Testimony of Michael French
Vice President, Space Systems
Aerospace Industries Association
before the
Subcommittee on Space and Aeronautics
Committee on Science, Space, and Technology
U.S. House of Representatives

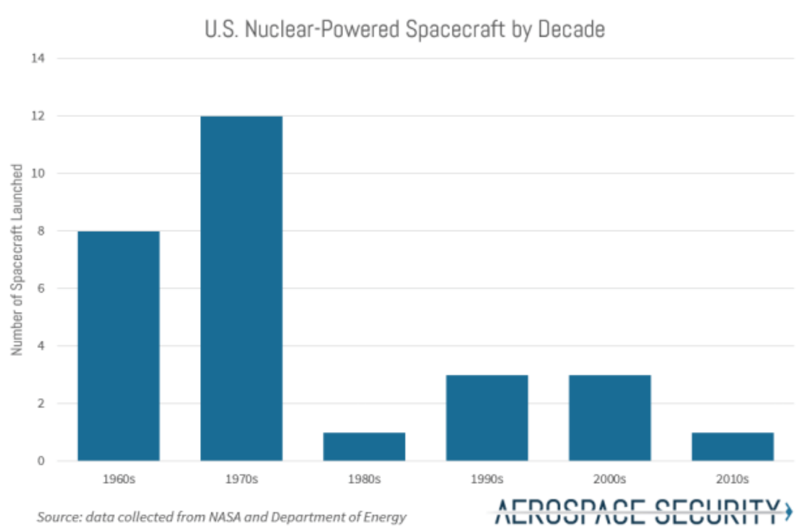
Chairman Beyer, Ranking Member Babin, and distinguished members of the Subcommittee, thank you for the opportunity to provide testimony today on the policy and budgetary enablers to accelerate deep space travel with space nuclear propulsion.

The Aerospace Industries Association (AIA) is proud to represent the largest and most diverse coalition of aerospace companies in the United States, an industry that generates $909 billion in economic output and supports 2.1 million employees across the country. With over 300 member companies from across the aerospace and defense supply chain, AIA members range from family-owned small business component manufacturers to large system integrators, and include publicly traded, privately held, and venture funded entities. AIA member companies design, manufacture, operate, and launch space vehicles across the commercial, civil, and national security space sectors with missions from low Earth orbit to cislunar space and beyond.

Congress has been a consistent supporter of nuclear propulsion activities, particularly nuclear thermal propulsion, through both NASA funding and direction. As outlined further below, Congress's continued investment coupled with authorizing legislation will serve as key accelerants to developing this capability for Mars and other deep space exploration.

Government Policies to Match Technology Maturity

The use of nuclear technologies in space is not new and has been a critical enabler of our nation's space-based accomplishments since the beginning of the Space Age.



Graphic Source: Center for Strategic and International Studies [i]

Early communications and weather satellites used nuclear technology as power sources, as did the Apollo Lunar Surface Experiment Packages, instruments left on the moon by the Apollo astronauts to collect and transmit scientific data back to Earth.[ii] The use of nuclear technologies to provide power to space science missions has continued, including on NASA's Mars rovers Curiosity and Perseverance, and on recent NASA missions to Jupiter, Saturn, and Pluto.[iii]

Nuclear propulsion systems, particularly nuclear thermal propulsion (NTP), would provide a new set of capabilities for deep space exploration. Nuclear thermal propulsion is three times more efficient than today's chemical systems, enabling more efficient human missions to Mars or scientific exploration in deep space. This technology does not replace chemical rockets but enhances our exploration capabilities by providing a more efficient means of propulsion for elements chemical rockets initially put into space.

While the concept of nuclear propulsion was explored in the past, technological advancements now make it practical. First, and importantly, today's nuclear propulsion systems use low-enriched uranium (LEU). This allows for safer systems not possible in the past. Second, modern analytics allow for detailed digital analysis and design with less extensive ground testing than historically required. Given these technological changes, the United States is not alone in pursuing this technology for exploration. China and Russia have also announced nuclear in-space propulsion plans.

U.S. government policies need to leverage this successful legacy of activity, the significant technology developments behind next generation nuclear propulsion systems, and the advancements in computer modeling and simulation techniques. Fortunately, policy improvements have already taken place within the Executive Branch that considers these factors, beginning with a recent update to the policy for launching nuclear payloads, National Security Presidential Memorandum-20, Launch of Spacecraft Containing Space Nuclear Systems.

