Contribution ID: **77** Type: **poster**

Radiological Safety Assessment on AmO 2/Am 2O 3 BASED Radioisotope Heater Unit (RHU) for long-term Korean Lunar mission

The Moon experiences a day-night cycle lasting approximately 27.3 days. Near the Moon's equator, daytime temperatures reach about 120℃, while nighttime temperatures drop to -130℃. During the night, lunar exploration equipment is exposed to extreme temperatures, causing it to discharge and cease functioning. A method to prevent this is by incorporating a heat source, such as a Radioisotope Heater Unit (RHU), into the equipment. The RHU works by utilizing the energy emitted during the decay of isotopes, which is then shielded to generate heat. To produce 1 W of energy, a certain amount of Am-241 or Pu-238 is required. This study evaluates the size, shape, dose rates, and shielding effects of heat sources based on Am-241 using Monte Carlo calculations, in accordance with the ICRP 74 Dose Conversion Factor (DCF). For a 16.6 W RTG heat source, the surface dose rate of the pellet was estimated to be 10.824 Sv/hr, and at a height of 10 cm above a sealed pellet surface, the dose rate was 0.434 mSv/hr (gamma radiation from Am-241 only). The dose contribution factors of Am-based RHUs include prompt photons (59 keV), alpha-induced neutrons, and gamma emissions from the reaction < 17,18 O(α, n) 20,21 Ne + r>. The dose contribution rates were analyzed by varying parameters. For calculating alpha-induced neutron reactions (α, n), the JENDL 5 (2022) and TENDL 19 (2019) libraries were used. Additionally, neutron dose calculations from the reaction of Am and O-17, O-18 (α, n) were performed using the JENDL and TENDL libraries. For each alpha particle from Am-241, 1.48E-08 neutrons were calculated, and for a 3 W RHU (92.254 Ci), the number of neutrons emitted from an Am 2O 3 pellet was found to be 5.08E+04 neutrons/sec. Further analysis of surface and 10 cm abovesurface detector readings will be conducted in future analytical calculations.

Workshop topics

Applications

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