5.2 Reactor Core

Applicability

This specification applies to the design of the reactor core.

Objective

To assure compatibility of the reactor core with the present safety analysis.

Specifications

1. The reactor core may consist of up to 27 fuel elements approximately 2-3/8" on a side. The fuel shall be plates of uranium in the form of UAl alloy or UAl_x with a maximum of 50 w/o uranium in the fuel matrix clad by a layer of aluminum metal incorporating fins on the surface that enhance the heat transfer and having a nominal clad thickness of 0.015 inches at the base of the groove between the fins.

2. Design of in-core sample assemblies shall conform to the following criteria:

   a. they shall be positively secured in the core to prevent movement during reactor operation,

   b. materials of construction shall be radiation resistant and compatible with those used in the reactor core and primary coolant system,

   c. sufficient cooling shall be provided to insure structural integrity of the assembly and to preclude any boiling of the primary coolant,

   d. the size of the irradiation thimble shall be less than 16 square inches in cross section.

Basis

The thermal design analysis in the SAR and the power distributions on which the analysis was based assumed fuel elements of the type specified

in item 1. Any change in this design would require re-evaluation of the heat transfer and flow characteristics of the element.

The nominal clad thickness of 0.015" is based upon standard practice for MTR type elements with clad of similar thickness. Reference 5.2-1 states (p. 148) that the release of radioactive fission gas to the primary cooling water appears to be adequately prevented by cladding of uniform thickness (>0.2 mm, >0.008 in). This corresponds to the minimum nominal cladding permitted for ATR fuel, where the term "uniform" implies a provision for minor manufacturing deviations (e.g. scratches, indentations, etc.) from the uniform thickness. Ref. 5.2-2, (p. 672) shows that a thick clad increases the delay time for heat removal in event of a fast transient. Therefore, the clad should be as thin as possible while still remaining compatible with fission product retention requirements.

In-core sample assemblies which satisfy Specification 2a cannot be credibly ejected during operation and are therefore considered part of the reactor structure.

Specification 2b and 2c insure the structural integrity of the assembly and prevent chemical interactions with the core and primary coolant system.

Specification 2d limits the size of the irradiation area as required by 10 CFR 50.2(r).

References

Ref. 5.2-1 Beeston, J.M., R.R. Hobbins, G.W. Gibson, and W.F. Francis, "Development and Irradiation Performance of Uranium Aluminide Fuels in Test Reactors", Nuclear Technology, Vol. 49 p. 136-149 (June 1980).

Ref. 5.2-2 Thompson, T.J., and J.G. Beckerly (eds.), The Technology of Nuclear Reactor Safety, Vol. I, the MIT Press, Camb. MA (1964).