THE LOW ASPECT RATIO CONCEPT-POSSIBILITY OF AN ACCEPTABLE FUSION POWER SYSTEM*

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A scoping study has been performed to evaluate the Low Aspect Ratio (LAR) magnetic confinement concept. As a power plant, it has the potential physics benefits of high toroidal beta > 55%, bootstrap plasma current fraction >99%, high average power density, large scrape-off-layer, with no disruptions. It has many uncertainties due to the lack of experimental maturity. Questions such as confinement scaling, start-up, current drive and edge flux expansion are being studied. Encouraging experimental results are reported by START. When compared to the tokamak approach, the LAR concept provides a lower cost development path. This study takes the analytical and parametric results projected by the physics group at General Atomics and evaluates the reactor potential of the LAR concept by optimizing the design toward the minimum cost of electricity while operating under engineering design constraints. A system code was developed to support the evaluation, and the costing evaluation was benchmarked with the ARIES system costing code. We aimed at a GWe design that has a total estimated capital cost of <$4B, and a COE < 60 mill/kW. hr, which could be quite competitive with other energy sources in the future. A relatively small machine is predicted with major and minor radii of about 2.5 m and 1.75 m, respectively, an elongation of 2.5–3 and an aspect ratio of ~1.4. To keep the machine small we designed to a high neutron wall loading of 8 MW/m^2 by using a helium-cooled, lithium breeder, V-alloy blanket. At a coolant outlet temperature of 650°C, a closed cycle gas turbine system provides a thermal conversion efficiency of 46%. This is a water-cooled normal coil machine using Glidcop as the conductor material. The safety concern of using Li and water in the fusion power core is alleviated by the identification of five separate physical barriers. To minimize the recirculating power in the normal coil TF magnets, the conducting path length is kept to a minimum by using minimum. The projected lifetime of the central column and blanket is 1 to 2 full power years. Critical technology and engineering issues of Cu-alloy central column design, radiating mantle/divertor to spread the surface heating to the first wall and divertor, and the use of helium with controlled impurities with V-alloy will be presented in this paper.

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