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IMPACT MODELLING AND SAFETY TESTS FOR THE ESA RADIOISOTOPE POWER SYSTEMS

Abstract

Since 2009, ESA has been conducting RD activities leading towards the future development of a European capability in radioisotope power systems (RPS) for space. The programme is focused on the use of americium-241 as an innovative alternative to the plutonium-238 fuel used by USA and Russia. Two different RPS technologies, radioisotope thermoelectric generators (RTGs) and radioisotope heater units (RHUs), are currently being developed by the University of Leicester in the UK. The development of containment architectures, known as heat sources, has recently evolved from the design stage to more representative prototypic systems. These include a platinum-rhodium cladding as the first line of defence surrounding the fuel. Additional layers of carbon based insulators and carbon-carbon composites ensure that the heat source can survive all possible accident conditions from launch failures to Earth re-entry, minimising the risk of inadvertently releasing radioactive material into the environment. Validated heat source accident models are necessary to inform the design iteration of the European Am-based RHU and RTG, and to construct a safety case for their launch. The research project here presented is a collaboration, supported by ESA, between the University of Leicester in the UK and ArianeGroup in France. The aim is to develop computer models to simulate the behaviour of the containment systems under different impact conditions, which can arise from launch failure (e.g. launch pad explosion where fragments from the launch vehicle and spacecraft can impact the heat source), launch abort (where the system may not have reached orbit and impacts on the ground or in the sea) and atmospheric re-entry with ablation, followed by impact on ground or the ocean. The models are validated experimentally, thanks to the infrastructure and expertise of ArianeGroup in this field. Tested samples are then characterised at ESA/ESTEC, in order to understand the behaviour of the fuel containment materials under the most relevant accident conditions. This paper reports on the activities performed so far, namely software impact modelling and the testing campaign in France, and the next steps envisaged for this research project.