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Analysis of the spatial and spectral neutron distribution of various conceptual core designs with the aim of optimising the SAFARI-1 research reactor.

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Abstract content
   (Max 300 words)

SAFARI-1 is a 20MW research reactor which is over 45 years old, and is expected to reach the end of its operating life between 2020 and 2030. The purpose of this study is to investigate various alternative conceptual core layouts of the SAFARI-1 reactor in order to facilitate more efficient use of the reactor, while potentially extending its operating life. The spatial and energy neutron distribution is one of the most important parameters in the characterization of such an alternative core layout. This neutron distribution is a result of basic physics processes such as particle matter interactions, nuclear reactions, material properties, effect of temperature and the time evolution of the system. In this study we will focus on the steady-state neutron distribution within the highly heterogeneous and complex geometry of the reactor core for the various alternative core layouts. Basically, we are looking for a different inhomogeneous neutron distribution within the core, arising from a different core layout, which can nonetheless still achieve efficiency in the operation for various design purposes, but with a lower power output.
The safety and utilization requirements for the SAFARI-1 research reactor are quantifiable in terms of its steady-state neutron flux distribution. A SAFARI-1 reference core, obtained via an equilibrium cycle calculation, was used to generate a set of safety and utilization targets against which alternative designs may be measured. Alternative core layouts were developed by using a parametric study to scope the size and power level of potential candidate conceptual cores with the aim of minimizing the power level while adhering to the safety requirements. Utilization parameters of interest include isotope production capability, thermal flux levels in beam tubes and production levels in the silicon doping facility.
Results indicate that an alternative core with a power of 17MW can achieve similar performance as the current 20MW SAFARI-1 design, by simply rearranging components in the core. Additional power reduction is only possible if significant core design changes are allowed.

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