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USAEC - AECL COOPERATIVE PROGRAM

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This document is furnished pursuant to the memorandum of understanding of June 7, 1960, between the U. S. and Canadian Governments establishing a Cooperative Program on the development of heavy water moderated power reactors.

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SECTION I

REACTOR PHYSICS EXPERIMENTS

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INTRODUCTION

The SE hot organic loop soon will be used for measurements of the temperature coefficient of reactivity in D_2O moderated - organic cooled lattices with simulated burned-up UO_2 fuel. As a preliminary to the tests with simulated burned-up fuel (just returned to Savannah River from Chalk River), the neutron temperature was measured at various positions in a lattice cell containing HWOCR UC rod clusters and "Dowtherm"* A coolant.

SUMMARY

Comparison of HAMMER calculations with neutron temperature measurements based on the ^{177}Lu-^{64}Cu technique shows that the HAMMER calculation overpredicts the degree of spectrum hardening in UC fuel as was observed in earlier tests with UO_2 fuel.

DISCUSSION

Neutron temperature measurements in a HWOCR UC rod cluster containing "Dowtherm" A were made by the ^{177}Lu-^{64}Cu foil activation technique. Paired bare and cadmium-covered lutetium and copper foils were located in the fuel and on aluminum wire frame ladders projecting into the moderator. Similar paired ^{177}Lu-^{64}Cu reference foils were simultaneously irradiated on a reference spinner in the SP thermal column. The subcadmium activity ratio

* Dow Chemical Co., Trademark

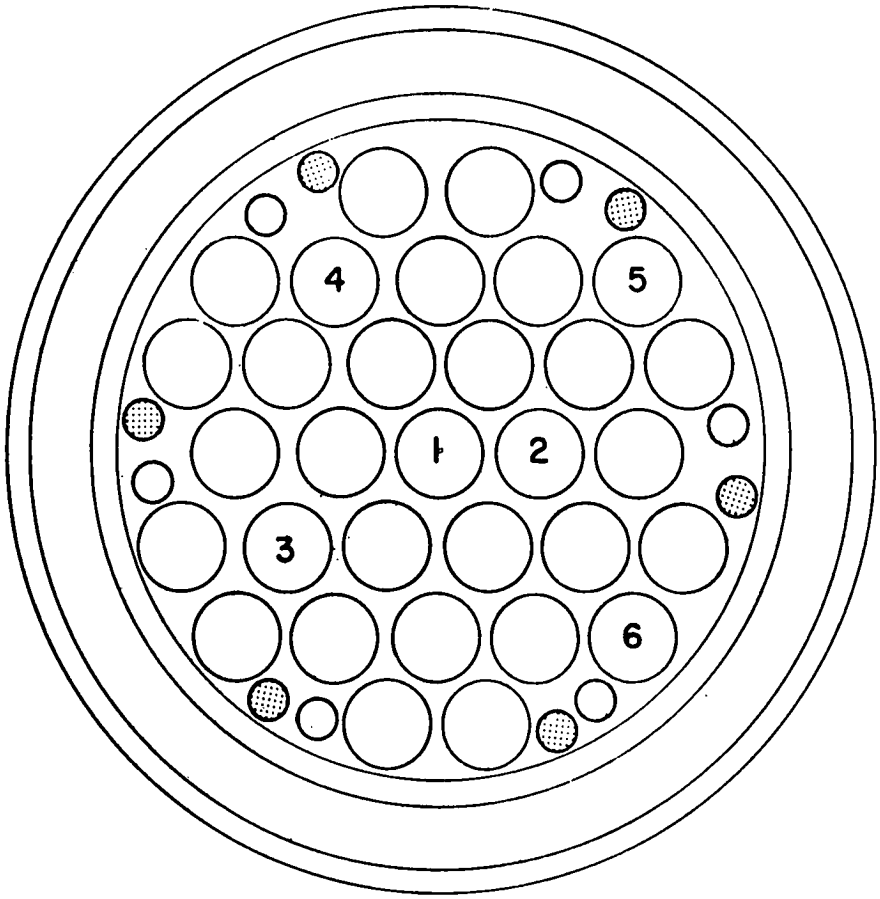
$$g_s/g_{ref} = \frac{[^{177}Lu/^{64}Cu] \text{ Lattice}}{[^{177}Lu/^{64}Cu] \text{ Th. Col. Ref.}}$$

is used as a spectrum index. The experimental results are shown and compared with HAMMER calculations in Figures 2 and 3.

The disagreements between HAMMER calculation and experiment observed in the 20°C UC measurements are similar to disagreements previously observed in measurements of organic cooled, natural uranium oxide rod cluster lattices in D_2O (DPST-66-83-10). In comparison with the present tests as well as the earlier tests, HAMMER overestimates the magnitude of the spectrum hardening in the fuel assembly at 20°C and similarly at a coolant temperature of 260°C. It should be noted, however, that even though the calculated values for fuel neutron temperatures differ appreciably from the measurements, the calculated temperature coefficient would be in considerably better agreement.

