

CONGRESSIONAL WHITE PAPER

Nuclear Thermal Propulsion:

A Focused, Fast Initiative for 2030 Operations

Dark Fission Space Systems • March 2026

ISSUE

The United States faces an urgent need to develop and deploy nuclear thermal propulsion (NTP) to maintain space dominance in the face of advancing adversary capabilities. Congress has appropriated approximately \$120 million in NASA's FY2026 budget specifically for NTP development. The question is how to allocate these funds most effectively - choosing between continued research programs that have historically stalled, and a focused, flight-oriented initiative that can deliver an operational nuclear orbital transfer vehicle by 2030.

Specifically: Will NASA's execution of the FY2026 NTP appropriation deliver measurable progress toward on-orbit operations - including meaningful investment in innovative small businesses that bring the agility, cost discipline, and flight-proven operational experience needed to get nuclear propulsion off the ground and into space?

DISCUSSION

Strategic Context

Nuclear thermal propulsion uses compact, lightweight fission reactors to heat propellant to extreme temperatures, achieving roughly twice the specific impulse (efficiency) of the best chemical rockets. This translates directly into faster transit times and greater payload capacity for missions between low Earth orbit, geosynchronous orbit, the Moon, and beyond. NTP is not a speculative technology—the United States successfully demonstrated nuclear thermal engines during Project NERVA/Rover in the 1960s and early 1970s, producing engines that ran for hours at power levels exceeding 1,000 megawatts.

The strategic imperative is clear. China is constructing a permanent lunar outpost, developing advanced space capabilities, and has publicly stated its intent to dominate cislunar space. Russia continues to advance space nuclear power and propulsion programs. Both nations view space as a domain for military advantage. A reusable nuclear orbital transfer vehicle (OTV) would give the United States rapid, low-cost access to any orbit in cislunar space—enabling commercial growth, agile maneuver for national

security, and sustained presence that chemical propulsion alone cannot efficiently provide.

The Problem with Legacy Approaches

Despite decades of intermittent investment, the U.S. has not flown a nuclear propulsion system since the SNAP-10A reactor in 1965. Recent programs, including the recently terminated DARPA/NASA Demonstration Rocket for Agile Cislunar Operations (DRACO), have taken important steps but remain oriented towards traditional large-contractor development timelines (i.e., DRACO’s first flight was projected to occur no earlier than 2028 under optimistic assumptions, prior to cancellation). The historical pattern has been one of extended research phases that absorb funding without reaching flight, followed by a long hiatus and programmatic resets.

This is not an argument against pursuing efforts like DRACO - rather, it highlights a need for complementary pathways that leverage the agility and cost discipline of small businesses to retire key risks in parallel, hedge against “big program” delays and overruns, and accelerate the path to operations.

A Private-Sector, Flight-First Strategy

Dark Fission Space Systems, a Loudoun County, Virginia-based small business, proposes a three-step approach to achieve operational NTP capability by 2030. The company is currently executing a \$1.9M SpaceWERX Direct-to-Phase-II SBIR contract for nuclear thermal engine development and is developing the DARKFORCE engine based on a radial-inflow particle bed reactor (RI-PBR) - a proven reactor concept that offers high power density in a compact, flight-weight configuration.

The three-step plan:

- 1. DARK SCOUT — Regulatory & Operations Pathfinder (~\$5M, 18 months to orbit). A rapid, low-cost satellite carrying a small quantity (1-2 kg) of commercial-grade fissile fuel—the first U.S. flight of enriched nuclear fuel in nearly 60 years. DARK SCOUT will conclusively demonstrate Dark Fission’s ability to navigate the commercial space nuclear regulatory regime (FAA, NRC, DOE), while rehearsing orbital transfer vehicle operations including rendezvous, pickup/dropoff, and maneuver. Built with largely commodity smallsat components by a team with deep experience in rapid spacecraft development.**
- 2. DARK RANGER — Proto-OTV (~\$40M, 2028). A full-scale, 1:1 functional mockup of the operational DARKFORCE OTV, flown with a subcritical nuclear fuel loading. DARK RANGER carries the complete complement of OTV sensors, effectors, and algorithms, serving as a full dress rehearsal for DARKFORCE operations—proving out**

refueling, payload handling, and orbit-to-orbit transfer procedures to the satisfaction of federal regulators and potential customers.

