DPST-67-83-7

USAEC - AECL COOPERATIVE PROGRAM

MONTHLY PROGRESS REPORT

July 1967

J. L. Crandall

Experimental Physics Division
Savannah River Laboratory

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.

E. I. du Pont de Nemours and Co.
Savannah River Laboratory
Aiken, South Carolina

Contract AT(07-2)-1 with the
United States Atomic Energy Commission

August 29, 1967

REACTOR PHYSICS EXPERIMENTS

INTRODUCTION

Experiments have been performed in the PDP to measure $1/\eta\ d\eta/dT$ and the effects of asymmetric control rod placement in simple lattices of natural uranium fuel rods in D_2O. Preparations are also underway for measuring the temperature coefficients of reactivity on the simulated burned-up fuel assemblies used in the earlier SRL tests and for developing a two-dimensional version of the HAMMER code to calculate these fuel assemblies.

SUMMARY

Additional analysis was performed on both the $1/\eta\ d\eta/dT$ experiments and on the companion measurements of the effects of asymmetric control rod placement.

The hot organic loop to be used in the temperature coefficient measurements for the simulated burned-up fuel was placed into operation using UC fuel clusters for the HWOCR as stand-ins for the simulated burned-up fuel clusters.

Preparatory to combining it with the multigroup HAMMER code, the single-group collision-probability code, CLUCOP, was tested against SRL fuel cluster measurements.

DISCUSSION

$1/\eta\ d\eta/dT$

In last month's report, preliminary values of the migration area, M^2, as determined from reactor kinetics measurements were listed for a 5.05-inch square lattice of 1-inch-diameter natural uranium rods contained in copper cladding tubes. The corresponding numbers for a 7-inch triangular lattice are given below together with corrected numbers for the 5.05-inch lattice.

TABLE I

MIGRATION AREA MEASUREMENTS

Lattice Pitch	Temp., °C	Doubling Time	M^2, cm^2	$\overline{M^2}$, cm^2	M^2, HAMMER	$\frac{dM^2}{dT}$
5.05-inch square	20.9	80	271	269	264	
		41	268			
						+.31 $cm^2/°C$
	59.9	74	282	281	275	
		35	281			
7.0-inch triangular	20.8	99	341	344	359	
		41	348			
						+.82 $cm^2/°C$
	61.9	96	374	378	377	
		44	382			

Asymmetric Control Rods

The asymmetric control rod experiments consisted of buckling worth determinations for each rod (1) located vertically in the center of the 7-inch triangular $d\eta/\eta T$ lattice and (2) located horizontally and asymmetrically, and of gold pin irradiations to determine the neutron flux distributions for the perturbed and unperturbed reactor. A description of the control rods and their exact location in the reactor was given in DPST-67-83-6.

The following table gives the preliminary results of the buckling worth determinations.

TABLE II

CONTROL ROD WORTHS

Rod Location	Worth, μB Cd Rod	Worth, μB H_2O Rod
Vertical, center	22	10
Horizontal, off center	14	8

Figures 1 and 2 show schematically the flux depressions in the PDP resulting from the asymmetrically placed cadmium-covered, D_2O-filled control rod, and from the H_2O-filled aluminum rod. Figure 3 is a radial plot of relative flux values for the asymmetric cadmium-covered rod made at the approximate elevation of the rod. Detailed axial and radial flux plots are being transmitted directly to the Chalk River Laboratories.

Hot Organic Loop Startup

A series of experiments are scheduled for October and November to determine the temperature coefficients of reactivity for the simulated burned-up fuel assemblies with D_2O, organic, and gas coolants. The experiments with organic and gas coolants depend on the capabilities of a hot organic loop built under the U.S. HWOCR Program to circulate "Dowtherm A"* at temperatures up to 350°C through test fuel assemblies in the Subcritical Experiment. The "Dowtherm A" may be used either as the organic coolant mockup or merely as a heating medium for the fuel, in which case it is drained before making the nuclear measurements, thus simulating hot gas-cooled fuel assemblies. The HWOCR Program was canceled at the end of FY-1967, i.e., on July 1, before all the capabilities of the hot organic loop were explored, and it has been necessary to perform a few additional studies with the HWOCR UC fuel clusters as stand-ins for the simulated burned-up fuel clusters.