FIGURE 1

UC Fuel Assembly Showing Locations of Irradiation Rods



UC FUEL ROD

1/4" OD TUBING FILLED WITH DOWTHERM "A"

3/16" Al ROD

FIGURE 2

SPECTRAL INDEX PROFILE AT 20°C

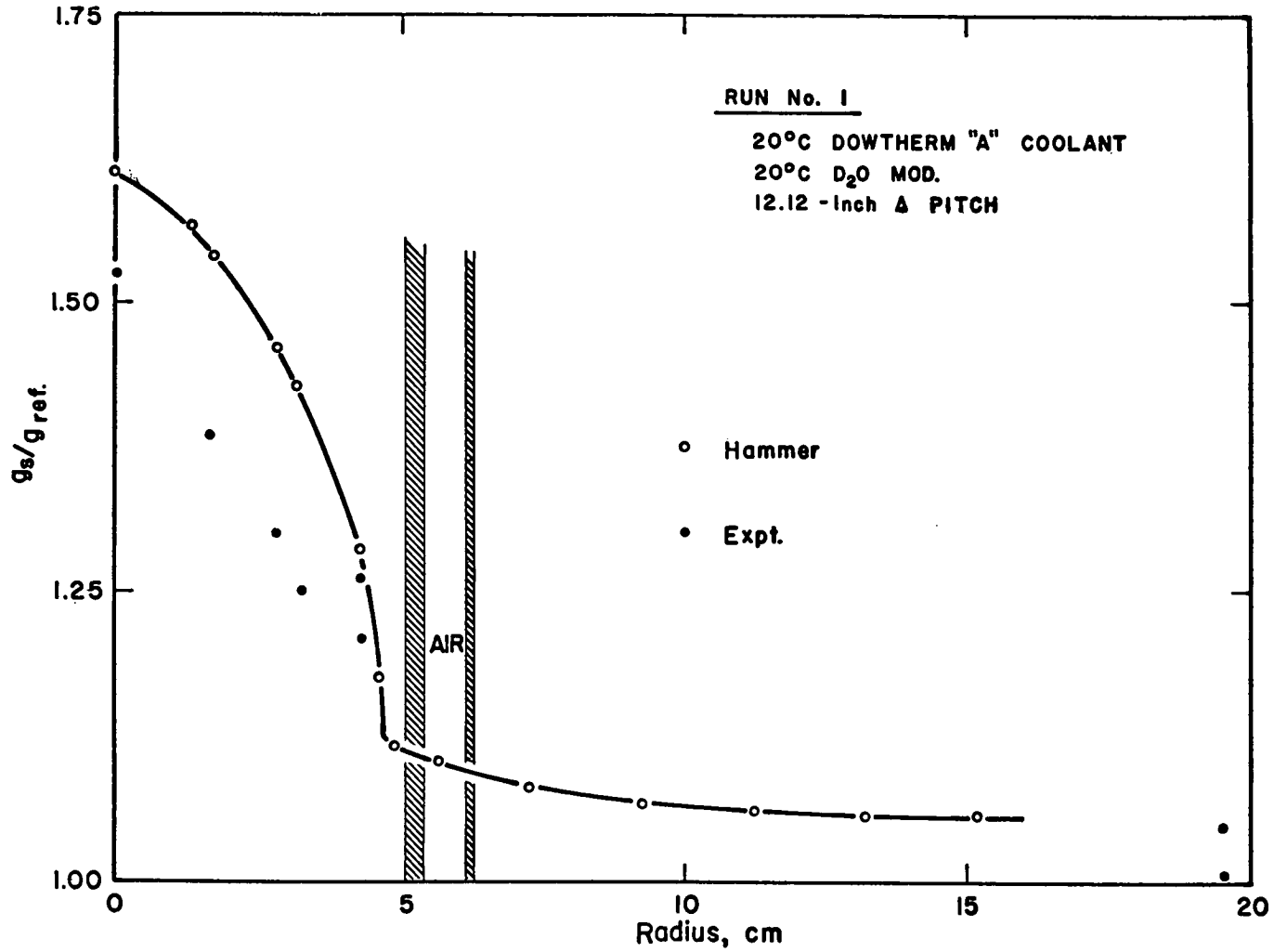
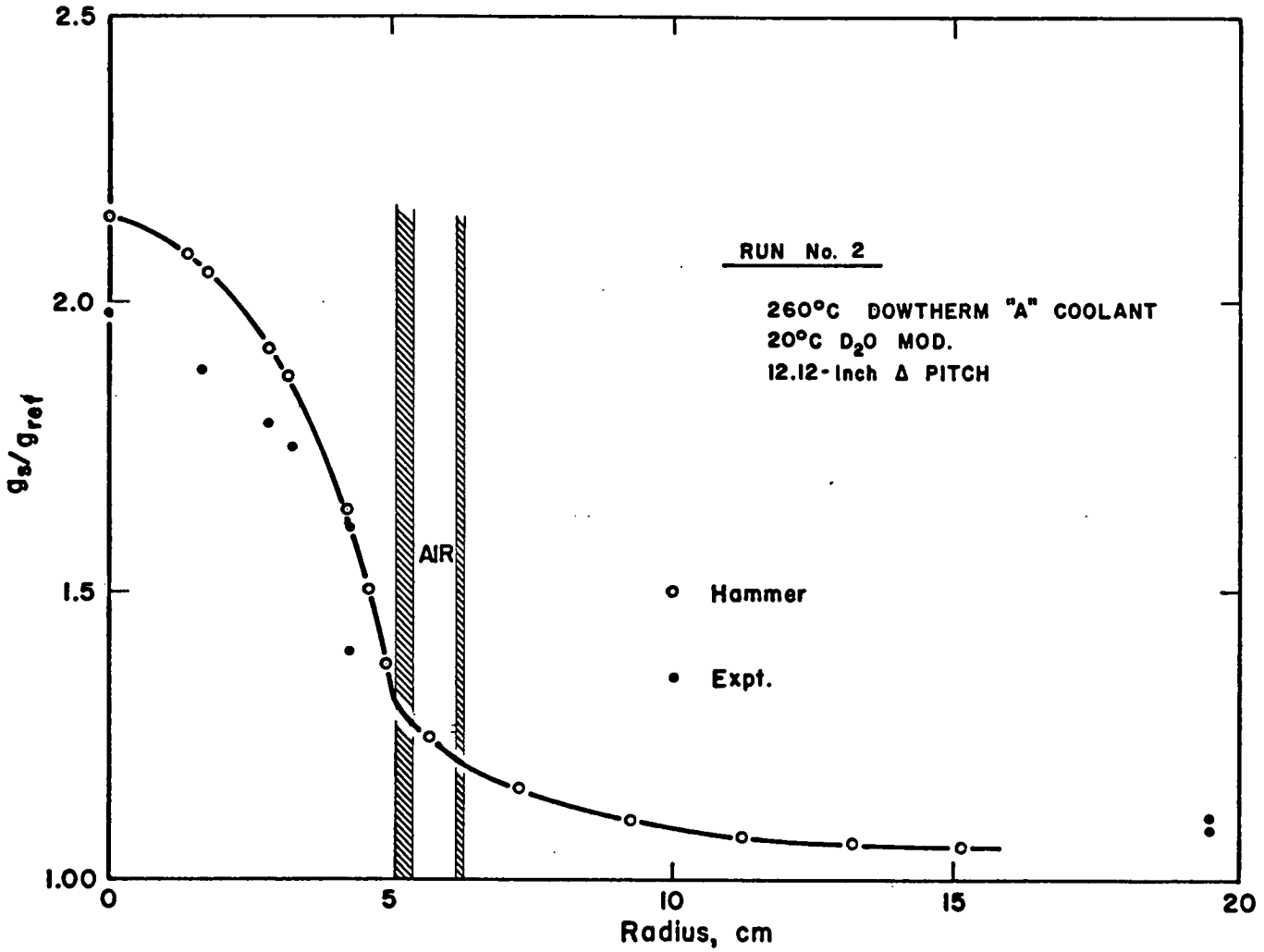


