

The background of the entire image is a deep space scene. It features a dark, velvety blue-black sky filled with numerous small, bright yellow and white stars. On the right side, there are large, ethereal nebulae in shades of purple, magenta, and orange, with some brighter, more defined star clusters. The overall effect is one of vastness and celestial wonder.

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24 October 2022

NASA's Space Nuclear Propulsion Project

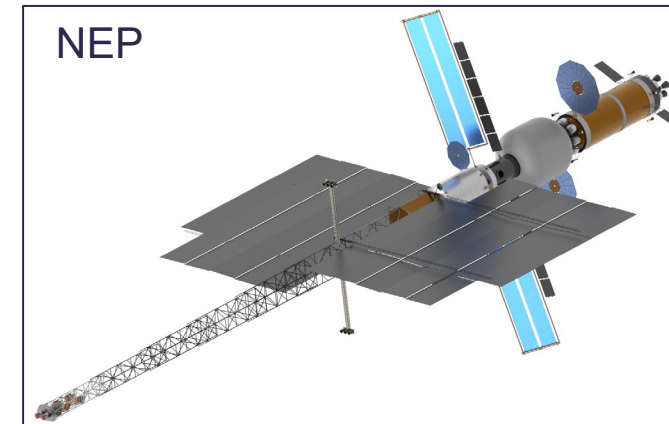
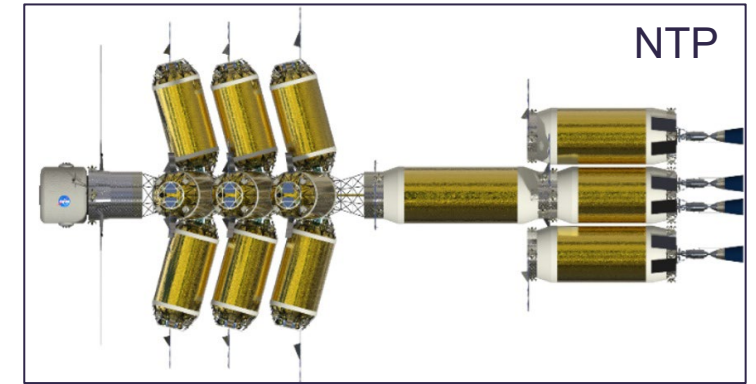
Kurt Polzin

Space Nuclear Propulsion Project Chief Engineer
NASA Marshall Space Flight Center

Space Nuclear Propulsion (SNP)

Power source is decoupled from the propellant selection

- **Nuclear Thermal Propulsion (NTP)**
 - Low molecular weight propellant (e.g., H_2)
 - Achieve higher specific impulse (I_{sp})
 - Nuclear fuel very hot (≥ 2850 K for ≥ 900 s I_{sp})
 - Hot H_2 is very corrosive
- **Nuclear Electric Propulsion (NEP)**
 - Reactor heat converted to electricity
 - Achieve very high I_{sp} (2000-6000 s)
 - Nuclear system closer to terrestrial conditions
 - Large radiators to reject heat to space

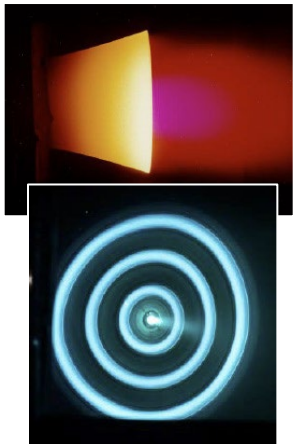
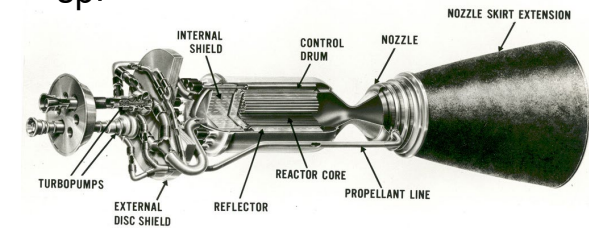


Can these systems be made to work while using Low-Enriched Uranium (LEU) (< 20% enrichment)?

SNP Project Strategy Developing a Human Mars Propulsion System

For **NTP**: Pursue multiple parallel options (government and industry efforts) to develop a viable demonstration-scale nuclear engine that shows NTP is scalable to the Mars mission.

- HALEU fuel form with reactor propellant exit temperatures $\geq 2700\text{ K}$ ($\geq 900\text{ s } I_{sp}$)
- Design capability of scaling to size supporting Mars mission engine needs
- Demonstration engine key attribute goals: 10-15 klb_f thrust, 900 s I_{sp}



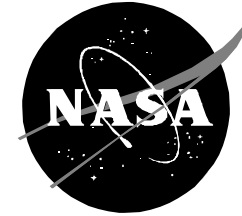
For **NEP**: Multiple parallel development options to mature key technologies and systems for a MW_e -capable system.

- Developed a technology maturation plan to guide project direction and investments
- Build and test hardware at relevant conditions (e.g., temperatures, power levels)
- Take advantage of recent and ongoing multi-agency investments
- Where feasible, advance strategy that aligns with industry participation

Goal is buy-down future mission risk through relevant hardware-based demonstrations of space nuclear propulsion components and systems.

SNP Project – Present Efforts

NASA and DOE collaborating with industry and academia on SNP development efforts



NTP Efforts

- Government-led effort to develop the materials (fuel, moderator, insulators, etc.) needed for an NTP system and test in relevant environments.
- Phase 1 contracted industry efforts to design an NTP reactor that can meet human Mars mission KPPs.
 1. BWX Technologies
 2. General Atomics
 3. Ultra Safe Nuclear Technologies

NEP Efforts

- Broad technology assessment of NEP technologies → identify specific, high-confidence, viable NEP system design options, and develop an understanding of the tasks required to mature critical technologies.
- Drafted a Technology Maturation Plan (TMP) based on inputs provided by the technical community
- Maturation for an order of 1 MW_e electric propulsion capability.
 - **Hard on purpose** milestone-driven schedules for the specific technologies.
 - Non-Advocate Reviews (NARs) at major decision points.

Work represents a broad national effort to develop the technologies and systems for Space Nuclear Propulsion and show those systems can be realized.



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