Figure 4 is a piping diagram of the hot loop while Figure 5 is an isometric of its installation in a shed immediately outside of the SE. The principal components of the hot loop are a heating tank with a 75-kw electric heater, an expansion tank for the hot organic, a canned rotor pump for circulating the organic, two sets of manifolds - one for a test loop and the other for the SE fuel assemblies - and the necessary valves, piping, and controls. An interconnected cool organic system adds an H_2O heat exchanger and a cold organic storage tank.

The fuel housings used for the UC fuel are identical to those which will be used with the simulated burned-up fuel and are illustrated in Figure 6. They consist of a double wall housing tube,

* Dow Chemical Co., Midland, Mich.

positioning plates for the fuel rods, and inlet and outlet connections for the organic. The air space between the two walls of the housing tubes serves as insulation to cut down heat transfer from the hot organic to the cool D_2O moderator outside of the test assembly. The hot organic is forced to the bottom of the test assembly through small aluminum tubes at the fuel cluster periphery and then allowed to rise through the cluster before being taken off at the top.

Although additional work is required in developing the specific irradiation assembly for the simulated burned-up fuel studies, the hot organic loop itself has now been completely proved out and is ready for operation.

CLUCOP Treatment of Rod Clusters

A copy of the Swedish CLUCOP code for one-group treatment of rod cluster fuel assemblies was received from the Combustion Engineering Company, who had rewritten the code. It is planned at a later date to incorporate the CLUCOP treatment into the HAMMER code. However, before performing this work it was desired to see whether the code gave adequate results in the simple one-group form. Accordingly, CLUCOP was tested against the thermal flux distribution measurements made on the fuel assemblies in the simulated burned-up fuel program. Generally speaking, excellent results were obtained, which will be presented in a separate report.

