ARTEMIS MOON AND MARS NUCLEAR POWER

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INTRODUCTION

Competing with Russia, China and India, the USA is announcing plans to fast-track the building of a nuclear fission reactor on the moon. According to a NASA directive:

> "To properly advance this critical technology to be able to support a future lunar economy, high power energy generation on Mars, and to strengthen our national security in space, it is imperative the agency move quickly."

The Artemis program is a Moon exploration program led by the United States' National Aeronautics and Space Administration, NASA formally established in 2017. It intends to reestablish a human presence on the Moon for the first time since the Apollo 17 mission in 1972, with the goal of eventually facilitating human missions to Mars. It includes a series of missions, starting with Artemis I, which, was an uncrewed test flight, followed by the crewed Artemis II mission in 2026.

In Greek mythology, Artemis, twin sister of Apollo, is the goddess of the hunt, the wilderness, wild animals, nature, vegetation, childbirth, care of children, and chastity. In later times, she was identified with Selene, the personification of the Moon. She was often said to roam the forests and mountains, attended by her entourage of nymphs.

In versions of the myth, Artemis was born first, but other storytellers variate the myth by having Apollo born first. The goddess was said to have helped her mother birth Apollo before her, and hence the naming of the Artemis program to follow the earlier Apollo moon program.

LUNAR ACCESS HISTORY

The last crewed mission to the Moon was Apollo 17, which landed in December 1972 and returned to Earth later that month. In all, 24 astronauts have travelled to the Moon and 12 of them have walked on its surface, all during the Apollo program. Of the 24 to have been to the Moon, just five are still alive.

The USA first went to the Moon in the 1960s, primarily in competition with the Union of Socialist Soviet Republics USSR to assert its geopolitical and technological dominance. Once that goal was achieved, political enthusiasm and public interest ebbed out. The Artemis program grew out of a desire to return humans to the Moon, but this time for a longer-term presence built around new technology and commercial partnerships.

Several other countries have ambitions to put people on the Moon in the 2030s. European astronauts are set to join future Artemis missions and Japan has also secured seats.

China is building its own craft, targeting a first landing near the Moon's south pole by 2030.

Russia continues to talk about flying cosmonauts to the surface and building a small base sometime between about 2030 and 2035.

India has also expressed ambitions to some day see its own astronauts walking on the Moon. Following the success of India's Chandrayaan 3's landing near the lunar south pole in August 2023, India's space agency set out a goal of sending astronauts to the Moon by about 2040.

ARTEMIS PROJECT

The USA lunar program is called Artemis. In Greek mythology, the goddess Artemis is the sister of Apollo. She allowed him to be born first before her. A budget of $93 billion is allocated to NASA for this project.

Its first major milestone is supposed to return American astronauts to the moon in 2027. However, there is little chance of hitting that target, as critical components are still in development. China is planning to land an astronaut on the moon by 2030.

Figure 1. USA depiction of an unrealistic surface lunar base due to space radiation. Lunar volcanic underground lava tubes would be a more realistic alternative. Source: NASA.

NUCLEAR POWER NEED

Micro-nuclear reactors are considered essential to a sustained presence on the moon because lunar days and lunar nights last for two weeks each, rendering photo-voltaic solar panels and batteries insufficient.

Because of high space radiation levels without a protective atmosphere as well as identified high-voltage electrostatic dust charges, a lunar base may have to be sheltered in underground volcanic lava tubes.

If one stays in one spot on the moon, he does not experience day and night as the moon is not spinning around itself and is inertially coupled to the earth.

NASA is assigning a leader of the nuclear-reactor project and gathering industry perspectives. The overarching goal is to launch a nuclear reactor with at least 100 kilowatts of generation power by late 2029.

Earlier NASA design work had a smaller, 40-kilowatt reactor weighing more than five metric tons. The contracted designers for that effort with about an initial $5 million each were Lockheed Martin, Westinghouse and IX, a joint venture of Intuitive Machines and X-Energy. UK's Rolls-Royce said it was soliciting space-industry partners to develop a micro-nuclear reactor suitable for Artemis.

