RADIOISOTOPE POWER SYSTEMS FOR IN-SITU EXPLORATION OF TITAN AND VENUS

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In-situ exploration of moons and planets are essential to answer questions about the formation of our solar system and habitability. NASA's Solar System Exploration Road Map, in line with recommendations by the National Research Council, identified five flagship class missions over the next three decades. Two of these would have months to years of operation at or near the surfaces of Titan and Venus, whose deep atmospheres greatly attenuate the amount of solar energy reaching the surface. These vehicles must operate under vastly different conditions. While the near surface environment of Titan is cold (-178°C), the temperature and pressure on Venus could reach +460°C and 90 bars, respectively. Their high density atmospheres lend themselves to air mobility mission architectures, two of which utilize balloons and airships. Space missions are typically mass and power limited. While balloons could significantly increase traversing – compared to surface rovers – the benefits would be offset by reduced payload mass. Therefore, the selection of suitable power sources for these missions is critical. Energy storage devices (batteries and fuel cells) greatly limit mission duration. Thus, it is expected that long lived in-situ missions to destinations where solar power is not available, would require internal power sources, such as Radioisotope Power Systems (RPS). On Titan, beside power generation, the excess heat from an RPS could be used to heat a Montgolfière (hot air) balloon; therefore, plutonium reduction for this mission would not be a key driver. However, the cold environment would necessitate re-sizing of the cooling fins of the Multi-Mission Radioisotope Power System (MMRTG), considered for this architecture. (An advanced RPS with improved specific power could increase power to the spacecraft, but would require technology development.) Conversely, on Venus, extreme environment mitigation would call for a new type of RPS; a Stirling Radioisotope Generator, which could generate power while providing active cooling to the instruments inside the pressure vessel. In this paper, further discussions are given on RPS requirements and possible configurations for these proposed Titan and Venus missions, performing in-situ science investigations and validation of remote sensing measurements.

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