

LIQUID METAL REACTOR PROGRAM

JASPER

USDOE/PNC Shielding Research Program

Technical Progress Report

April 1 - May 31, 1987

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EXPERIMENTAL PROGRAM

The report on measurements for the JASPER Program Radial Shield Attenuation Experiment has been issued as ORNL/TM-10371. The final report on the Fission Gas Plenum Experiment has been reviewed, corrections made, and will be submitted to the publisher within two weeks.

Work continues on the fabrication of the sub-assemblies for the Axial Shield Experiment, with delivery of the last pieces scheduled for June 30. The experimental program has been delayed during this reporting period for lack of permission from DOE to operate the reactor. When the reactor will become operational is still uncertain.

In an attempt to resolve the discrepancy in the relative ratios of boron and carbon in the B₄C powder, several samples from each of the purchases made in 1986 and 1987 were submitted for analysis. For the B₄C purchased in 1986, the boron content varied from 76.2% to 78.2%, while corresponding carbon content varied between 20.6% to 19.6%, the sum of the two values varying from 96.8% to 97.8%. For the 1987 material, the boron percentage varied from 78.0 to 78.2, while the carbon content ran between 20.0 and 20.4%. Again, the sum of boron and carbon does not give 100%, a difference that cannot be attributed to an impurity content. The errors quoted for the analysis were less than ±2%. The samples were re-submitted, this time to look for possible compounds such as B oxide or B nitride that might account for the missing 2%. The carbon data account for all carbon possibilities.

Fuel pins/rods for use in the first fission experiment have been located at the University of Florida. The pins contain 4.81% enrichment of ²³⁵U, clad in a SS wrapper. Negotiations are underway for their delivery before the end of this fiscal year.

Blueprints for fabrication of the iron vessel and sleeve inserts to be used in the Iron Slit Experiment should be completed during the next reporting period. Fabrication will not begin before October 1 due to insufficient funds this fiscal year.

ANALYSIS

Attenuation Experiment

One-dimensional calculations were performed on two configurations to determine the effect of group structure on the calculated fast-neutron spectra. The calculations were performed with the 61-broad-group structure and the 174-fine-group structure of which the 61-group structure is a subset. The configurations used were II.D (consisting of layers of steel

and B₄C followed by 7.6 cm of lead) and VI.F (consisting of 61 cm of graphite followed by a thin layer of B₄C to limit gamma-ray production from neutron captures in the 15.2 cm of lead which followed).

The calculated fast-neutron spectra are compared with the measured spectra in Figs. 1 and 2 for Configurations II.D and VI.F, respectively. For the comparisons, the 1-D calculated spectra were normalized by applying to both the 61-group and 174-group spectra the factors that made the 1-D 61-group integral fast-neutron flux agree with the 2-D 61-group integral fast flux (the factors were: 1.23 for Configuration II.D and 1.25 for Configuration VI.F). For Configuration II.D, the fine-group results are essentially the same as the broad-group results, although slightly higher above 1.0 MeV. For Configuration VI.F, the fine-group results show more structure in the spectrum above 6 MeV but are otherwise in better agreement with the measured results than are the broad-group results. A comparison of the integrated fast-neutron flux showed the fine-group results to be 1.03 and 1.26 times the broad-group results for Configurations II.D and VI.F, respectively. Thus, with the fine-group structure, one would expect a slight improvement in the C/E for Configuration II.D from 0.88 to 0.91. On the other hand, the C/E for Configuration VI.F would improve from 0.84 to 1.06, in excellent agreement with the measured results.

It was expected that the fine-group modelling of the ¹¹B cross sections would result in a significant change from the broad-group results for Configuration II.D; yet, the calculations showed only a 3% increase in the fast flux. One can only conclude that the 61-group structure was adequate for ¹¹B cross sections. However, the fact that both the fine- and broad-group structures give fluxes significantly higher than measured in the 4 to 10 MeV range for Configuration II.D may be indicative of the ¹¹B cross sections being too small in that energy range.

Calculations for this experiment are essentially completed. The sensitivity of the results to aluminum will be studied and if found to be important, a few additional calculations may be performed if alternate data are available. Results will then be documented.