The United States tested the SNAP-10A nuclear reactor in space for 43 days in 1965. The USSR sent about 40 nuclear-electric satellites into space, mostly powered by the BES-5 reactor. The more powerful TOPAZ-II reactor produced 10 kilowatts of electricity.

ARTEMIS II LAUNCH [3]

The first crewed Moon mission in more than 50 years is to be launched by Nasa on the first week of February 2026. Nasa would roll out its gigantic new Space Launch System (SLS) Moon rocket and Orion Space Capsule from the Vehicle Assembly Building (VAB) to the launch pad.

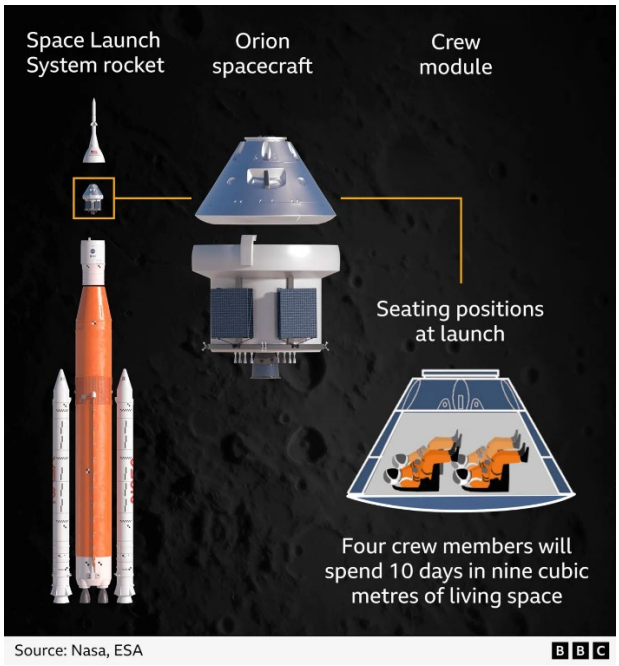

Figure 2. Artemis II space vehicle.

The Artemis II mission will last about 10 days, could take its astronauts further into space than anyone has been before. It aims to set the stage for an eventual human landing on the lunar surface for the first time since the Apollo missions of the 1960s and 1970s.

The Crawler-Transporter-2 takes up to 12 hours to move the space vehicle to the launch pad. Once there, engineers would carry a series of launch pad preparations, including connecting ground support equipment such as electrical lines, fuel environmental control system ducts, and cryogenic propellant feeds.

As well as the rocket being ready, the Moon has to be in the right place too, so successive launch windows are selected accordingly. This means one week at the beginning of each month during which the rocket is pointed in the right direction followed by three weeks where there are no launch opportunities.

Artemis II's mission involves the first crewed flight of the SLS and Orion. Upon launch, they have to maneuver an escape from the high radiation levels in the Van-Allen radiation belts.

Once they are safely in orbit, the astronauts will test how the Orion spacecraft handles. This will involve manually flying the capsule in Earth orbit to practice steering and lining up the spacecraft for future Moon landings. They will then head out to a point thousands of kilometers beyond the Moon to check Orion's life-support, propulsion, power and navigation systems. The crew will also act as medical test subjects, sending back data and imagery from deep space.

They will work in a small cabin in weightlessness. Radiation levels will be higher than on the International Space Station, which is in low-Earth orbit, but still safe. On return to Earth, the astronauts will experience a bumpy and fiery return through the atmosphere and a splashdown off the west coast of the USA in the Pacific Ocean.

ARTEMIS III MISSION

The launch of Artemis III will take place no earlier than 2027. It is believed 2028 is the earliest possible date. The final choice of a spacecraft to take the crew down to the lunar surface has not yet been made. It will either be the SpaceX's Starship Lander or a craft designed by Blue Origin. New spacesuits made by USA company Axiom are also being developed.

