SPACE PROPULSION SYMPOSIUM (C4)
Joint Session on Nuclear Propulsion and Power (7.-C3.5)

Author: Mr. Roger X. Lenard
LPS, United States

IMPACT OF ADVANCED TECHNOLOGIES ON NUCLEAR POWER AND PROPULSION SYSTEMS

Abstract

Recent advances in materials such as graphene, silicon carbide composites, and high efficiency turbomachinery may be able to provide major reductions in nuclear power system mass. Not only can new technologies reduce mass, but in many cases the technologies enable innovative packaging, highly flexible materials such as graphene may allow very large radiators to be packaged in greatly reduced volumes, a limitation exhibited by fixed radiator structures. Improvements in power conditioning systems can provide a more direct-drive approach to powering electric propulsion capability. Efforts to improve the thrust-to-weight of electric propulsion systems can provide substantial gains as well. This paper will address the impact of these advances employing a very detailed set of power system sizing relationships developed during the Jupiter Icy Moons Orbiter project by NASA. In many ways the Jupiter Icy Moons Orbiter program elucidated how to make a nuclear electric propulsion spacecraft heavy, when, of course the objective is to make it as light as possible. In many cases, technologies had become more reliable, while NASA retained a low level of reliability for many subsystems, resulting in proliferation and redundancy of heavy systems. The end result was not only a heavy spacecraft, but lower reliability due to complexity. Advanced technologies may have other advantages. For example, if it is possible to make a high thrust-to-weight (for electric propulsion) system with small radiators that can be thermally shielded, it can take advantage of thrusting close to massive objects, improving the velocity attainable substantially on a given amount of fuel. Ultimately, achieving speeds necessary for rudimentary interstellar travel will require some major innovation to escape the limitations of available energy. Techniques for extending known technologies to gain greater speed will be investigated. The objective will be to find ways to approach very low specific mass values; approaching 1 kg/kWe is the Holy Grail of electric propulsion systems, a theoretical analysis will be performed to ascertain whether such a goal is realistic with presently understood technologies.