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REACTORS—RESEARCH AND TESTING

UNITED STATES ATOMIC ENERGY COMMISSION

**PRELIMINARY INVESTIGATIONS FOR AN
ADVANCED ENGINEERING TEST REACTOR**

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April 16, 1957

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INTERNUCLEAR COMPANY
Addendum to INTERNUC-9

PRELIMINARY INVESTIGATIONS
FOR AN
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Work performed under Contract No. AT(11-1)-500

1.0 INTRODUCTION

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On February 22, 1957, Internuclear Company in fulfillment of Contract AT(11-1)-500, submitted a report entitled "Preliminary Investigations for an Advanced Engineering Test Reactor"¹ to the Atomic Energy Commission. Because of the interesting and unique reactor features which evolved from that study, and to further demonstrate the practicability and desirability of the facility recommended in that study, Internuclear Company decided to carry the design into a more detailed stage. It is the purpose of this report to present the results of this additional work and to illustrate the refinement of design. To eliminate the need of repeating the information previously reported, this report is considered an addendum to INTERNUC-9, "Preliminary Investigations for an Advanced Engineering Test Reactor".

2.0 GENERAL DESCRIPTION OF REACTOR UNIT

The basic reactor unit is designed around a 6-inch diameter through-hole in the center of the reactor. The general arrangement of the reactor unit is shown by Figures 1 and 2. The arrangement represents a compromise between that most suitable for a gas-cooled central test hole and that most suitable for a water-cooled central test hole, and is quite satisfactory for either type of experiment. The reactor is H₂O cooled and has a D₂O reflector. The reactor power of 65 Mw is based on providing an average thermal neutron flux of 10^{15} n/cm² sec in the central test hole volume within the reactor core.

Access to the 6 inch diameter central test hole is provided through the top of the reactor. A 1/16 inch stainless steel liner provides a stagnant air gap which insulates the 7 inch inside diameter aluminum pressure tube. Since the air gap is not sealed at the bottom, the stainless steel liner is not subjected to pressure stresses. The aluminum pressure tube is designed for an internal pressure differential of 2000 psi and an external pressure differential of 300 psi at 200°F.

Additional experimental holes have been incorporated in the light water annulus between the reactor core and central test hole and also in the heavy water reflector. The average thermal neutron flux in the 1.5 inch I.D. test holes

¹ INTERNUC-9.

in the H₂O annulus is about 9×10^{14} n/cm² sec while in the 3 inch I.D. holes in the D₂O reflector it is about $2.5\text{--}3 \times 10^{14}$ n/cm² sec.

The reactor is reflector controlled by the scheme shown by Figure 2.F of INTERNUC-9, although the scheme shown by Figure 2.G of INTERNUC-9 would be equally suitable.

2.1 Tentative Technical Data

Below are summarized tentative technical data for the typical reactor unit shown by Figures 1 and 2.

Reactor Data

Type	Heterogeneous
Moderator-Coolant	Light water
Reflector	D ₂ O
Reactor power	65 Mw

Core Data

Inside diameter	13 inches
Outside diameter	17 inches
Volume	55 liters
U ²³⁵ content	~8 Kg

Fuel Assemblies

Type	Al clad plate type
Overall dimensions	1.75x2.0x36 inches
Plate thickness	0.050 inches
Gap between plates	0.060 inches
Number of plates per assembly	16
Number of assemblies per core	22

Primary Coolant Data

Pressure at reactor tank inlet	300 psi
Coolant inlet temperature at reactor	130°F
Coolant outlet temperature at reactor	225°F
Number of flow passes through reactor	1
Velocity of flow in core passages	35 fps
Coolant flow through core	4500 gpm
Heat transfer area	300 ft ²
Average heat flux	750,000 Btu/ft ² hr.
Maximum heat flux	1,250,000 Btu/ft ² hr.
Maximum metal temperature	400°F

Pressure Vessel

Inside diameter (at core)	17 inches
Wall thickness(at core)	0.75 inches
Overall length	31 ft 9 in.

Experimental Hole Neutron Fluxes

	<u>Unperturbed thermal neutron flux, n/cm² sec</u>	
	<u>Maximum</u>	<u>Average</u>
Central test hole		
water filled	13.2x10 ¹⁴	10x10 ¹⁴
void	8.7x10 ¹⁴	7.2x10 ¹⁴
Test holes in H ₂ O annulus	11.8x10 ¹⁴	9.7x10 ¹⁴
Test holes in D ₂ O reflector	3.4x10 ¹⁴	2.8x10 ¹⁴

2.2 Neutron Flux Distributions

The thermal neutron flux distributions at the reactor midplane are shown by Figure 3. These are based on the arrangement shown by Figure 4, which corresponds closely to that shown by Figure 2. Curve A of Figure 3 shows the thermal neutron flux distribution when the central test hole is water filled, while curve B shows the distribution when the central test hole is empty. Curve C shows the improvement in thermal neutron flux in the water filled central test hole that is achieved by cooling the reactor core with D₂O, but still retaining the H₂O annulus between the core and the central test hole. As yet, an economic analysis has not been conducted to compare the relative merits of the D₂O cooled versus the H₂O cooled reactor. The additional complications in design of the D₂O cooled core with the inner H₂O annulus could be partially overcome by use of a solid moderator such as zirconium hydride for the annulus between the core and the central test hole.

3.0 REACTOR FACILITY ARRANGEMENT

Two different arrangements of a reactor facility in which six of the reactor units previously described are incorporated are included. Figures 5 and 6 show the first floor plans and building elevation respectively of an arrangement in which the six reactor units are separated into two groups of three, with the spent fuel storage canal located between them. The spent fuel assemblies can be discharged directly from the reactors to the canal. The major equipment associated with the reactor coolant loops is located on below grade floors while the reactor control rooms and rooms for equipment of major test loops are located at ground floor level. Figures 7 and 8 show a similar arrangement, but with the reactors in a single hexagonal pattern with the canal extending to one side. In both arrangements the biological shield forms a level and sizeable working area above the reactors.

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PLAN SECTION A-A

Figure 2. A.E.T.R. Reactor
Mid-Plane Cross Section.

Figure 3. Midplane Thermal Neutron Flux Distribution in Typical AETR Reactor Unit.

ARRANGEMENT FOR NUCLEAR CALCULATION
IN TYPICAL A.E.T.R.

FIG. 4

Figure 5. A.E.T.R. Layout "A" Floor Plan.

Figure 6. A.E.T.R. Layout "A" Building Elevation.

Figure 7. A.E.T.R. Layout "B" Floor Plan.

Figure 8. A.E.T.R. Layout "B" Building Elevation.