NASA Progress on the Development and Qualification of a 12-kW Hall-Effect, Solar Electric Propulsion Thruster

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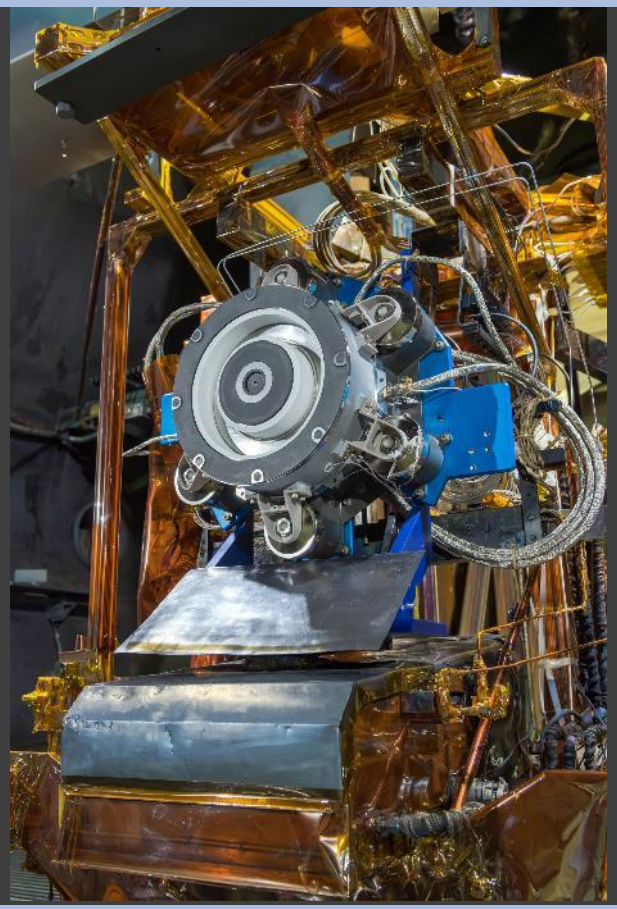
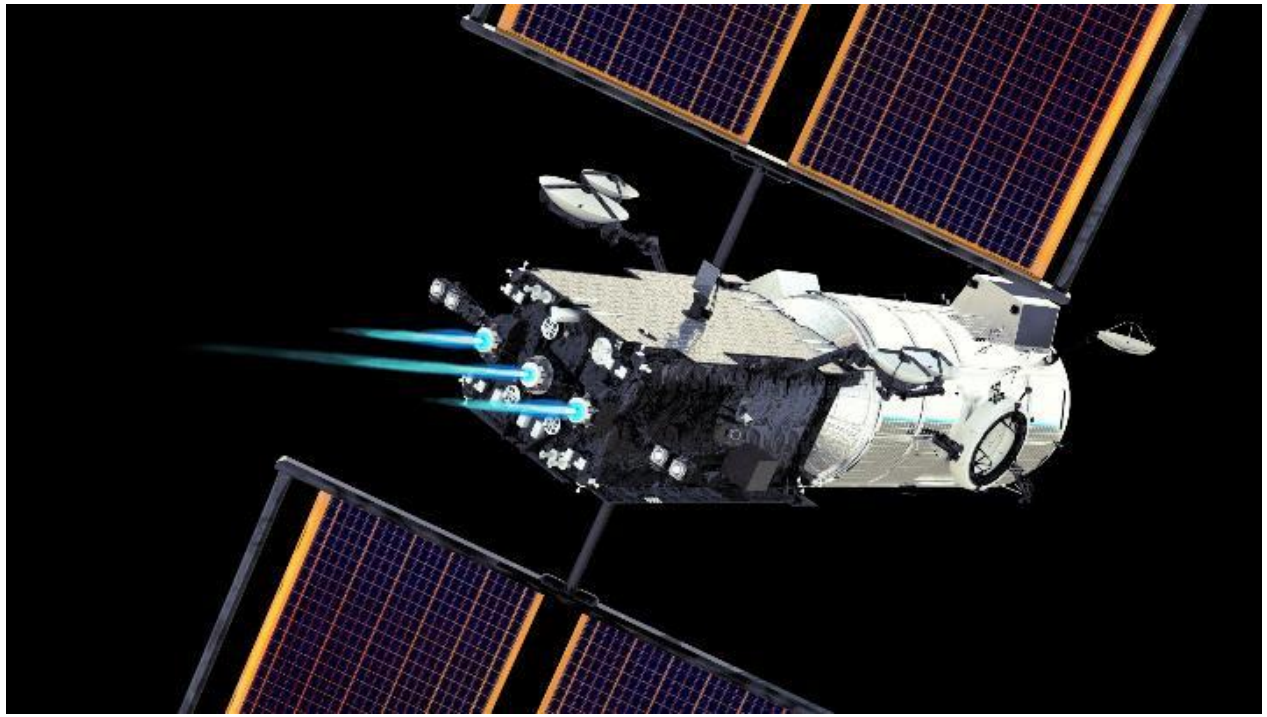
NASA Technology Demonstration Missions (TDM)