Fission Gas Plenum Experiment

Calculations were begun for the Fission Gas Plenum Experiment. The four configurations were modeled with homogeneous layers in 2-D R-Z geometry and test calculations were made. Boundary fluxes are being saved at the boundary between the spectrum modifier and the fission gas plenum so that Monte Carlo calculations can be made on the heterogeneous mockups. Results will be reported in the next progress report.

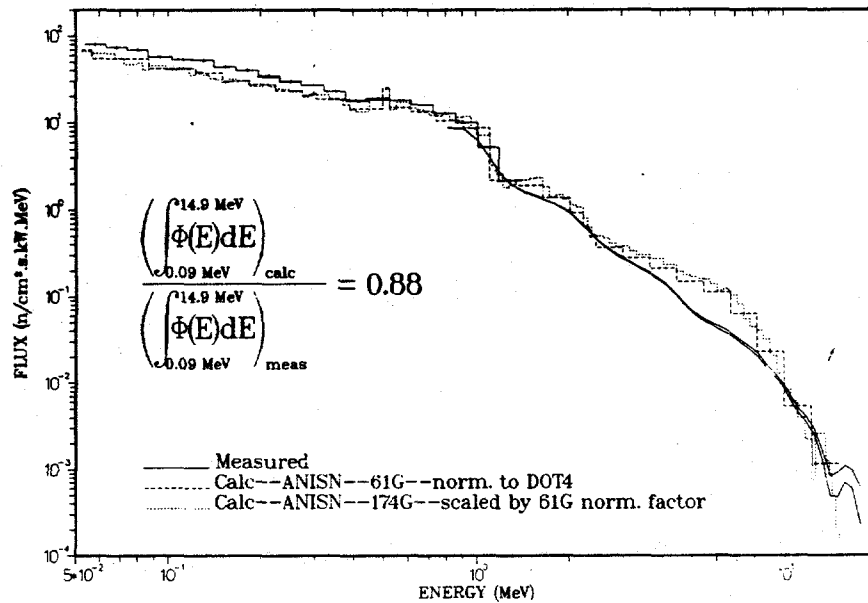


Figure 1. Comparison of calculated 61-broad-group and 174-fine-group fast-neutron spectra with measured spectra for Configuration II.D.

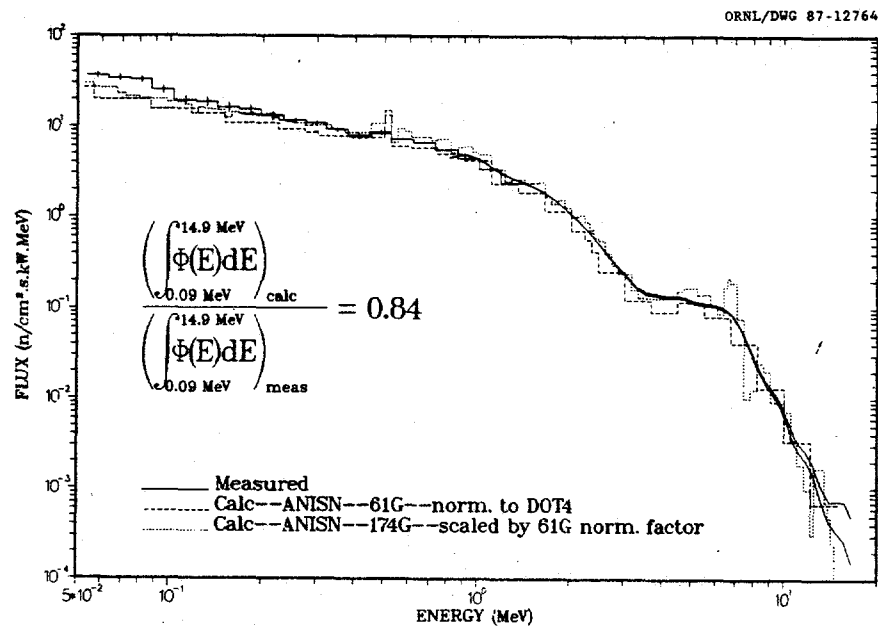


Figure 2. Comparison of calculated 61-broad-group and 174-fine-group fast-neutron spectra with measured spectra for Configuration VI.F.