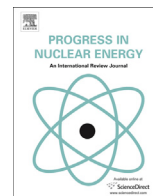




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Neutronic study of a new generation of the small modular pressurized water reactor using Monte-Carlo simulation



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ABSTRACT

Small Modular Reactors (SMRs) are the innovative design of nuclear reactors making remarkable interest during recent years. Since there is not enough available operating experience on SMRs, it might be possible to initiate extensive investigations on these types of reactors for the purpose of improving the current performance level of these systems, significantly. The main purpose of this present study is neutronic study of a typical small modular pressurized water reactor via Monte-Carlo method using the MCNPX code. The CAREM25 is chosen as the reference SMR. The reactor core geometry is simulated and neutronic parameters are visualized and analyzed via high qualified 3-D figures. They are figure out neutronic nature of the chosen case study. They capture the simulation of the reactor core geometry, and skim the neutron flux and power distribution, radial and axial power peaking factors and the influence of the control rods on the thermal flux. Central fuel assembly is determined as the hottest fuel assembly with power peaking factor of 1.778. The hottest fuel rod power peaking factor is calculated as 1.846 in the hottest assembly. The maximum calculated axial power peaking factor of the hot rod is 2.85. Results show that the maximum axial power along the fuel rods occurred below the mid-plane of the rod. The ratio of the hot to average rod axial power peaking factor as a safety parameter used to calculate the maximum heat flux in the hottest channel, is calculated close to 2 in almost 70% of the core height.

The core reactivity at cold and hot shut down without safety injections of boron acid is calculated as $0.09712 \left(\frac{\Delta k}{k} \right)$ and $-0.00103 \left(\frac{\Delta k}{k} \right)$, respectively.

Results show suitable neutronic behavior and responses during virtual tests and analyses.

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1. Introduction

During the past few years, there has been remarkably wide-spread interest in SMRs (small modular reactors). The SMRs would generate between 10 and 300 MWe of electricity, with power levels much smaller than those of the current status operating reactors (Ingersoll, 2009; NEA, 2011; Vujic et al., 2012; Yan et al., 2012). In specific, integrated PWRs, encapsulate all PWR primary coolant system components such as pressurizer, steam generators, pumps and control rod drive mechanism into a tall reactor pressure vessel.

Because of high capital cost of large nuclear reactors, as well as

endangering the grid operation and stability due to large power additions in many areas, SMRs technology could be an attractive option only if their cost of electricity is proven to be competitive with the market (Carelli et al., 2010; Ingersoll, 2009).

SMRs are aimed at solving some of the multiple problems plaguing the nuclear industry and allow the possibility of using nuclear power in market niches that have previously been difficult to enter. These market niches include developing countries with smaller electric grids, remote locations, water desalination, and industrial heat supply (Ingersoll, 2009; NEA, 2011; Vujic et al., 2012; Yan et al., 2012).

There are very wide varieties of SMR designs with distinct characteristics that are being developed. Several countries are developing and planning to construct SMRs, including the United States, Russia, China, France, Japan, South Korea, India, and Argentina. One global assessment from predicts that there would

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