IDA SCIENCE AND TECHNOLOGY POLICY INSTITUTE

# Criteria to Compare HEU and LEU Systems

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# About the Science and Technology Policy Institute (STPI)

- Federally Funded Research and Development Center (FFRDC) created by Congress
- Provides scientific and technical analysis to the Office of Science and Technology Policy (OSTP) and other Executive Branch Departments and Agencies
- Works primarily for the U.S. Federal government
- Non-advocacy, unbiased, and objective
- Rigorous and data-driven

# Context

- No existing U.S. policy that prescribes enrichment levels for space nuclear reactors
- There are existing U.S. programs regarding reducing the use of HEU in civilian research reactors
- Space systems face unique operating requirements and conditions
- Decision regarding whether to use HEU or LEU should consider several criteria beyond performance, proliferation being one

➢ No comprehensive studies that make the comparison on all dimensions

# Assessment Criteria

- **Performance:** mass, complexity, lifetime
- **Safety:** launch and re-entry accidents
- **Security:** proliferation concerns
- **Timeliness:** meeting demand timelines
- **Cost:** system, fuel, security, launch, insurance, bureaucracy
- **Other:** sustainability, applications to other markets, commercial availability

# Assessment Factors

- Performance
- Safety
- Security
- Timeliness
- Cost
- Other

**Specific power:** LEU typically results in higher mass

**Power scalability:** HEU better for low power environments

**Reliability and technical risk:** Comparable LEU systems are more complicated

**Other factors:** Length of operational capability; development risk (nuclear system and complementary systems); extensibility; operability

# Assessment Factors

- Performance
- Safety
- Security
- Timeliness
- Cost
- Other

**Launch Safety:** More challenging to avoid inadvertent critically with LEU

- Moderated reactors on submersion accidents
- Less design space for accident mitigation

**Other factors:** Risk of and from re-entry; Operational safety (health risk, environmental contamination risk)

# Assessment Factors

- Safety
- Security
- Performance
- Timeliness
- Cost
- Strategy
- Political

**Time to performance system:** HEU system closer to launch readiness

**Coordination time** (launch approval, interagency, international): Using HEU may require increased interagency coordination and lead-time

# Assessment Factors

- Performance
- Safety
- Security
- Timeliness
- Cost
- Other

**Security:** Higher security costs for HEU

**Launch costs:** Higher launch mass for LEU

**Certification and other approvals:** HEU will likely have higher approval costs

**Other factors:** Cost of R&D (includes testing requirements); nuclear system; fuel complementary systems; launch ready system; insurance/indemnification; and logistical and infrastructure costs

# Launch Approval Process Covers All Space Nuclear Systems

- Presidential Memorandum on Launch of Spacecraft Containing Space Nuclear Systems, issued August of 2019
- The highest reviewed category, Tier III, of systems includes systems with criticality potential that utilize any fuel other than LEU
- Tier III requires presidential approval of the launch

# Summary

- Some analyses and trade studies have been done but they only address parts of the trade-space
- Not all criteria are equally important
- The devil is in the details
  - Performance tradeoffs vary drastically based on power levels and reactor design
  - Harder to engineer systems for LEU for missions and safety criteria
  - Many of the costs are already considered or baked into mission decisions

# BACKUP

# Factors Required for Assessment

- Performance
- Safety
- Security
- Timeliness
- Cost
- Other

**Availability of fuel:** HEU has more established fuel lines than HALEU

**Political risk:** HEU programs could be cancelled for that reason

**Commercial Availability:** LEU makes it easier to share more of the mission with private partners can go under cost

Other factors: Sustainability, level of bureaucracy, applications to other markets (military, power, niche commercial)