National Aeronautics and Space Administration

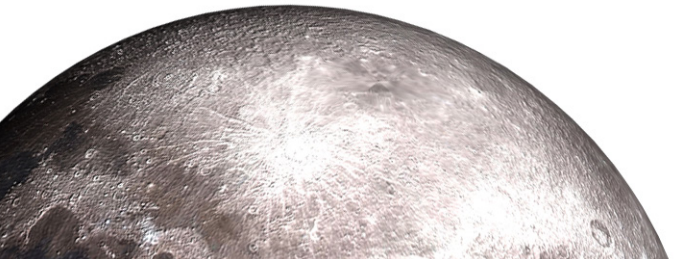
Robotic Refueling Mission 3:

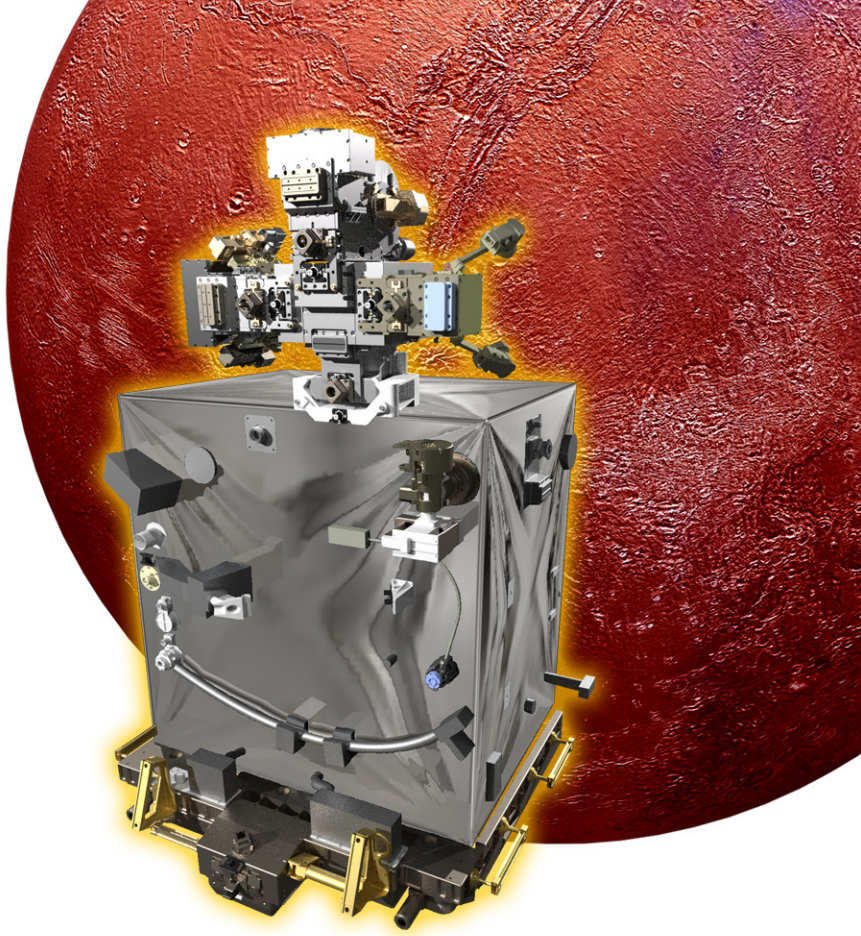
Advancing Servicing Technologies and Driving Exploration

The key to a long journey is fuel. This is as true in space as it is on Earth. Imagine packing all the gas necessary for a yearlong road trip—there wouldn't be much room for anything else! Refueling spacecraft throughout long duration missions, just like refilling your gas tank on a road trip, would leave additional room for other mission-critical supplies.

As an exterior payload on the International Space Station, the Robotic Refueling Mission 3 (RRM3) will demonstrate innovative methods to store and replenish cryogenic fluid in space. These fluids have chemical and physical properties that make them useful for spaceflight, but storing them is tricky because they boil off over time. In addition to replenishing cryogenic fluid, RRM3 will store it for six months with zero boil off to demonstrate the efficient use of these important consumables. RRM3 builds on two previous robotic refueling technology demonstrations—RRM1 and RRM2.

Not only could these technologies make refueling spacecraft in orbit possible, but the resulting capabilities could also be applied to exploration missions to the Moon and Mars.