Solar Electric Propulsion (SEP) Project Overview



Project Description	Key Information
The Solar Electric Propulsion (SEP) project is developing and qualifying an advanced 12 kW Electric Propulsion (EP) thruster to the Power and Propulsion Element (PPE) requirements, which are applicable to human/robotic exploration and commercial spaceflight missions. SEP technology development includes a 12 kW magnetically shielded Hall thruster.	Project Phase: D Milestone Dates: Qualification System Acceptance Review (QSAR) #1: Q1FY2026 QSAR#2: Q3FY2027 Qualification Wear Test (23,000 hours) Complete: Q2FY2029

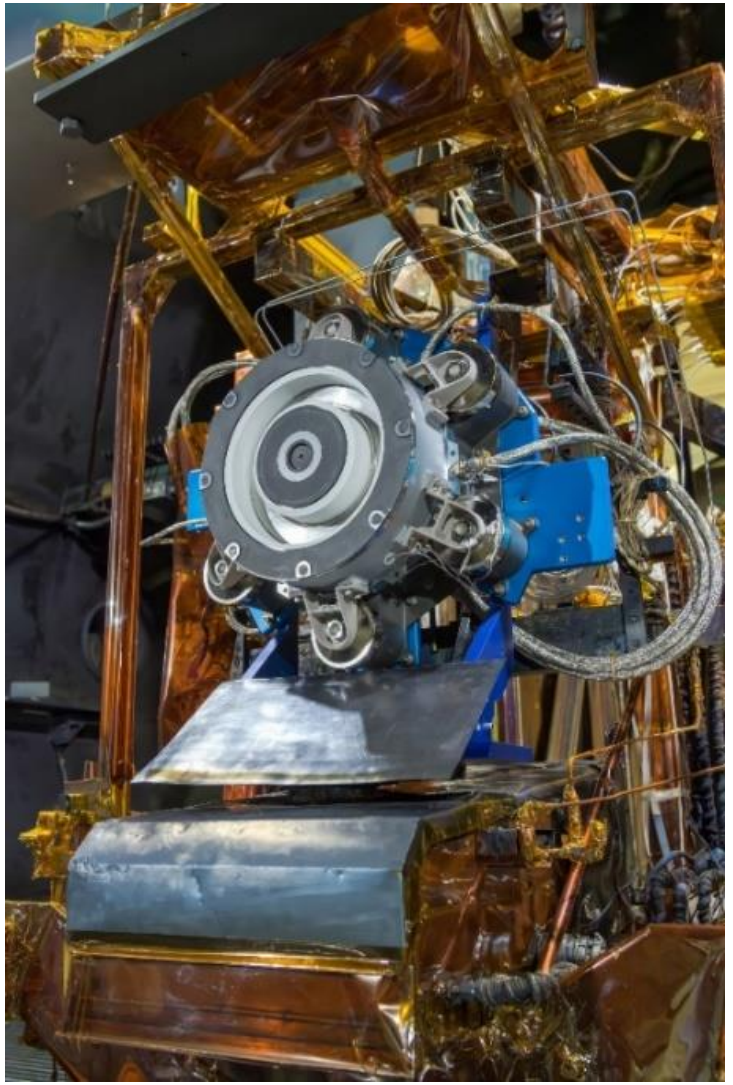
SEP Project

The SEP Project focuses on the following activities

- **Develop, manufacture, and qualify high-power (12 kW) next generation electric propulsion thruster for space flight system integration**
- **Mature manufacturing processes** to enable a commercially available high-power electric propulsion thrusters for space vehicle integration
- **Complete qualification of 12 kW Advanced Electric Propulsion System (AEPS) thruster** to include qualification wear-testing to at least 100% of the PPE mission-based throughput requirement of 23,000 hours per thruster
- **Reduce interface and plasma interaction uncertainty** to improve demonstration of mission success and enable private-sector infusion to enhance future exploration application of the SEP/AEPS technologies