Nuclear Launch Policies

In 2019, the Administration issued National Security Presidential Memorandum-20, Launch of Spacecraft Containing Space Nuclear Systems.[iv] This update created a tiered, risk-based approach for approving the launch of nuclear systems, replacing a singular approach developed in the 1970s. Under the prior framework, all launches of nuclear systems required the assessment of an interagency working group and approval from the President. The President's approval was delegated to the Director of the White House Office of Science and Technology Policy or made by the President directly at the Director's recommendation.[v]

Under the new system, the characteristics of the nuclear system, the level of potential hazard, and national security considerations determine the required approval process. The prior system remains for the highest risk launches, designated as "Tier III" in the new policy. Lower risk launches, Tier I and II, allow delegation of approval at the head of the sponsoring agency level, following interagency review and other safety assessments detailed in the policy. For example, the NASA Administrator would likely be the approval authority for a NASA science mission using heritage nuclear power systems as a Tier I launch under the policy. A nuclear propulsion flight demonstration would likely be considered a Tier II mission under the policy given technology heritage and the expected use of low enriched uranium. This policy change is an important enabler to a near term flight demonstration of nuclear thermal propulsion systems needed to achieve a human rated system in the 2030s.

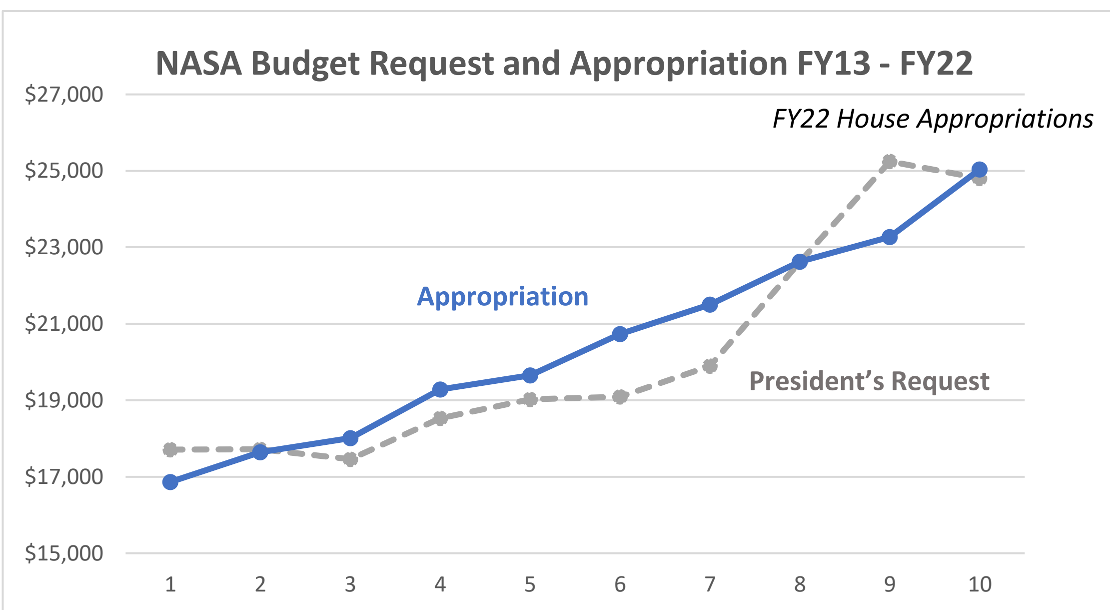
Space Policy Directive 6

A second recent policy development of note is Space Policy Directive 6, National Strategy for Space Nuclear Propulsion and Power ("SPD-6"), signed in December 2020.[vi] SPD-6, "outlines high-level policy goals and a supporting roadmap that will advance the ability of the United States to use [space nuclear power and propulsion] systems safely, securely, and sustainably."[vii] SPD-6 acknowledges and creates a whole of government approach to leverage and advance nuclear space systems. An example of the coordination outlined by SPD-6 is taking place between the Defense Advanced Research Projects Agency (DARPA) and NASA's Marshall Space Flight Center, with support from NASA Headquarters and other national security agencies, to establish joint working groups to achieve common goals in their respective nuclear thermal propulsion activities.

SPD-6 also provides a roadmap for the further development of nuclear space systems with specific agency roles and responsibilities. Particular to advancing nuclear thermal propulsion, SPD-6 directs, "[b]y the late-2020s, establish the technical foundations and capabilities — including through identification and resolution of the key technical challenges — that will enable NTP options to meet future DoD and NASA mission needs." Maintaining interagency coordination and defined milestones is an enabling policy for accelerating nuclear propulsion capabilities and should be maintained.

