National Aeronautics and
Space Administration

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Committee on Science, Space, and Technology
Subcommittee on Space and Aeronautics

U.S. House of Representatives

Statement of:
Dr. Bhavya Lal
Senior Advisor for Budget and Finance
National Aeronautics and Space Administration

117th Congress

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Good morning. I am Bhavya Lal, the senior advisor for budget and finance at NASA, and I am delighted to be here to talk about space nuclear propulsion.

Distances in space are vast. You may remember, it took the New Horizons spacecraft over nine years to reach Pluto, and when it arrived, it did not have the propulsive ability to stop and take a more extensive look. The spacecraft flew past Pluto, collecting what data it could on its speedy fly-by. And it took over a year to send all that data back to Earth. All this was because we were both power- and propulsion-constrained. Just imagine what else we could have learned if we'd had the capability for a longer stay.

To date, chemical rockets and solar power have served our Nation well, but both have limitations, especially as we go deeper into the solar system. Mass-efficient, high-energy solutions to power space vehicles, operate in harsh radiation environments, and increase mission flexibility would open up new opportunities for space exploration.

Nuclear fission systems can provide such solutions, delivering the high power levels needed to conduct exciting activities on the surface of the Moon, reduce trip times of crewed missions to Mars, and accommodate larger payloads with expanded maneuverability for robotic missions into deep space.

Nuclear propulsion systems are not needed to get to the Moon, but could be valuable in sending payloads to Mars and more distant destinations. There are two ways fission reactions can power propulsion systems, although neither of these has yet been developed. When combined with a chemical stage, a Nuclear Electric Propulsion (or NEP) system could provide faster Mars transit capability, which leads to reduced crew exposure to galactic and cosmic radiation, as well as their exposure to a reduced gravity environment. NEP reactors could also provide extensibility to higher-power surface reactors, and are considered the lowest-mass solution for a fast transit to Mars.

A Nuclear Thermal Propulsion (or NTP) system, would provide both high thrust and high specific impulse, which may enable a smaller and more versatile system, along with faster trip times. The ability of an NTP system to generate high thrust on demand could provide greater mission flexibility, including mission abort and return-to-Earth options if vital crew systems are not functioning properly. As with NEP, the shorter trip provided by NTP would reduce crew time in a reduced gravity environment and lower exposure to space radiation.

Despite their potential and investment, especially in NTP systems in the 1950s and '60s, both technologies face steep developmental challenges. NASA-internal and external studies, including a 2021 assessment performed by the National Academies of Sciences, Engineering, and Medicine, have concluded that the maturity and readiness of both systems are low, and additional long-lead development is needed to mature either.

To date, NASA has prioritized nuclear funding for fission surface power, which is a key capability for both lunar and Martian surface mission needs. Congress continues to signal through annual appropriations that NTP is a priority. As such, NASA's development in FY 2021 and prior years has focused on NTP.

The Space Technology Mission Directorate at NASA has been leading both of these efforts. In all areas of research and development, NASA is working closely with academia, industry, and other Government agencies to explore nuclear-propulsion-related options and capabilities. For instance, we are working with the Department of Defense and the Department of Energy to develop a source of low-enriched uranium fuels from industry, and recently funded three companies to develop space-capable reactor designs. NASA is also sharing its expertise in cryogenic fluid management to support the Defense Advanced Research Projects Agency (DARPA) on their NTP flight demonstration planned in the mid-2020s.

Let me end my testimony by reiterating that nuclear power and propulsion applications could help to enhance U.S. leadership in space. They represent the type of investment that could help the U.S. maintain its global technological edge at a time when more countries around the world seek to fulfill space exploration objectives. Development of space nuclear systems would also advance the state-of-the-art for smaller, more efficient, and safer terrestrial nuclear power plants, to help reduce greenhouse gas emissions.

Nuclear power systems that could be used on the Moon could be developed within the decade. Nuclear propulsion capabilities will cost more and take longer – realizing these capabilities would require sustained commitment and substantial investment over the next 10-20 years. I also cannot emphasize enough the importance of collaborating with other Government agencies as well as academic and commercial stakeholders in ensuring cost-sharing and innovative development.

Thank you for the opportunity to discuss how space nuclear propulsion could support us in exploring Mars and beyond. We look forward to working with Congress on these important priorities. I look forward to your questions.

Dr. Bhavya Lal, Senior Advisor for Budget and Finance, NASA

Dr. Bhavya Lal serves as the senior advisor to the NASA Administrator for budget and finance. She was the seniormost White House appointee and Acting Chief of Staff at NASA for the first 100 days of the Biden Administration, the agency's transition under the administration of President Joe Biden. Before that, she served as a member of the Biden Presidential Transition Agency Review Teams for both NASA and the Department of Defense.

Lal brings extensive experience in engineering and space technology, serving as a member of the research staff at the Institute for Defense Analyses (IDA) Science and Technology Policy Institute (STPI) from 2005 to 2020. There, she led analysis of space technology, strategy, and policy for the White House Office of Science and Technology Policy (OSTP) and National Space Council, as well as federal space-oriented organizations, including NASA, the Department of Defense, and the intelligence community. She has applied her expertise in engineering systems and innovation theory and practice to topics in space, with recent projects on commercial activities in low-Earth orbit and deep space, in-orbit servicing assembly and manufacturing, small satellites, human exploration, space nuclear power, space exploration, and space science. She has published more than 50 papers in peer-reviewed journals and conference proceedings.

Before joining STPI, Lal served as president of C-STPS LLC, a science and technology policy research and consulting firm in Waltham, Massachusetts. Prior to that, she served as director of the Center for Science and Technology Policy Studies at Abt Associates Inc. in Cambridge, Massachusetts.

Lal is an active member of the space technology and policy community, having chaired, co-chaired, or served on five high-impact National Academy of Sciences, Engineering, and Medicine (NASEM) Committees including, most recently, one on Space Nuclear Propulsion Technologies released in 2021. She served two consecutive terms on the National Oceanic and Atmospheric Administration (NOAA) Federal Advisory Committee on Commercial Remote Sensing (ACCRES) and was an External Council member of NASA's Innovative Advanced Concepts (NIAC) Program and the Technology, Innovation and Engineering Advisory Committee of the NASA Advisory Council (NAC). She co-founded and is co-chair of the policy track of the American Nuclear Society's annual conference on Nuclear and Emerging Technologies in Space (NETS) and co-organizes a seminar series on space history and policy with the Smithsonian National Air and Space Museum. For her many contributions to the space sector, she was nominated and selected to be a Corresponding Member of the International Academy of Astronautics.

Lal earned Bachelor of Science and Master of Science degrees in nuclear engineering, as well as a Master of Science degree in technology and policy, from the Massachusetts Institute of Technology, and holds a doctorate in public policy and public administration from George Washington University. She is a member of both the nuclear engineering and public policy honor societies.