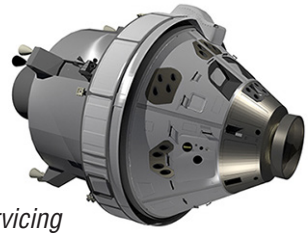


RRM3 Module: *The washing machine-sized module contains tanks and transfer lines on the inside and a tool pedestal on the outside (top). Together, they will test the storage and transfer of liquid methane, a type of cryogenic fluid, in space for the first time. RRM3 will also help lay the foundation for transferring xenon, an efficient propellant used for solar electric propulsion.*

What is Cryogenic Fluid?

Cryogenic fluid is an important consumable for spaceflight. As a propellant it produces high thrust, or acceleration, making it powerful enough to launch a rocket from Earth or another planet. Liquid oxygen, another cryogenic fluid, is used in astronaut life support systems.

Cryogenic fluid is also useful for spacecraft operations. It can serve as a coolant to keep spacecraft operational. If cryogen supplies are replenished, the lifespan of spacecraft could be extended by years.



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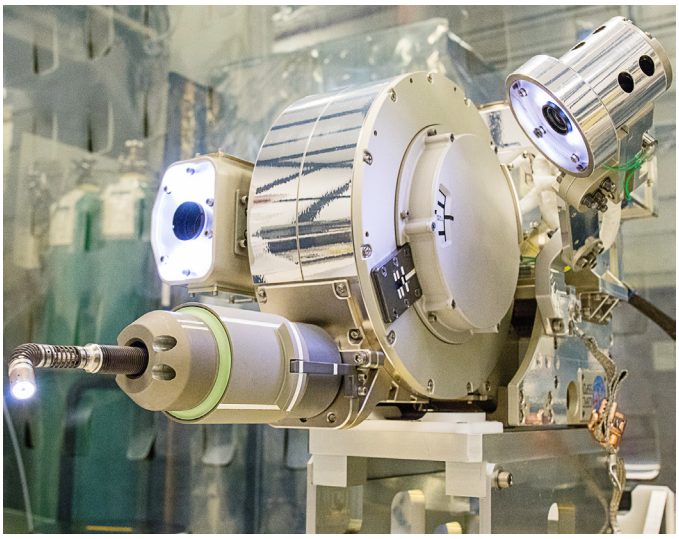
Specialized Tools to Demonstrate Technologies

A suite of three primary tools, designed to be used by the space station's Dextre robotic arm, will conduct RRM3 operations. The tools will enable the transfer of cryogen from the source tank to the receiver tank, both contained within the RRM3 module.



Engineer with the cryogen servicing tool (left) and the Visual Inspection Poseable Invertebrate Robot 2 (VIPIR2) (right)

Cryogen Servicing Tool:

Connects the source tank to the receiver tank to allow for cryogen transfer.

Multi-Function Tool 2 (MFT2):

Operates adapters for cryogen transfers.

Visual Inspection Poseable Invertebrate Robot 2 (VIPIR2):

Verifies proper cryogen transfer between tanks using a state-of-the-art robotic inspection camera.

To the Moon, Mars and Back

A refueling and efficient cryogen storage capability in space will help crewed missions embark on longer journeys to the Moon and Mars.

Hydrogen and oxygen (two types of cryogenic propellant) from water found on the Moon could be separated and used as fuel. With a refueling capability at the Moon, missions launching from Earth could significantly reduce their fuel load.

For crewed Mars missions, departure rockets could be refueled by converting the planet's atmosphere into liquid methane (another type of cryogenic propellant).

For long duration space travel, spacecraft transporting astronauts will need to store liquid oxygen, a cryogenic fluid, to maintain life support systems. Future deep space or planetary habitats will also require large and renewable supplies of liquid oxygen.

Mission Facts

Launch / Lifespan: No earlier than December 2018 / Two years

Location: International Space Station, ExPRESS Logistics Carrier 1

Management: Technology Demonstration Missions program within the Space Technology Mission Directorate at NASA Headquarters and the Satellite Servicing Projects Division at NASA's Goddard Space Flight Center

For more, see
https://sspd.gsfc.nasa.gov/RRM3.html
Media resources:
https://svs.gsfc.nasa.gov/12798