LETTER TO THE EDITOR

SAFETY OF FUEL-FREE REGIONS

Dear Sir:

A recent article[1] gives the results of investigations into the use of fuel-free regions placed in the core of a light-water-moderated reactor in order to enhance the thermal-to-fast neutron ratio for beam-tube experiments. At the Union Carbide Corporation's 5-MW pool-type research reactor in Sterling Forest, New York, a somewhat similar arrangement has been in use since March 1966 for increasing the subthermal (<0.005 eV) to epicadmium neutron ratio (or signal/noise ratio) seen by an inelastic neutron spectrometer.[2]

The 6-in.-diam beam-tube serving this spectrometer contains a liquid-nitrogen-cooled beryllium filter and, as a result of the 60° angle with which the tube approaches the core, straddles three adjacent core positions on the outside of the approximately rectangular core. The MTR-type fuel element in each of these positions is modified ("window element") in that each of its 16 fueled plates has a 6-in.-long region in which fuel is omitted. Each plate normally has a 24-in. fueled length containing about 12 g of 93% enriched ^{235}U in the form of U/Al alloy clad with Al. The beam tube terminates at this unfueled "window" region, in which the metal/water volume ratio is the same as for the fueled regions.

While no operational problems have arisen in the use of these window elements, two matters significant to safety do arise. One is that the inevitable thickening of the fuel alloy that occurs at the end of the two fueled regions in each window-type plate is placed in a region of high thermal flux at the window. The resulting "hot spots" have to be considered. A similar thickening (or "dog-boning") occurs in a normal plate but is located in the lower flux regions at each end of the fuel element. The other matter arises from the discontinuous fuel distribution. As a fuel element is raised out of the core, fuel is introduced into a region of higher importance and reactivity can be increased. Unlike the normal situation, the removal of a window element can therefore (initially) give a positive reactivity effect. In our case, this effect amounts to $\approx 0.08\%\ \Delta K/K$ per element.

The measured improvement in signal-to-noise ratio for the inelastic spectrometer was ≈50%, which, while not large, is quite significant for this experiment. How much of this change is due to reduction of fast background is not known. Before the use of window elements, the three core positions adjacent to the end of the beam tube contained two normal fuel elements separated by one empty (water-filled) position.

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REFERENCES

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