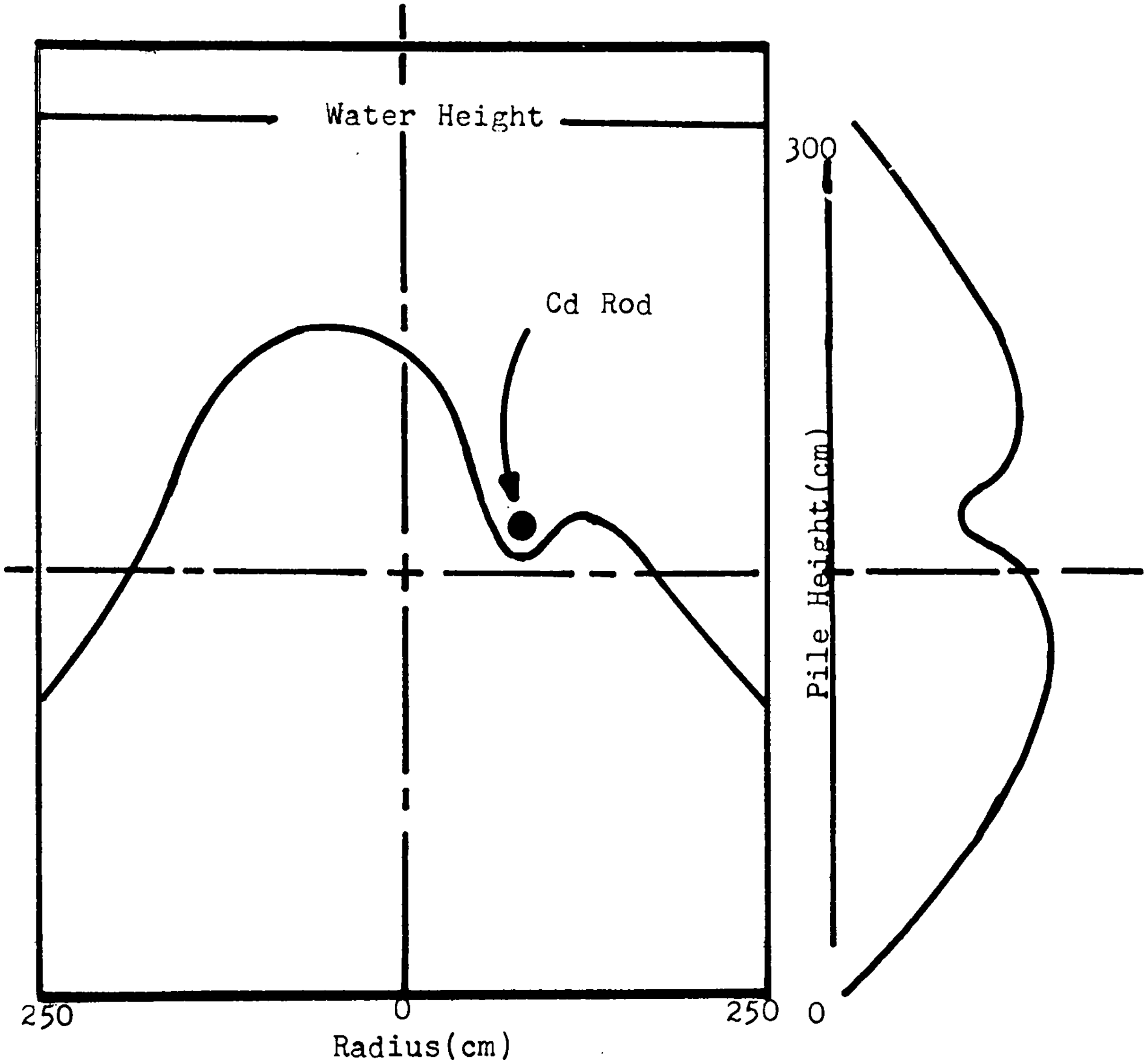

FIG. 1 FLUX DEPRESSION - CADMIUM COVERED ROD

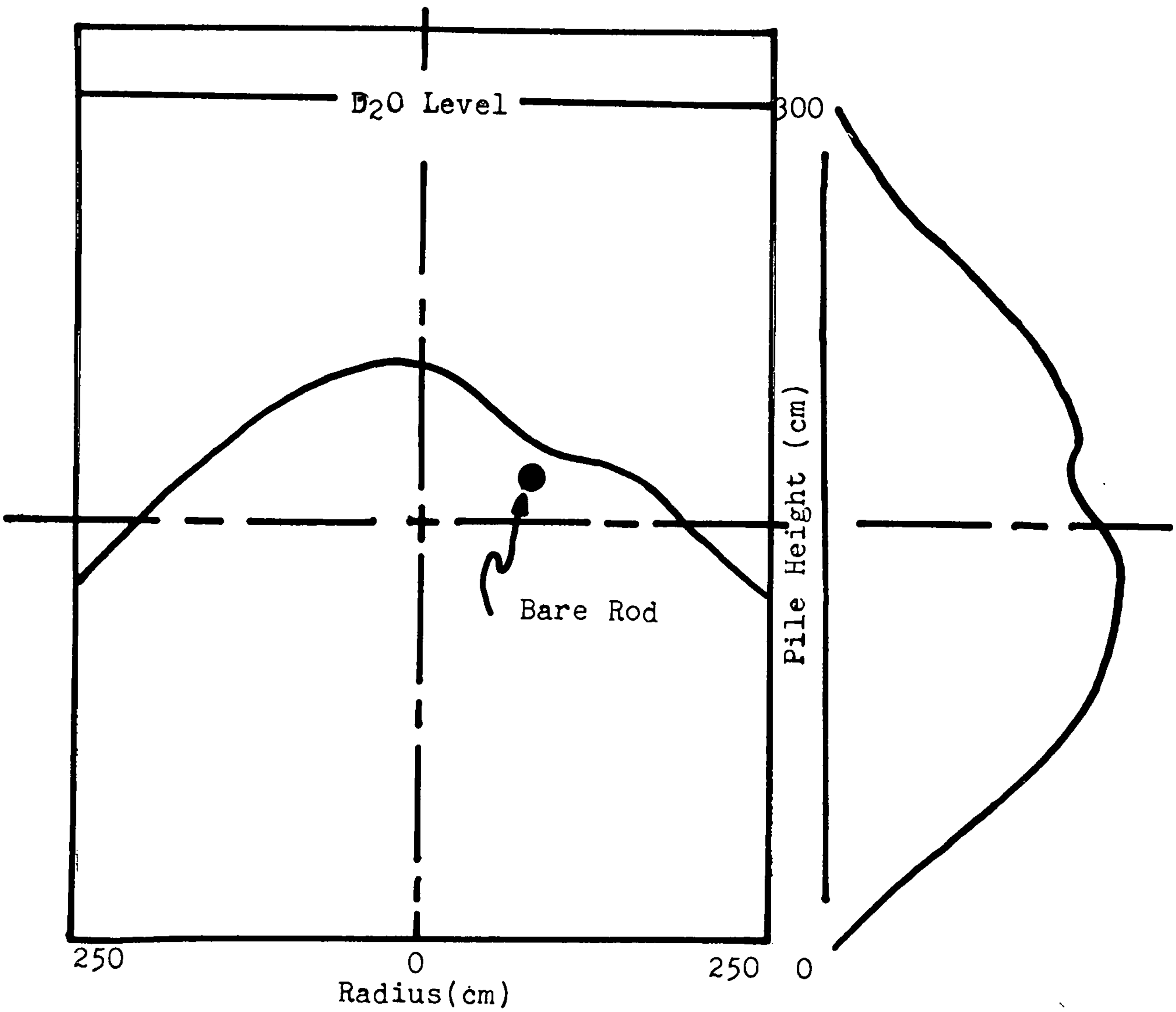

FIG. 2 FLUX DEPRESSION - BARE, H_2O FILLED ROD

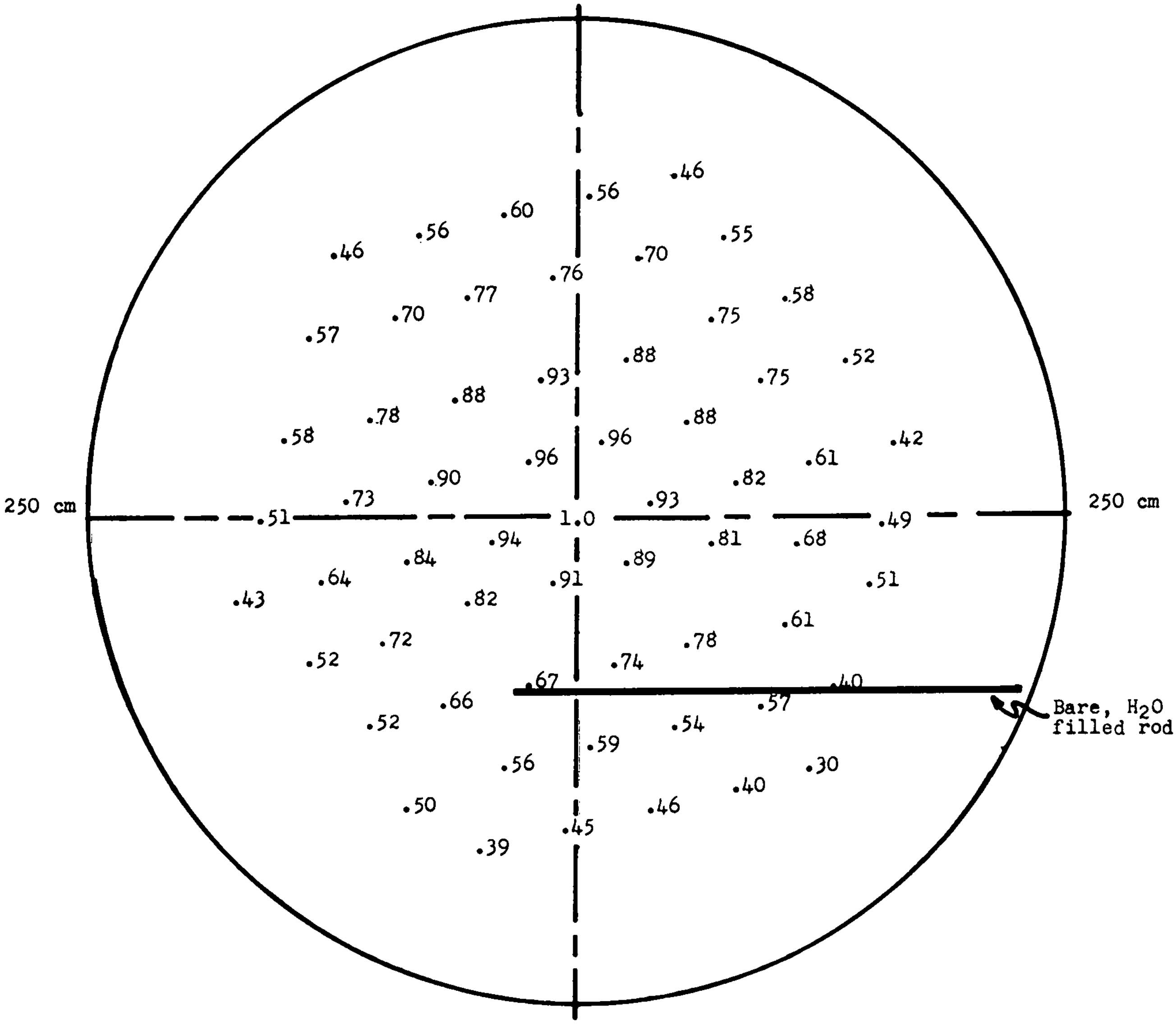

FIG. 3 RELATIVE RADIAL FLUX PLOT
-At Same Plane as Rod-

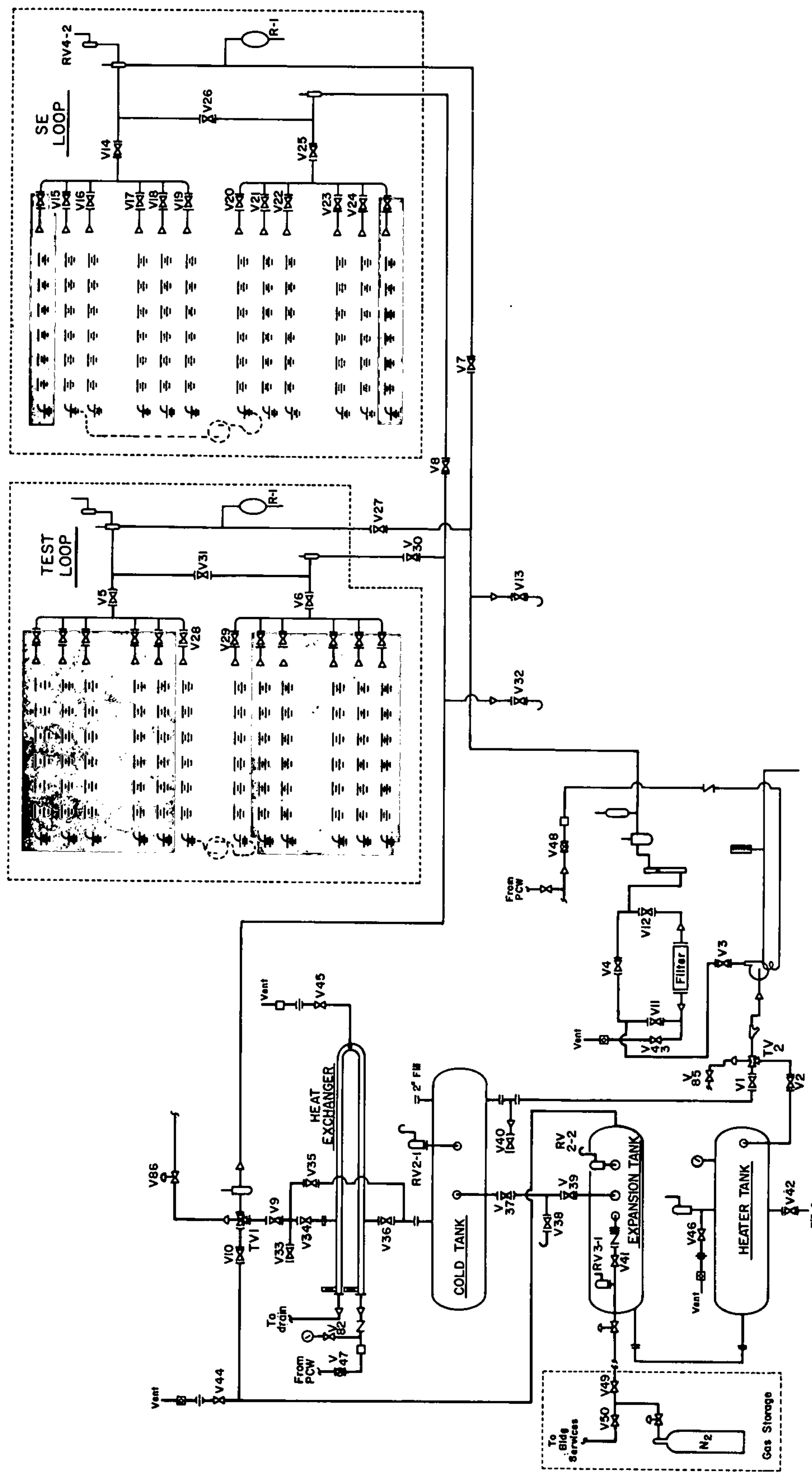

FIG. 4 FLOW DIAGRAM - HOT ORGANIC LOOP

