LONGER LIFE CORES FOR SLOWPOKE-2 REACTORS

by

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SLOWPOKE-2 is a 20 kW pool-type research reactor. It produces a thermal neutron flux of $10^{12} n.cm^{-2}.s^{-1}$ which is used mainly for neutron activation analysis and the production of short-lived isotopes.

There are six operating SLOWPOKE-2 reactors in Canada, one at the University of the West Indies in Jamaica, and one under construction at the Royal Military College in Kingston, Ontario.

Six of the operating reactors have an effective life of one full-power-year, which corresponds to approximately ten calendar years at a typical university installation. A simple method has been devised to extend the core lifetime significantly for future cores.

SLOWPOKE-2 reactors are light water cooled and moderated and the seven operating reactors are fuelled with highly enriched uranium (93 wt% U-235 in U) contained in approximately 296 fuel elements made of uranium-aluminum alloy. The reactors have 10 cm thick beryllium reflectors radially and below the core. A beryllium reflector is also located above the core. The top beryllium reflector can have a thickness ranging between zero and 10 cm, and at the beginning of core life it is typically 1.7 cm thick. Its thickness is increased, as U-235 is consumed, by adding semi-circular beryllium plates manually, with a long handling tool. In typical use at a university, a plate is added about once per year.

The original approach-to-critical procedure required that fuel elements be loaded into the core until k-effective was 0.995. The thickness of the top beryllium reflector was then increased in steps until k-effective approached 1.0034 with the central control absorber removed. The remaining beryllium for the top reflector was then added in the following years, so that after each adjustment k-effective was equal to or just less than 1.0034. The resulting core lifetime after the full 10 cm had been added, was one full-power-year.

Reactor physics calculations showed that the core lifetime could be extended significantly if the first approach to critical were modified slightly so that fuel loading continued until k-effective was equal to or just less than 1.0034. This leaves the total thickness of the top beryllium reflector to be added in later years to compensate for the reactivity lost to fuel burnup.

This approach was used during the commissioning of the latest SLOWPOKE-2 reactor in June 1984 at the AECL Radiochemical Company's Kanata facility. At Kanata, 317 fuel elements were loaded into the core to give a k-effective of 1.0029. This 7 per cent increase in fuel loading over that used for previous SLOWPOKE-2 reactors will double the core lifetime. For the average SLOWPOKE-2 reactor at a university the core would be expected to last at least 20 years. The large increase in reactor lifetime, due to a relatively small increase in fuel loading, is due to the fact that towards the end of core life the rate of decrease of k-effective with burnup is reduced significantly, because an equilibrium samarium concentration has been reached; whereas, initially the change in k-effective is mainly due to the buildup of samarium.