13kW Advanced Electric Propulsion Flight System Development and Qualification

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OUTLINE

• Power and Propulsion Element

• Advanced Electric Propulsion System (AEPS) Program Summary
  – Requirements

• AEPS Component Development Progress

• AEPS Qualification

• Summary
PPE PROVIDES FOR A DEMONSTRATION OF AEPS

PPE is the first element of NASA’s Gateway and is key to accomplishing the Artemis lunar exploration goals.
**PROGRAM ELEMENTS**

**Current Activity**
On-going development testing of the AEPS components (Thruster, PPU and XFC)

**Future Activity**
CDR
Qualification testing of the AEPS Components and EP String Wear testing

AEPS Goal is to Qualify a 12.5 kW Hall Thruster EP System
## Key Requirements and Capabilities

*Flexibility in Power and Discharge Voltage provide for a robust design*

<table>
<thead>
<tr>
<th>EP String Total Input Power</th>
<th>Discharge Voltage</th>
<th>Thrust (mN)</th>
<th>Specific Impulse (s)</th>
<th>Total System Efficiency</th>
<th>System Mass†</th>
</tr>
</thead>
<tbody>
<tr>
<td>13.5 kW</td>
<td>600 V</td>
<td>589</td>
<td>2600</td>
<td>57%</td>
<td>123 kg</td>
</tr>
<tr>
<td>11.3 kW</td>
<td>500 V</td>
<td>519</td>
<td>2400</td>
<td>55%</td>
<td></td>
</tr>
<tr>
<td>†Excludes cable harnesses</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9.1 kW</td>
<td>400 V</td>
<td>462</td>
<td>2200</td>
<td>54%</td>
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<tr>
<td>7.0 kW</td>
<td>300 V</td>
<td>386</td>
<td>1800</td>
<td>52%</td>
<td></td>
</tr>
</tbody>
</table>

Performance Range Meets PPE Needs and Allows Mission Flexibility
PROGRESS ON AEPS DEVELOPMENT

Development Testing has begun on the AEPS EP String Components

Engineering Test Unit Thruster

Breadboard PPU with STE

Xenon Flow Controller
AEPS Qualification Test Objectives

Objectives

- Complete formal verification of component and system environmental and life requirements
  - PPU
  - HCT
  - XFC
  - System
- Determine if the system has any operational restrictions over life

Hardware/Process Maturity

- Flight production hardware built to formally released and configuration controlled drawings and work instructions
- Full material traceability
- Qualified processes
- Formal quality control during assembly and test

Test Scope

Environmental Testing: Qual String #1

- Flight production PPU, HCT, XFC subsystem acceptance tests
- Subsystem level qual vibe, shock
- Subsystem level TVAC/EMI/EMC
- System level hot fire test
- Thruster radiated emissions

Wear Testing: Qual String #2

- Flight production PPU, HCT, XFC component acceptance test
- System level hot fire test
- System level wear test

Parallel Env & Wear Testing Yields Results Prior to First Launch

Two Qual Units Allow Separation of Environmental and Life Testing
AEPS QUALIFICATION TEST LOGIC

Qual String #1 – Environmental

- PPU Acceptance Testing (Functional, Vibration, Thermal Vacuum)
- HCT Acceptance Testing (Functional, Vibration)
- XFC Acceptance Testing (Functional, Vibration)
  - Ref. Hot-Fire at GRC
  - HCT Qual Vibration and Shock Testing
  - XFC Qual Vibration and Shock Testing

Qual String #2 – Hot Fire and Wear Testing

- Individual String Elements (PPU, HCT and XFC) Subjected to Acceptance Testing Only
  - Ref. Hot-Fire at GRC
  - Conduct LIF
  - Conduct 4500 hour Wear Test
  - Ref. Hot-Fire at GRC
  - Qualification Testing Complete
  - Qual String #2 Turned Over to NASA for Additional Wear Testing

PPU Qual Vibration & Shock Testing
HCT Qual Vibration and Shock Testing
XFC Qual Vibration & Shock Testing

PPU TVAC, EMI/EMC and Power Quality Testing
Conduct TVAC at JPL (ETU/EDU PPU & EDU XFC)
Conduct Radiated Emissions Test at Aerospace Corp.

Qualification Testing Complete

Subsystem Level
EP String Level
Ref. Hot-Fire at GRC
Ref. Hot-Fire at GRC
Ref. Hot-Fire at GRC
Conduct LIF
SUMMARY

• ETU hardware entering development testing
• CDR planned after development testing – Summer 2020
• Qualification testing begins in mid-2021
• AEPS slated for PPE flight in late 2022

AEPS is an enabling technology for large-scale NASA & Commercial Missions
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