Commercially Available Radioisotopes to Survive the Lunar Night. B. Fisher[1] and C. Morrison[1], [1]Ultra Safe Nuclear, 2320 W Commodore Way, Seattle, WA 98199. (Contact: b.fisher@usnc-tech.com)

Introduction: With greater access to the lunar surface, an increasing importance is being placed on exploring permanently shadowed regions (PSRs) and surviving the lunar night. Currently, many tens of kilograms of batteries are necessary to not just electrically power the instrumentation of lunar landers and rovers but also provide the thermal power required to protect electronics from extreme colds. Radioisotope systems offer a uniquely high specific power which answers many of the needs for landers and rovers to explore extreme lunar environments. However, the traditional radioisotope thermoelectric generators which rely upon Plutonium 238 or Strontium 90 have several practical limitations and cost drivers that keep them from addressing commercial efforts.

Ultra Safe Nuclear is productizing a family of radioisotope offerings around its core technology, Ember. Ember's novel manufacturing process leverages the established supply and quality systems of the medical radioisotope industry. This approach enables customization of modular radioisotope products to meet mission objectives while minimizing volume and mass. By prioritizing a commercially feasible radioisotope with a clear path toward launch, Ember-based products are ideal for integration into commercial landers and rovers.

Applications: EmberCore is a radioisotope heater unit (RHU) built from multiple Embers. Ultra Safe Nuclear is progressing towards a 2024 flight demonstration of a 40W_{th} solution as the first offering in the EmberCore product line of 1 to 40+ W_{th} commercial RHUs. The 40 W_{th} EmberCore will provide passive, reliable heat for multiple lunar nights or extended investigation of PSRs.

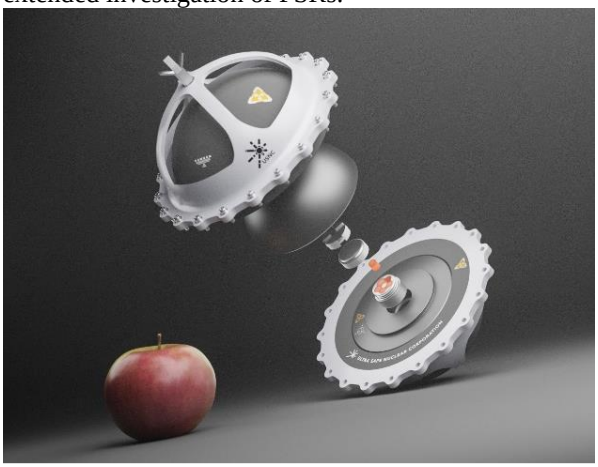

Figure 1: EmberCore RHU assembly

EmberPower is a radioisotope electrical power system powered by EmberCore. New capabilities enabled by sun-independent power are expected to allow for scientific discovery as previously inaccessible terrains can be explored. Many of these regions concentrate volatile organic compounds which are anticipated to be central to in situ resource utilization. While static power conversion using thermoelectric is a flexible near-term option, higher efficiency dynamic power conversion is an attractive alternative. Regardless of the means of conversion, radioisotope power mitigates the risk of exploring locations where dust poses a challenge to solar based systems.

EmberSource is an additive product which utilizes the high energy photons from radioisotopes sources as a science instrument for gamma and x-ray fluorescence and backscatter. This scientific use case leads to shorter acquisition times with an expanded range. These advances can be used to identify substances such as water in regolith over greater distances than currently accessible, allowing for more efficient evaluation of regional in situ resource utilization potential. EmberSource can be added as a functionality with either the EmberCore or EmberPower products.

Conclusions: The Ember-based product line is developing a suite of solutions to greatly expand the scope of lunar lander and rover operations. By selecting an appropriate radioisotope source in alignment with the mission scope commercial customers can optimize their system and payload design. Ultra Safe Nuclear has a development roadmap revitalizing this technology for the commercial space age, including licensing, ground, and flight demonstrations. Interested parties are encouraged to reach out to the author and attend the meeting session to learn more or contact the author.