SURVIVING THE LUNAR NIGHT WITH MASTEN'S NITE SYSTEM. J. Slavik, T. Vazansky, and M. Kuhns, Masten Space Systems, 1570 Sabovich St Mojave CA 93506

Introduction: 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 -232°C (or -387°F).

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

Solution: Masten Space Systems' Nighttime Integrated Thermal and Electricity (NITE) 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, including polar craters and lava tubes.

The NITE System is designed as a low-mass payload that can be attached to landers, rovers, and other lunar 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. 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.

Radioisotope thermoelectric generators (RTGs) can serve as an alternative for longer missions, but they're highly radioactive and impose severe constraints on cost, availability, and safety.

In contrast, the NITE System relies on controlled exothermic chemical reactions to generate heat and power, using safe, affordable reactants. The system is restartable on demand, low mass, and unaffected by lunar dust. And unlike the alternatives, NITE doesn't require solar power to operate.

Benefits: Masten's NITE System 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 Masten has seen so far.

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+ in direct 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 as Masten further develops the power generation subsystem.

Status and next steps: Following Masten's NASA Small Business Innovative Research (SBIR) Phase I award in 2018, Masten developed the initial proof of concept for NITE and down selected the combustion chemistry. Masten is now in the process of completing the SBIR Phase II award and will finalize the heat generation subsystem of the NITE System by mid-2022.

Masten was also granted a NASA Tipping Point award to further develop the power generation subsystem and advance the overall technology readiness of the NITE System, which allow the company to get one step closer to testing NITE in the lunar environment.