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Author: Ms. Alessandra Barco
University of Leicester, United Kingdom

Dr. Richard Ambrosi
University of Leicester, United Kingdom
Mr. Jean-Luc Dumont
ArianeGroup SAS, France
Mr. Pierre Brunet
ArianeGroup, France
Mr. Cédric Lemarié
ArianeGroup SAS, France
Mr. Keith Stephenson
European Space Agency (ESA), The Netherlands

SAFETY STUDIES FOR THE ESA RADIOISOTOPE POWER SYSTEMS

Abstract

Since 2009, the European Space Agency (ESA) has been conducting R&D activities leading towards the future development of a European capability for the independent design, production and management of radioisotope power systems (RPS) for space applications. The program is focused on the use of americium-241 as an innovative alternative to the plutonium-238 fuel currently used by USA and Russia. The University of Leicester in the UK is leading the development of a 10 W_el radioisotope thermoelectric generator (RTG) with a specific electric power of around 1 W_el/kg (and the ability to scale the electrical power output up to 50 W_el by using the 10 W_el RTG system as the building block), and a 3 W_th radioisotope heater unit (RHU). The americium-based RHU is baselined for the European Large Logistics Lander (EL3) mission.

An important aspect of the overall program is safety, and this involves ensuring that the design of these systems meets a set of stringent requirements: it is fundamental to properly design the heat source (i.e. fuel and containment layers) in order to avoid inadvertently releasing radioactive material into the environment in case of accident. Validated heat source accident models are necessary to inform the design iteration of the European americium-based RPS, and to construct a safety case for their launch.

The activities here presented started in 2018 as a collaboration supported by ESA, between the University of Leicester and ArianeGroup. The goal was to begin the process of understanding the behavior of the fuel containment systems under the most relevant accident conditions by computer modelling, to validate them experimentally given the infrastructure, test facilities and expertise of ArianeGroup in this field, and to characterize the different materials. This project has been the first experimental step in the safety studies for the ESA americium-based heat sources, and it is closely related to other ongoing activities that shall allow to achieve TRL5 for the development maturity of the encapsulation systems. Since Europe and ESA currently do not have an operational launch safety framework, this activity is also closely related to the ongoing definition of a launch safety and authorization process (LSAP) for European missions with RPS.