The Artemis III astronauts will be heading to the Moon's south pole where meteoric water is expected to be found. Water could be dissociated through electrolysis into hydrogen and oxygen as rocket fuels for prospective future planetary travel.

Afterwards, the aim is to have a sustained human presence on the Moon, and later Mars.

ARTEMIS IV, V, MOON SPACESTATION

The Artemis IV and V programs will begin building Gateway, a small space station circling the Moon. That will be followed by more Moon landings, extra sections being added to Gateway,

and new robotic rovers operating on the surface of the moon. More countries will be involved in keeping people living and working on and around the Moon for longer periods.

NEW EARTH SPACE STATION

An accelerated project is to replace the fading International Space Station (ISS), awarding contracts to at least two companies within six months of NASA issuing a request for proposals.

The current ISS is scheduled for decommissioning at the end of 2030, after which it will be sent into a controlled de-orbit that should see most of it burned up, with the remaining hunks of glowing-hot metal landing in the empty part of the Pacific Ocean.

If it is not immediately replaced, China would have the only operational space station. Companies who have pursued space station business include Axiom Space, Vast and Blue Origin.

INTERNATIONAL LUNAR RESEARCH STATION ILRS RUSSIA CHINA PROJECT

A joint Russian-Chinese plan to build a lunar nuclear reactor of their own is in progress. In May 2025, the countries signed a memorandum of cooperation by which they will collaborate on a reactor to power the planned surface International Lunar Research Station (ILRS), which they hope to have operational by 2036.

Led by China, but part of a collaboration with many other countries including Venezuela, Belarus, South Africa, Pakistan, Egypt and Kazakhstan, the facility is intended to conduct scientific research within a 62-mile radius of the lunar south pole. Other outposts are to follow over the following decades.

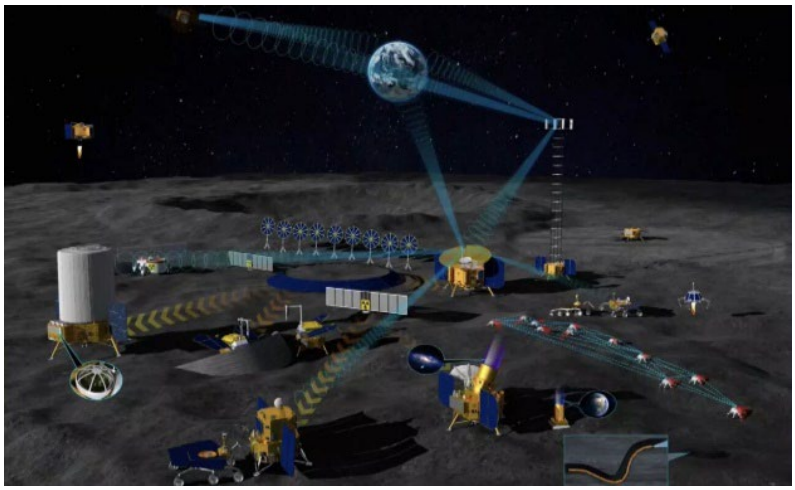

Figure 3. China National Space Agency depiction of an International Lunar Research Station ILRS. A more realistic alternative is for it to be located in identified Lunar volcanic underground lava tubes or on the side of crater cliffs.

In 2024, China retrieved the first soil and rock samples from the far side of the Moon and returning them to Earth. The Chang'e-6 craft used a drill and scoop to mine more than four pounds of material from the moon's deepest crater. Their study of the material raised the possibility that the far side may be significantly drier than the near side, but the single sample is not conclusive.

DISCUSSION

The Moon and Mars are going to change the course of human history whether for good or for bad. The sociopolitical ramifications of control of access to outer space are consequential. The moon is the gateway to the solar system, and the future evolution and survival of humanity exists there.

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