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DEVELOPMENT OF SPACE NUCLEAR REACTORS FOR LUNAR PURPOSES: OVERVIEW OF TECHNICAL AND NON-TECHNICAL ISSUES

Abstract

Space nuclear reactor systems are considered enabling technologies for the establishment of settlements on the Moon and on Mars. Their compactness, high power density, high reliability, long life and lower recurring cost are advantages compared to other energy sources. In addition, space nuclear reactors are capable of operating independently of the Sun, have an enhanced ability to operate in hostile environments and greatly simplify spacecraft attitude and control functions for most missions. On the other hand, space nuclear power systems do require additional mass for shielding radiation sensitive payloads and require measures to be taken to protect human beings from output nuclear radiations. The objective of this paper is to provide a succinct and partial overview of technical and non-technical issues that engineers have been confronted with during development, past and present, of space nuclear reactor systems.

First, technical issues are examined. Nuclear propulsion, both electric and thermal, is given a brief description. Next, examples of nuclear propulsion engines are presented: the SP-100 design is covered in some detail, a Stirling power conversion system is described, and then different possible combinations of nuclear reactor and conversion systems are presented. Ideas relating to the establishment of nuclear power generation stations on the Moon are explored, including a pressurized water reactor, a fast breeder reactor and a system which uses the fine lunar sand as convective cooling method instead of using a radiator. Finally, safety issues regarding the launch and operation of nuclear rockets, and the disposal of spent nuclear reactors, are investigated.

Then, non-technical issues are reviewed. Space Nuclear power is a highly controversial subject in the public mind and that has affected its technical development. It has been suggested to incorporate the public's views during the design phase of any mission so that those that are flown contain acceptable risks. Congressional actions are lowering the budgets of agencies responsible for SNP missions. This is putting in peril the infrastructure on which SNP development relies. The latter is therefore hampered and as a consequence fewer young engineers are entering the field. There is no transmission of expertise to the younger generation and the wealth of SNP information accumulated over the past few decades is being lost.