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MEMORANDUM

NAA-SR

Memo No. 5307

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Copy 13 of 30 Series 2

Issued To

TITLE: Preliminary Results of Step Input Transients in the KEWB "B" Core

PROGRAM AND PROJECT: Kinetic Experiment on Water Boilers (KEWB)

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Issue Date: June 1, 1960

PRELIMINARY RESULTS OF STEP INPUT TRANSIENTS
IN THE KEWB "B" CORE

By

R. K. Stitt

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I. INTRODUCTION

The purpose of this memorandum is to present a review of the preliminary data obtained with the KEWB "B" core, which is of cylindrical design (Figure 1). The data presented here are based on a small number of tests and may be subject to change as further detailed investigations are made.

Experiments on the KEWB "A" core, a prototype 50 kilowatt spherical core, were completed in August 1959 and that core was removed from the system. The "B" core was installed, then an extensive modification of the facility and wiring system was completed. The instrumentation necessary for operation was installed and checked out by January, 1960. A review of the hazards associated with the change of cores was requested by the AEC before loading of the "B" core was undertaken. This review was submitted on February 4, 1960, and approval to load was received March 7.

The "B" core was made critical on March 11. By April 12 loading of the excess reactivity was completed, a control rod calibration had been made and transient testing was begun.

To date step input transients have been run with periods ranging from 0.53 seconds down to 0.93 milliseconds. The results are reported herein.

II. EXPERIMENTAL RESULTS**A. Critical Assembly**

On March 11, 1960, the KEWB "B" core was made critical with 1450 grams U^{235} at a fuel solution volume of 16.3 liters. The loading was then continued until an excess reactivity of \$6.2 ($\sim 5\% \Delta k$) at a fuel volume of 18.0 liters and 1772 grams U^{235} was attained. Mass and water coefficients of reactivity determined during loading of the excess reactivity are \$.016/gm U^{235} and \$0.60/liter respectively. The total worth of the control rods at the final loading was determined to be \$8.70 ($\sim 7\% \Delta k$).

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B. Step Input Transients

A series of step input transients have been run with stable periods ranging from 0.53 seconds down to 0.93 milliseconds. Initial conditions were 70 cm Hg core pressure, 25°C core temperature and less than 1 milliwatt initial power. No damage was sustained by the core system during any of these runs. Some slight bending of the horizontal through-tube and the dust covers over the control rods occurred during the 0.93 millisecond transient. Additional support has been added to the top of the secondary enclosure to reduce this motion and the short period transients have been repeated with no bending of the auxiliary components.

Figure 2 shows peak power as a function of stable period for the runs made and compares these data to the results obtained from the "A" core 85% full sphere experiments. The maximum power achieved for the 0.93 millisecond transient run was 2,200 megawatts.

The amount of energy released in the bursts has been determined for some of these runs by integration of the power-time recordings. These data are given in Figure 3 again with the comparative data for the "A" core experiments. The total energy release in the burst for the 0.93 millisecond transient was 9.0 megawatt-seconds.

Pressure data were recorded from 7 transducers located in an array of positions from the bottom to the top of the core vessel. The two transducers which show the highest pressures are one located at the center of the bottom of the core and one located in the center of the deflection dome about 1.5 feet above the fuel solution. The data from these transducers are given in Figure 4 along with similar data taken during the "A" core under-full tests. The pressure pulses recorded at the bottom of the core are broad expansion pressure pulses due to the rapid expansion of the fuel solution. The pressures at the deflection dome are sharp pulses caused by the fuel solution striking this dome as

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it is expelled upward by the transient. The maximum expansion pressure observed was 315 psi. The maximum impact at the dome was 590 psi. Even though the maximum pressure is greater at the deflection dome it is not important when considering the danger of rupturing the core vessel since it is delivered to an internal member and not the vessel walls.

As shown in Figure 4, the maximum expansion pressures in the "B" core are less than those observed in the "A" core 85% full case for the same period.

III. CONCLUSIONS

The results of the preliminary "B" core tests are substantially as expected. Two of the prime objectives of the "B" core experiments have, in part at least, been accomplished. They are: (1) obtaining a clear and complete recording of the initial expansion pressure wave, and (2) operate the reactor on a 1 millisecond period to observe the effect of core-reflector de-coupling¹.

REFERENCE

1. J. W. Flora, "Status Review of KEWB Program,"
NAA-SR-MEMO 3569, January 28, 1959.

TABLE I

Transient No.	Period (ms)	Peak Power (Mw)	Inertial Pressure (psi)	Impact Pressure (psi)	Energy Release (Mw-sec)
1001 B	530	0.21			
1002 B	230	0.37			
1003 B	76	1.3			
1004 B	40	4.3			
1005 B	16.5	20			
1006 B	9.57	57			
1007 B	4.60	170	30		
1008 B	5.15	140	27		
1009 B	3.77	220	43		
1010 B	2.46	400	80		
1011 B	1.85	645	120	40	3.8
1012 B	1.59	880	160	100	4.8
1019 B	5.17	160	29		2.0
1020 B	1.36	1250	200	230	6.4
1021 B	1.15	1550	245	440	7.4
1022 B	0.93	2200	315	590	9.0

FIG.2

PEAK POWER vs PERIOD

FIG 3

ENERGY RELEASE vs PERIOD

Fig 1 KEMB "B" Core Installation

MAXIMUM PRESSURE vs PERIOD

FIG. 4

K&E LOGARITHMIC
KEUFFEL & ESSER CO. MADE IN U.S.A.
359-112
2 X 3 CYCLES

PRESSURE (psi)

REACTOR PERIOD (msec)