- **Publish and distribute** electric propulsion thruster life qualification, plasma plume model predictions, and interface information to allow for US private sector assessment, understanding, and infusion of the electric propulsion system
- **Develop the interface between the mission user (PPE) and electric propulsion contractor (L3 Harris Aerojet Rocketdyne)** to ensure electric propulsion requirements, capabilities, and qualification meet the mission needs

AEPS Thruster Overview

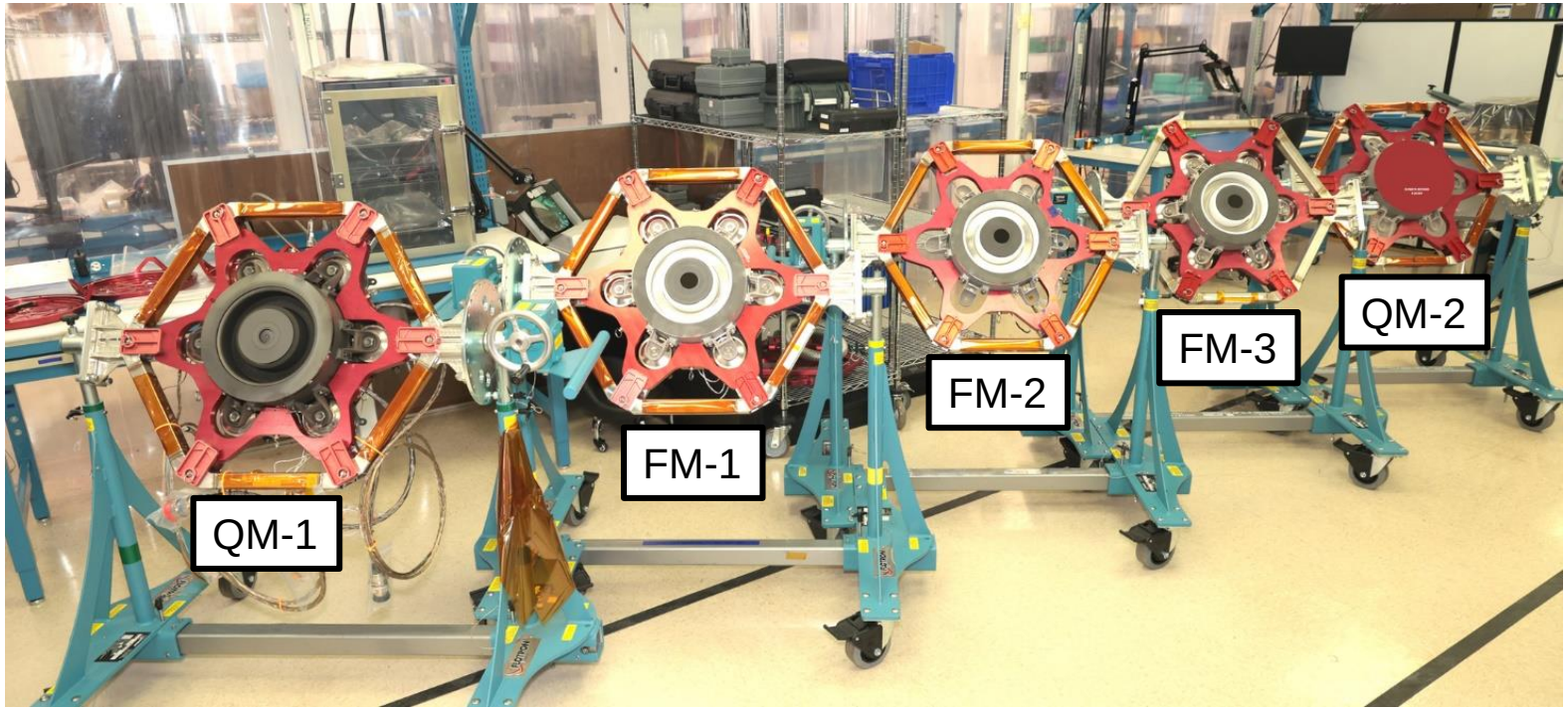
- **The 12-kW AEPS thruster is based on the NASA-developed Hall Effect Rocket with Magnetic Shielding (HERMeS)**
  - Aerojet Rocketdyne (AR) utilized the HERMeS design while making modifications to improve manufacturability, structural robustness, cycle life capability, and ease of spacecraft integration
- **Thruster envelope of 210 mm height x 530 mm diameter with 53 kg maximum mass**
- **Three harnesses provide discharge power, auxiliary power for cathode and magnet components, and power for thermal components (magnet heaters and temperature sensors)**
- **Throttle-able from 300 V, 6 kW to 600 V, 12 kW**
- **At full power, delivers ~600mN of thrust and ~2800s of specific impulse**
- **First mission is on the Power and Propulsion Element (PPE) for NASA's Gateway lunar space station**



