



Conceptual Design of a High Power Density Heat Source Module

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Abstract. Pacific Northwest National Laboratory (PNNL) is providing radioisotope heat source design guidance to assist Jet Propulsion Laboratory (JPL) in an ongoing feasibility study of a robotic lander mission on Europa. The robotic lander, called a cryobot, is envisioned to use radioisotope heat sources containing plutonium-238 (²³⁸Pu) to provide both electricity for the device and a source of energy to melt through ice. Based on feasibility studies completed previously at JPL, a basic and reasonable design of a radioisotope heat source with different properties than existing general purpose heat source (GPHS) modules is needed, but does not currently exist. To support ongoing feasibility studies, PNNL is providing a preliminary, conceptual design for a new radioisotope heat source that is configured for use in a cryobot. Thermal and other physical characteristics of conceptual designs are under investigation. Factors such as launch safety and fabricability are important but are a secondary consideration for initial feasibility analysis. PNNL is performing research and analysis including determining design considerations and constraints for a ²³⁸Pu heat source; creating an initial ²³⁸Pu microsphere-based heat source design description based on cryobot design considerations and constraints; generating a preliminary list of high-level research and development activities needed to support development and fabrication of the proposed heat source design; identifying the primary design parameters that impact the ²³⁸Pu fuel temperature and the amount of ²³⁸Pu that can be loaded into a module; and performing thermal analyses of a heat source including the heat source centerline temperature and surface temperature.

Keywords: Plutonium, microsphere, radioisotope, Europa, cryobot