

## Initial Activation Assessment for ARIES Compact Stellarator Power Plant

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The ARIES team is moving forward with a new study: the ARIES-CS compact stellarator power plant. It is a pioneer design that combines advanced physics and engineering approaches to minimize the major radius and hence the overall size of the machine. Regarding the engineering activities, five blanket/shield systems have been proposed (Flibe/FS/Be, LiPb/SiC, LiPb/FS/He, Li/FS/He, and Li<sub>4</sub>SiO<sub>4</sub>/FS/Be/He) and an effort is underway to integrate the internals (blanket, shield, and vacuum vessel) and develop a credible maintenance scheme that supports high availability of 85% or more. The blanket covers the majority of the first wall (~90%). At a few localized areas where the magnet moves closer to the plasma, a highly efficient, thin WC-based shield replaces the blanket to protect the magnet against radiation. We developed two radial builds for each blanket concept: one for the nominal blanket, shield, and vacuum vessel region and the other for the WC-shield and vacuum vessel region.

As inputs for the safety assessment that frequently requires knowledge of the activation parameters, we estimated the highest possible activity, decay heat, and waste disposal rating on the time scale after shutdown for the two radial builds mentioned above. In the absence of a reference design, we selected for this study two widely different systems (LiPb/SiC and LiPb/FS/He) employing SiC/SiC composites and low-activation ferritic steel (FS) as structural materials. The ALARA activation code, DANTSYS transport code, and FENDL-2 data have been used throughout the study. Key design parameters for this initial assessment include an average neutron wall loading of 2 MW/m<sup>2</sup>, a first wall lifetime of 5-6 FPY, and a permanent component lifetime of 40 FPY. It is found that the WC-shield generates the highest activity and decay heat among all components. The SiC structure of the blanket generates the lowest activity and decay heat and their initial values drop rapidly by 3-4 orders of magnitude at one day after shutdown. An estimate for the peak temperature at the SiC and FS structures during an accident is currently underway making use of the decay heat as a heat source. If the temperature exceeds the limit of the reusability of the structure, a separate decay heat removal loop will be installed within the WC-shield in particular to control its temperature during an accident.

Among the three radwaste management approaches envisioned for ARIES-CS, the disposal and clearance options have been investigated in detail. This paper focuses on the disposal issue while a companion paper covers the details of the clearance approach<sup>1</sup>. We evaluated the waste disposal rating (WDR) for a compacted waste using the most conservative waste disposal limits developed by Fetter and NRC-10CFR61. Our results show that all components including the WC-shield qualify as Class C low-level waste (LLW) at the end of a 100 y storage period following the decommissioning of the plant. Moreover, the SiC blanket, vacuum vessel, and magnet offer very low WDR (< 0.1) to the extent that a Class A LLW seems achievable for these components. On this last point, we will discuss the split between the Class A and Class C wastes, emphasizing our motivation to lower the level and minimize the volume of ARIES-CS radwaste.

1 L. El-Guebaly, P. Wilson, D. Paige, and the ARIES Team, "Evolution of Clearance Standards and Implications for Radwaste Management of Fusion Power Plants," These proceedings.