AEPS QM-1 installed within Vacuum Facility 5 (VF-5) at NASA Glenn Research Center (GRC)

AEPS Production Status

- **The AEPS contract was awarded to L3 Harris Aerojet Rocketdyne (AR) in 2016**
- **AR is on contract to develop and qualify the 12-kW AEPS thruster design, and deliver three flight model (FM) thrusters to NASA for use on PPE**
- **AEPS successfully passed Critical Design Review (CDR) in March 2022**
- **Qualification Model 1 (QM-1) fabrication completed in April 2023**
  - Presently undergoing environmental testing
- **Acceptance testing of flight thrusters expected to begin in 2024, with deliveries completed in 2025**

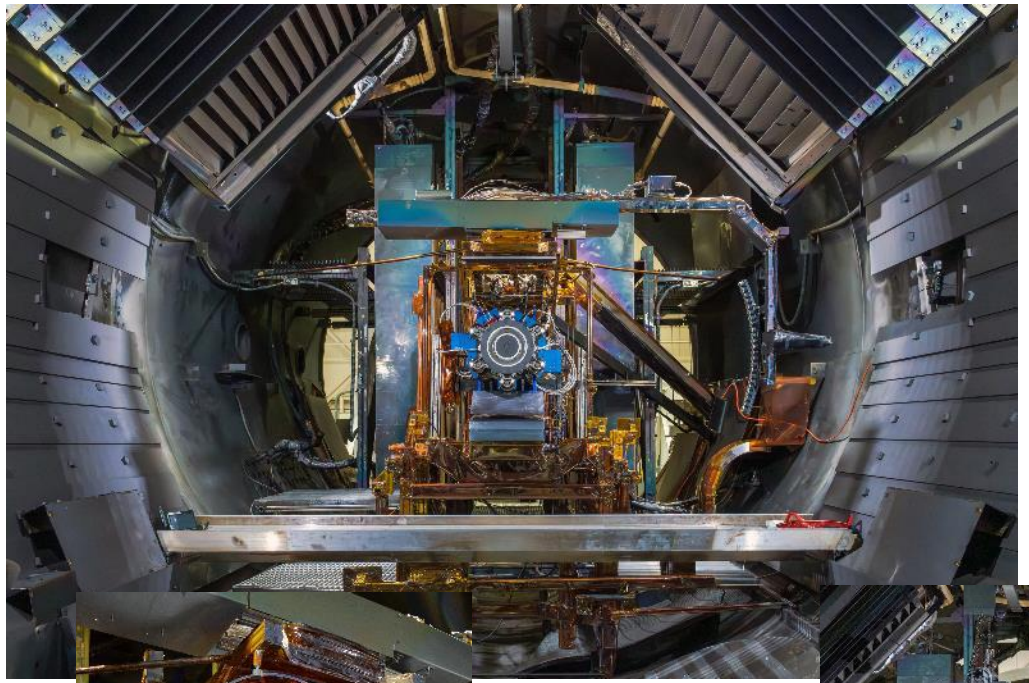


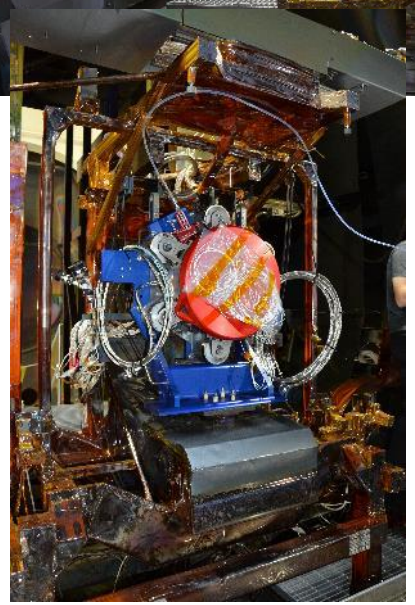
AEPS qualification and flight thrusters at Aerojet Rocketdyne facility in Redmond, WA