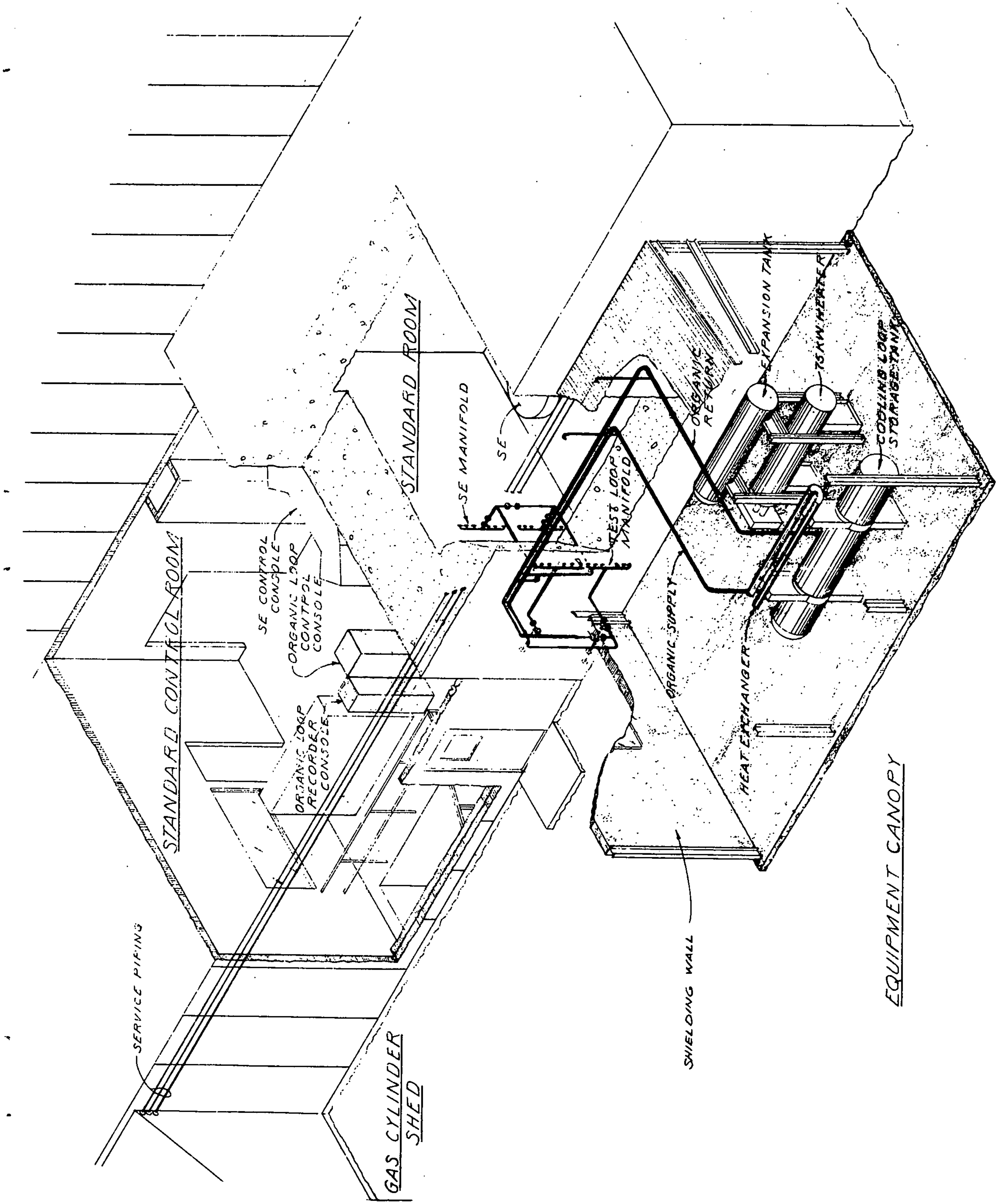

FIG. 5 HOT LOOP IN BUILDING 777

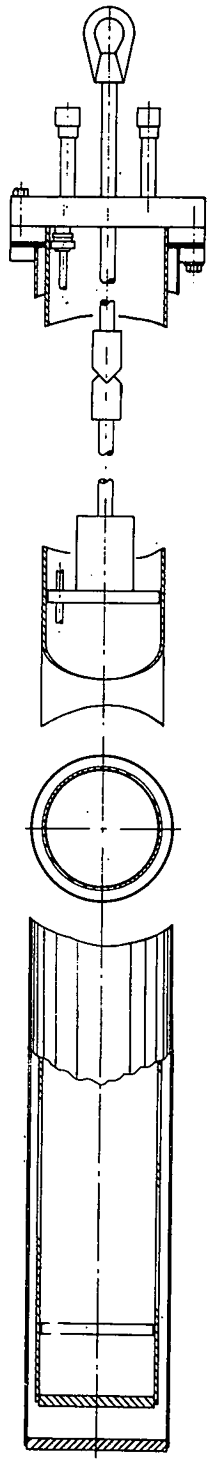

FIG. 6 HOT LOOP IN-PILE FUEL HOUSING

EXTERNAL DISTRIBUTION

RDT Site Representative, SR (2)

G. O. Robinson, SROO
J. A. Koch

Chief, Heavy Water Organic Cooled Reactors Branch, RDT
Chief, Instrumentation and Control Branch, RDT
Chief, Core Design Branch, RDT
