TOPIC # - TDC - 107

LUNAR MICRO-NUCLEAR REACTOR

PROBLEM/DESCRIPTION

Develop an innovative small-scale nuclear reactor design for lunar surface applications, focusing on providing reliable power for habitats, mining operations, robotic systems, and other essential infrastructure. Competitors will address the technical, logistical, and economic challenges associated with designing, transporting, and deploying the system on the Moon.

Competition Goals:

Reactor Design - Develop a small, robust, and efficient nuclear reactor capable of operating in the harsh lunar environment.

Power Output & Sustainability – Ensure a reliable energy supply capable of supporting critical infrastructure for long-duration lunar missions.

Mass & Transport Constraints – Optimize the reactor for space transportation and integration with lunar landers.

Safety & Shielding – Implement radiation shielding strategies to protect astronauts, equipment, and sensitive electronics.

Longevity & Maintenance – Design a system with minimal maintenance and a long operational lifetime.

Deployment & Operation – Propose methods for reactor assembly, startup, and remote operation on the Moon.

Lunar Resource Utilization (Optional) – Explore the possibility of using in-situ lunar materials for reactor components or shielding.

Competition Structure & Requirements:

Phase 1: Concept Design

- Teams develop preliminary designs for a lunar micro-reactor.
- Proposals must include system architecture, fuel type, cooling methods, power conversion, shielding, and deployment strategies.

Phase 2: Feasibility & Engineering Analysis

- Teams conduct technical analysis, including heat transfer, radiation shielding, neutron moderation, and structural integrity.
- Computational simulations (e.g., Monte Carlo neutron transport, thermal-hydraulics) are encouraged.

Phase 3: Transport & Deployment Plan

- Design packaging for launch and lunar transport.
- Define the integration plan with landers and surface deployment strategies.

Phase 4: Prototyping & Testing (Advanced Stage, If Feasible)

- Teams develop scaled physical or digital prototypes.
- Experimental verification of key components (e.g., heat transfer, structural materials, shielding effectiveness).

Key Constraints & Considerations:

- Power Output: 10-100 kWe range
- Mass Limit: ≤ 10 metric tons (considering launch and transport constraints)
- Fuel Type: Low-enriched uranium (LEU) or alternative advanced fuels
- Cooling System: Passive or active, suitable for lunar conditions
- Operating Lifetime: Minimum 10 years without refueling
- Environmental Considerations: Must ensure lunar surface safety and minimize radioactive contamination risks
- Integration: Compatibility with Artemis missions, lunar habitats, and ISRU (In-Situ Resource Utilization) systems

Evaluation Criteria:

Innovation & Technical Feasibility – Novelty, practicality, and soundness of the design.

Power Efficiency & Reliability – Effectiveness of energy production and distribution.

Mass & Launch Feasibility – Suitability for space transport and deployment.

Safety & Risk Mitigation – Strategies to manage radiation exposure and failure modes.

Sustainability & Long-Term Use – Lifecycle considerations and minimal maintenance requirements.

TEXAS SPACE GRANT CONSORTIUM DESIGN CHALLENGE	**TOPIC # - TDC - 107**
	LUNAR MICRO-NUCLEAR REACTOR

RESOURCE LINKS

https://www.nasa.gov/centers-and-facilities/glenn/nasas-fission-surface-power-project-energizes-lunar-exploration/

Three Contractors selected Link:
https://www.nasa.gov/news-release/nasa-announces-artemis-concept-awards-for-nuclear-power-on-moon/

Lockheed Martin of Bethesda, Maryland– The company will partner with BWXT and Creare.
Illustrations: https://www.flickr.com/photos/lockheedmartin/sets/72177720310050928
Animations:https://vimeo.com/manage/videos/829198706/45f0fd0981
YouTube video: https://www.youtube.com/watch?v=LSIILUKiiGE

Westinghouseof Cranberry Township, Pennsylvania– The company will partner with Aerojet Rocketdyne.
https://info.westinghousenuclear.com/news/westinghouse-design-takes-nuclear-power-to-outer-space

IX of Houston, Texas, a joint venture of Intuitive Machines and X-Energy– The company will partner with Maxar and Boeing.
https://x-energy.com/media/news-releases/intuitive-machines-and-x-energy-led-team-awarded-5-million-to-provide-a-solution-to-deliver-fission-surface-power-to-the-moon-by-2028

DESIGN TEAM PROFILE

NASA MENTOR:	Robert Nuckols (robert.s.nuckols@nasa.gov)
LEVEL:	Undergraduate students of any level
MAJOR/DISCIPLINE:	Open to all majors
TEAMS:	All teams eligible
DURATION:	One Semester (Second semester optional)