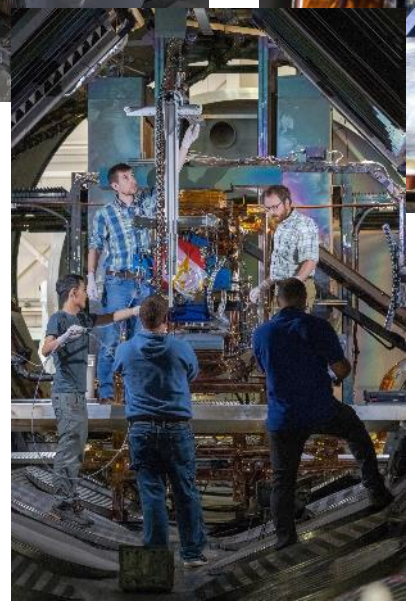
AEPS Qualification Acceptance Testing

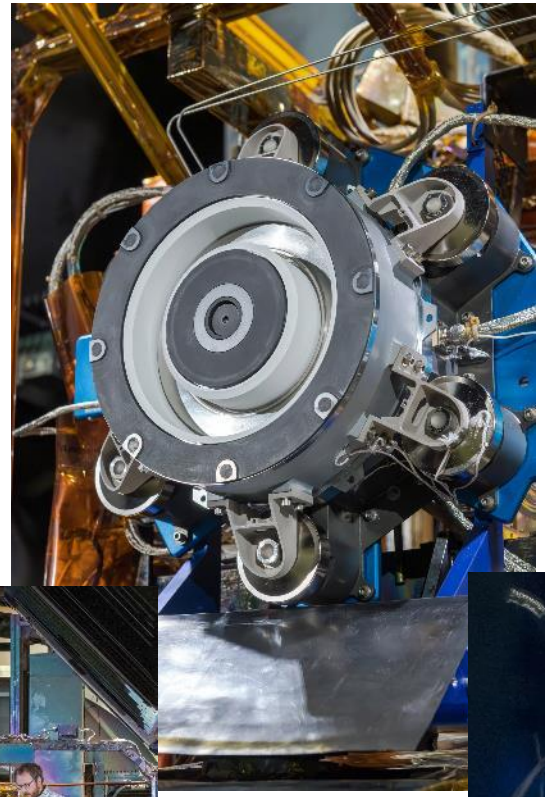
- **QM-1 subjected to acceptance testing identical to flight model thrusters**
  - Includes acceptance vibration testing (AR in Redmond, WA) and an acceptance hot fire (NASA GRC)
  - Thruster subjected to random and sine vibration at acceptance levels for all three axes
  - Electrical health checks and low-level sinusoidal sweeps both before and after test indicated no change in electrical or structural characteristics
- **QM-1 hot-fire included performance characterization at four nominal operating conditions (600 V and 9, 10, 11, 12 kW) as well as an acceptance test thermal cycle**
- **QM-1 met all AEPS requirements and could proceed into qualification testing**