Chief, Fuel Fabrication Branch, RDT
Chief, Control Mechanism Branch, RDT
Assistant Director for Reactor Technology, RDT
Chief, Fuels and Materials Branch, RDT
Chief, Reactor Physics Branch, RDT
Assistant Director for Program Analysis, RDT

Senior Site Representative, AI
Senior Site Representative, CE

USAEC Scientific Representative, Chalk River (10)
USAEC Technical Representative, Whiteshell

Director, HWOCR Program Office, Atomics International (6)
HWOCR Program Office-Windsor Representative (3)

HWOCR Project Manager, Babcock and Wilcox
Division of Metals and Ceramics, Oak Ridge National Laboratory
Associate Director, Pacific Northwest Laboratory (2)
Manager, Engineering Research Laboratories/Department of
Chemical Engineering, Columbia University

INTERNAL DISTRIBUTION

L. Squires - M. H. Wahl, Wilm.
J. W. Croach - L. C. Evans
S. A. McNeight
D. F. Babcock

W. P. Bebbington, SRP
L. W. Fox
J. E. Gregory

W. P. Overbeck - A. A. Johnson, SRL
G. Dessauer
J. W. Morris
C. H. Ice
J. L. Crandall
G. F. O'Neill
J. E. Beach
TIS File (5)
TIS File Record Copy
Vital Records Copy