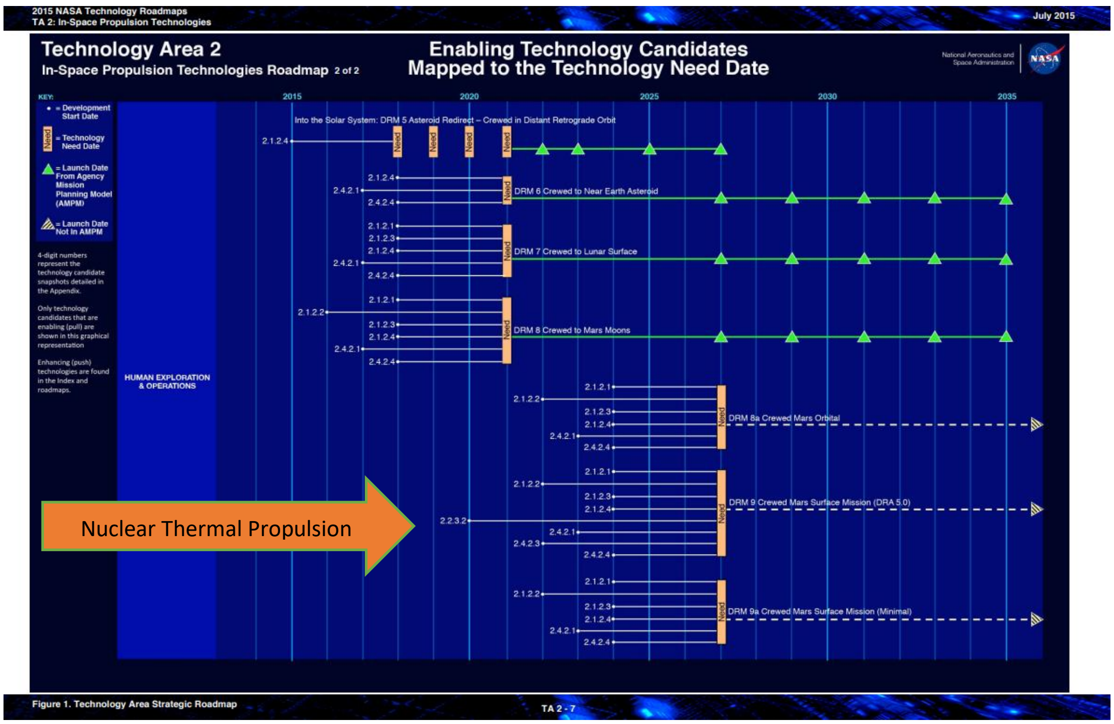
Consistent Congressional Support

Stable, sufficient investment is critical to accelerating the development of nuclear thermal propulsion technology for a Mars mission in the 2030s. Here, Congress deserves recognition. Congress has shown consistent support for the overall NASA budget on a bipartisan, bicameral basis – with <u>eight</u> consecutive years of appropriation increases (<u>nine</u> considering the pending FY22 House Appropriations mark).



Importantly, this support has been balanced across the NASA portfolio, not only recognizing NASA's contributions to human exploration, but supporting NASA's aeronautics, education, science, and space technology missions. Within this consistent, balanced series of appropriations, Congress has funded nuclear thermal propulsion activities on a multi-year basis at significant levels. Congress has also recognized the importance of a flight demonstration to move this capability forward, regularly including flight demonstration direction with the funding it provides.

Congress' funding aligns directly with timelines established in NASA's technology roadmaps for the development of needed capabilities for future human transportation to Mars. For example, NASA's 2015 Technology Roadmaps determined the need to develop nuclear thermal propulsion technology in the first half of the 2020s for a technology need date of 2027.[viii] Nuclear thermal propulsion remains an enabling technology in NASA's updated 2020 technology taxonomy.[ix]



Source: July 2015 NASA Technology Roadmaps TA 2: In-Space Propulsion Technologies[x]

Congress has similarly indicated its support for nuclear thermal propulsion, including a flight demonstration, through recent NASA reauthorization efforts. This Subcommittee in the previous Congress passed language directing the NASA Administrator to, "develop a plan, including a cost estimate, to achieve an in-space flight test of a nuclear thermal propulsion system within 10 years of the enactment of this Act." The Senate-passed NASA authorization included in the U.S. Innovation and Competition Act directs the NASA Administrator to develop a similar nuclear thermal propulsion plan and conduct a flight demonstration, "[n]ot later than December 31, 2026."

While Congress has consistently provided funding and direction for nuclear thermal propulsion, the President's Budget Request has not aligned as directly with NASA's technology roadmaps.