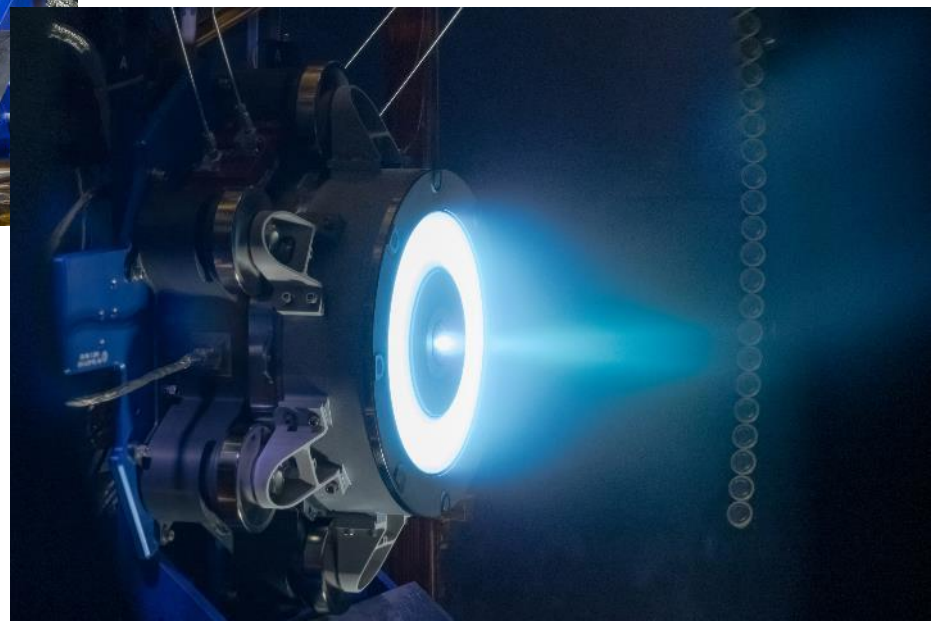
QM-1 Testing











SEP in the News

NASA, Aerojet Rocketdyne Put Gateway Thruster System to the Test – NASA

https://www.nasa.gov/centers-and-facilities/glenn/nasa-aerojet-rocketdyne-put-gateway-thruster-system-to-the-test

"Led by NASA's Technology Demonstration Missions program, the Advanced Electric Propulsion System (AEPS), built by Aerojet Rocketdyne, provides 12 kilowatts of propulsive power – over two times more powerful than current state-of-the-art in-space electric propulsion systems."

True Blue: High-Power Propulsion for Gateway – NASA

https://www.nasa.gov/image-article/true-blue-high-power-propulsion-for-gateway/

"The blue hue of the Advanced Electric Propulsion System (AEPS) is seen inside a vacuum chamber at NASA's Glenn Research Center in Cleveland during recent thruster qualification testing. This 12-kilowatt Hall thruster is the most powerful electric propulsion thruster in production, and it will be critical to future science and exploration missions at the Moon and beyond."

"The Solar Electric Propulsion project is led at NASA Glenn and managed by NASA's Technology Demonstration Missions program under the agency's Space Technology Mission Directorate."

First Alert Focus: Rocket testing at NASA Glenn Research Center

https://www.cleveland19.com/video/2024/03/25/first-alert-focus-rocket-testing-nasa-glenn-research-center/

SEP Summary

The AEPS thrusters will meet PPE mission needs

- Hardware exceeds minimum PPE requirements for performance, life, thermal and structural margins

Thruster design successfully passed CDR in 2022 with qualification activities and flight hardware fabrication underway

QM-1 thruster successfully underwent pre-environmental characterization, qualification vibration and shock testing, with TVAC testing expected to occur later in 2024

Component and cathode qualification testing is ongoing

Flight hardware fabrication and testing expected to be completed in 2025


TDM
NASA
Questions?