- 3. DARKFORCE OTV — Full-Scale Demonstration (~\$60M+, 2029-2030).** The operational nuclear thermal orbital transfer vehicle: refuelable, reusable, capable of transit anywhere in cislunar space. Powered by a 130-MW particle bed reactor producing approximately 6,000 lbs of thrust. Multiple revenue-generating missions from first flight, transitioning immediately from demonstration to commercial and government operations.

Key Technology Validation Requirements

In parallel with the flight program, Dark Fission is pursuing critical ground-based technology validation to mature the DARKFORCE engine's key component—the fuel element. Two specific test campaigns are essential and represent high-value investments of federal funds:

- **Full-Scale Fuel Element Testing at NASA MSFC NTREES:** Non-nuclear thermal-hydraulic testing of Dark Fission's RI-PBR fuel element at NASA Marshall Space Flight Center's Nuclear Thermal Rocket Element Environmental Simulator (NTREES). This facility can subject fuel elements to representative temperature and hydrogen flow conditions without requiring nuclear fuel, validating structural integrity, thermal performance, and reusability under repeated high-temperature cycles. Estimated cost: ~\$2M over 15 months, leveraging existing Space Force partnership.
- **In-Reactor Nuclear Fuel Element Testing at INL:** Irradiation testing of fueled elements in a research reactor at Idaho National Laboratory (e.g., TREAT facility) to validate fuel element performance under actual fission conditions with hot hydrogen flow. This is the definitive proof that the fuel element will perform as designed in the operational DARKFORCE engine. Estimated cost: \$3-5M.

Both test campaigns are achievable within the FY2026-27 timeframe and represent the single highest-leverage investments for retiring NTP technical risk. They directly support not only Dark Fission's program but contribute to the broader national NTP knowledge base.

The Small Business Advantage

Dark Fission is the only small business in the United States solely focused on nuclear thermal propulsion for space. The company's leadership team brings directly relevant experience: the CEO initiated the DRACO nuclear propulsion program while at DARPA (2017-2019) and subsequently served as the inaugural Director of the Space Development Agency; Dark Fission's co-founders bring senior executive experience from Space Micro and DOE labs, as well as executive experience from Vector Launch and Kratos Defense.

Small businesses bring several structural advantages to NTP development that complement large-contractor efforts: dramatically lower overhead and faster decision cycles; willingness to accept technical risk in exchange for speed; ability to leverage commodity smallsat supply chains and the commercial launch market; and direct accountability—the people making technical decisions are the people who built the company.

Furthermore, DARK SCOUT’s regulatory pathfinder mission has cross-cutting value that extends well beyond NTP. Successfully navigating the FAA/NRC/DOE approval process for orbiting fissile material establishes precedents and procedures applicable to all future space nuclear applications—including nuclear electric propulsion (NEP) and fission surface power systems. This makes DARK SCOUT a low-cost investment with outsized returns for the entire space nuclear enterprise.

RECOMMENDATION

NASA’s execution plan for the FY2026 NTP appropriation (and outyears) should include meaningful investment in small business-led flight demonstrations and technology validation, complementing ongoing large-scale development efforts. Congressional oversight should ensure the agency’s spending plan reflects the urgency and operational focus that motivated the appropriation. Specifically:

- 1. Fund critical technology validation through NASA Marshall and INL partnerships, enabling full-scale fuel element testing (NTREES) and in-reactor nuclear testing (Idaho’s TREAT reactor). These are the highest-leverage ground tests for retiring NTP technical risk; both can be accomplished for approximately \$5-7M over the next two years.**
- 2. Invest in the DARK SCOUT regulatory and operations pathfinder (~\$5M), which will be the first U.S. flight of fissile fuel in over 60 years and will establish the regulatory framework needed for all future space nuclear operations. This is a rapid, high-return investment that delivers results within 18 months.**
- 3. Ensure small business participation is a priority in the broader NTP program, recognizing that the agility and cost discipline of companies like Dark Fission complement and accelerate the work of larger contractors. Future appropriations should include directed opportunities or set-asides that give qualified small businesses meaningful access to NTP development funding.**

The total initial investment for technology validation and the DARK SCOUT pathfinder is approximately \$10-12M—a small fraction of the \$120M appropriation that delivers disproportionate returns in risk reduction, regulatory precedent-setting, and operational learning. This approach

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echoes the urgency of past national space initiatives: commit resources to a series of quick-win demonstrations, get hardware to orbit, and build operational confidence through flight experience rather than prolonged study.

“Always be flying.”

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