NASA Nuclear Thermal Propulsion Funding		
	President's Budget Request	**Congressional Appropriation and Report**
FY2017	Study funding requested; no specific funding line	$35M
FY2018	Study funding requested; no specific funding line	$75M
FY2019	Some activity funded within Space Technology; no specific funding line	$100M/$70M for design of a flight demonstration by 2024
FY2020	Some activity funded within Space Technology; no specific funding line	$110M/$80M flight demonstration
FY2021	$100M for both surface power and nuclear propulsion	$110M/$80M flight demonstration
FY2022	$0[xi]	$110M/$80M flight demo (House Appropriation)

A Portfolio Approach

As is recognized in SPD-6, accelerated nuclear space activity requires the coordination and contribution of multiple Federal agencies partnered with industry. The Department of Energy and NASA are key players, but overall technology development also includes the Department of Defense. DARPA's Demonstration Rocket for Agile Cislunar Operations (DRACO) program is an important example. This program is partnering with industry to advance nuclear thermal propulsion technology, particularly focused on advancing methods for modeling and simulation. DRACO is not a substitute for NASA's activities, but complementary. As noted by the National Research Council, "NASA could benefit from lessons learned by the DRACO flight demonstration (currently planned for late 2025) and could work collaboratively with DARPA to develop technologies and subsystems that contribute to the mission needs of both agencies."[xii]

SPD-6 and the President's FY22 Budget Request also seek to accelerate nuclear surface power technologies. These technologies are important to future Moon and Mars exploration, particularly long-duration activities, however, these activities are separate from the nuclear propulsion development activities and not "trades" from an exploration needs perspective.

Needed Congressional Actions

As outlined above, the Congress has been a consistent supporter of the investments and direction needed to accelerate space nuclear propulsion. Additionally, the Executive Branch has made important recent updates to U.S. Government policy to align with the accelerated use of nuclear space systems. AIA is pressing the current Adminstration to reaffirm these policy updates.

Congress can further accelerate the development of space nuclear propulsion by:

- Finalizing FY22 funding for nuclear thermal propulsion with flight demonstration direction;
- Adopting the NASA infrastructure investments included in pending infrastructure legislation;
- Continuing to consistently fund nuclear thermal propulsion development and a flight demonstration in FY23 and beyond; and
- Passing a NASA reauthorization that includes language authorizing nuclear thermal propulsion activities, establishes a 2026 nuclear thermal propulsion flight demonstration date, and

endorses accelerated partnership and coordination between NASA and the national security agencies on nuclear thermal propulsion flight demonstrations, common fuels, and operational systems production.

Thank you for the opportunity to present this testimony today, and we look forward to continuing to work with the Subcommittee to ensure the growth and health of the U.S. space industry.

[ii] "What Does the Trump Administration's New Memorandum Mean for Nuclear-Powered Space Missions?," Aerospace Security, Center for Strategic and International Studies, available at https://aerospace.csis.org/what-does-the-trump-administrations-new-memorandum-mean-for-nuclear-powered-space-missions/ (visited 10/15/21)

[ii] The History of Nuclear Power in Space, U.S. Department of Energy, available at https://www.energy.gov/articles/history-nuclear-power-space (visited 10/15/21)

[iii] Mars 2020 Launch Nuclear Safety, NASA, available at https://rps.nasa.gov/resources/81/mars-2020-launch-nuclear-safety/ (visited 10/15/21)

[iv] National Security Presidential Memorandum-20, Launch of Spacecraft Containing Space Nuclear Systems, 2019, available at https://trumpwhitehouse.archives.gov/presidential-actions/presidential-memorandum-launch-spacecraft-containing-space-nuclear-systems/ (visited 10/15/21)

[v] 1977 nuclear launch memorandum available at https://fas.org/irp/offdocs/pd/pd25.pdf (visited 10/15/21)

[vi] Space Policy Directive 6 available at https://www.federalregister.gov/documents/2020/12/23/2020-28457/posting-of-the-presidential-policy-directive-6-space-policy-national-strategy-for-space-nuclear (visited 10/15/21)

[vii] Id.

[viii] July 2015 NASA Technology Roadmaps, TA 2: In-Space Propulsion Technologies, NASA, available at https://www.nasa.gov/sites/default/files/atoms/files/2015_nasa_technology_roadmaps_ta_2_in-space_propulsion_final.pdf (visited 10/15/21)

[ix] NASA Technology Taxonomy, 2020, available at https://www.nasa.gov/sites/default/files/atoms/files/2020_nasa_technology_taxonomy_lowres.pdf (visited 10/18/21)

[x] July 2015 NASA Technology Roadmaps TA 2: In-Space Propulsion Technologies, available at https://www.nasa.gov/sites/default/files/atoms/files/2015_nasa_technology_roadmaps_ta_2_in-space_propulsion_final.pdf (visited 10/15/21)

[xi] NASA FY22 President's Budget Request Congressional Justification, ST-68, available at fy2022_congressional_justification_nasa_budget_request.pdf (visited 10/17/21)

[xii] National Academies of Sciences, Engineering, and Medicine 2021. Space Nuclear Propulsion for Human Mars Exploration. Washington, DC: The National Academies Press. https://doi.org/10.17226/25977 (visited 10/15/21)