR’s leading to the system review
- Project CDR in FY21
- Flight demonstration by mid-2020’s
## FY18 Plan Overview

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### Hardware development
- PM
- SE&I
- PLSS
- PGS
- INFO
- S&MA

### Requirements & I/F & Testing
- PM
- SE&I
- PLSS
- PGS
- INFO
- S&MA

### DVT Assy (Qty 1)
- PLSS

### Z-2.5 NBL Testing
- PGS
## FY19 Plan Overview

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**Legend:**
- Hardware development
- Requirements & I/F & Testing

[Diagram]

**Notes:**
- PM: Project Management
- SE&I: System Engineering & Integration
- PLSS: PGS Lite System
- PGS: Platform Group
- INFO: Information
- S&MA: Support & Management Assistant
Questions?