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SURVIVING THE LUNAR NIGHT WITH MASTEN'S NITE^{TM} SYSTEM

Abstract

Building a sustainable presence on the Moon requires us to survive and operate through the lunar night. The lunar day/night cycle includes 14 Earth days of continuous sunlight followed by 14 days of continuous darkness and extremely cold temperatures as low as -232C (or -387F).

The challenge is flight computers and payloads typically require a minimum operating temperature of -40C. Without a warming system, these extreme temperatures can cause irreparable damage or cause landers, rovers, and payloads to fail altogether.

Masten Space Systems' Nighttime Integrated Thermal and Electricity (NITE^{TM}) System provides a solution to this challenge by producing by both heat and power, enabling landers and payloads to survive the lunar night and extend operations in shadowed lunar regions.

NITE is designed as a low-mass payload that can be attached to landers, rovers, and other space assets for both robotic and crewed missions. It creates chemical reactions to deliver heat and power through the oxidation of metals using propellant margin from the lander's propulsion system for a vehicle scale system or from internal fuel storage for a modular system. It recycles reaction products to maximize thermal and electric energy return. NITE autonomously operates when temperatures fall below a specified threshold and can be deactivated during the lunar day to prevent overheating.

Ultimately, NITE avoids the pitfalls of existing technologies available to survive the lunar night. Based on Masten's testing on the NITE heat generation subsystem, here are the key benefits:

- Less mass, more heat: It produces significantly more heat (approximately 1900 Wh/kg) with a low-mass solution that's 12 times lighter than an equivalent battery for lunar night survival.

- Longer mission operations: It enables landers, rovers, and payloads to operate for 12 months or longer, depending on the oxidizer (e.g., lander propellant or lunar water) and mass allocated to the NITE System.

- Increased lunar accessibility: It enables operations in permanently shadowed regions, lunar poles, lava tubes, and other sunlight-deprived environments, providing thermal power at a temperature between -25 C and +25 C, as required by the payload.

- More cost effective: It saves $50M + indirect costs compared to nuclear solutions and saves$ 10M+ in mass penalties compared to battery solutions.

- Safer alternative: It's dust-proof and non-radioactive, enabling a safer alternative to nuclear and battery-based options.

Note more results will be available for the paper/presentation as Masten further develops the power generation subsystem.