FIGURE 3

SPECTRAL INDEX PROFILE AT 260°C



SECTION II

REACTOR PHYSICS CALCULATIONS

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INTRODUCTION

One of the programs which was to be undertaken during this fiscal year was the major part of the development of a version of the HAMMER system which would treat fuel assemblies consisting of clusters of fuel rods. The Swedish single energy rod cluster code CLUCOP has been mentioned in the past as being the most likely starting point for this work. DPST-67-83-9 indicated good agreement between CLUCOP and experiments in a number of cases.

SUMMARY

During the past month a major reassessment of this program has been undertaken. Some of the conclusions of this reassessment are:

- If CLUCOP is included in the HAMMER system directly without restricting the detail of the physics treatment, the resulting code would run for many hours on an IBM 360/65.

- If some compromises were made in the physics treatment (i.e., restricting the treatment of resonance capture to equivalence principle methods rather than the Nordheim method, and perhaps reducing the number of energy groups) the computing time could be brought down to less than an hour.

- If such a code were developed it would be obsolete shortly after completion. A "next generation" version of HAMMER, expected to be considerably more flexible and faster than the current version, would very likely be in operation within 6 months of the operation of the CLUCOP based code.

As a result of the above conclusions we recommend that effort be diverted from the former objective in order to reduce the amount of time necessary to develop the "next generation" version of HAMMER. This would be with the understanding that rod cluster geometry would be given a priority equal to that of annular geometry in the new system. The portion of the development work to be supported under the cooperative program would be the geometrical routines required to treat clusters, as well as "mixed" lattices.

DISCUSSION

New geometry routines for rod clusters are already under development at SRL. These are ray tracing routines which can be used with either integral transport methods or Monte Carlo methods. One of these geometry routines will be completed within a month. The CLUCOP program will be used to check the resulting integral transport routines.

It is anticipated that the development of the new system would not be complete during this fiscal year but might well be complete a year from now.

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