FISSION DISTRIBUTION TECHNIQUES FOR ROVER REACTORS

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In a Rover reactor, fuel loadings and coolant passage orifices are tailored to produce a flat temperature profile across the exhaust end of the core. Information required for this purpose is derived from detailed fission distribution measurements at literally thousands of positions.

The large number of radial distribution measurements employ aluminum-uranium (10 w/o) flux wires, 0.020 inches in diameter and 7.5 inches long. These are inserted in the fuel element axial coolant channels of interest, irradiated, and beta counted utilizing an automatic sample changer. The changer is a modified Wurlitzer Juke-box programmed by perforated tape to enable the 100-sample capacity to be counted in any arbitrary order.

One wire sample is chosen as a "standard" and counted periodically in the 100-sample sequence in order to correct for fission fragment decay and detector drift. The sequence is usually run three times with data recorded automatically on perforated tape. The automatic read-out system controls the sequencing of the Juke-box and records elapsed time from "scram", sample identification, count duration, and sample count. Preset counting time or preset count modes may be used.

The flux wire, wound in a flat spiral located at the center of a 7-in. steel disc (record), is positioned by the Juke-box between a gamma counter (NaI-T₄) and a beta counter (methane flow) for counting. Beta counting is preferred because of better stability and lack of cross-talk background problems.

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The data obtained are computer-processed to provide a number that is the ratio of activity of each sample to the activity of the "standard". This is accomplished by correcting the data for counter background, normalizing to unit time, and applying a spline fit to the decaying "standard" data points. Counting data are then ratioed to the spline fit of the "standard".

Typically, the uranium weight of 7-1/2-in. samples cut in sequence from a length of wire varies by less than 1% for a set of 100, so that in most cases a weight value of unity can be assigned to each wire in the set. However, if the particular measurement to be made requires greater precision, the uranium content of the wires is assayed by gamma counting each sample prior to irradiation. Relative weight values obtained in this manner are then included in the data reduction process performed by the computer.

Figure 1 is a plot of the ratio of two fission distributions measured in the Phoebus 2A reactor. One distribution was made with the reactor control drums rotated out 115° from full shutdown while the second profile had the drums at 95° . The resulting ratio shows how the fission flux is affected by control drum position and is compared to a prediction (solid line) obtained from similar measurements in the zero-power mockup of the reactor. As there is greatest interest in the outermost edge of the core, counting was performed to provide best statistics for that region. Precision obtained in routine measurements appears to be better than 1%.

Axial fission variation, which is of less concern in the performance of Rover reactors, has been obtained by a wire-scanning

technique. Wires that extend the full length of the core are irradiated and mounted on the perimeter of a rotating wheel. A beta counter with a narrow window then scans the wire. Data are accumulated in a pulse height analyzer operated in the multi-scaler mode, synchronized with wheel position. The wheel rotates at one revolution per second with each channel of the analyzer accumulating data repetitively over a particular interval of wire. One channel represents the activity of approximately one-half inch of wire.

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Fig. 1 . Fission density ratio for control drums at 115° and 95°.

7.5.1 C-PD