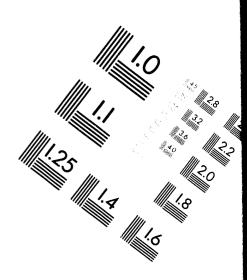
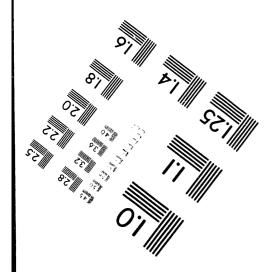




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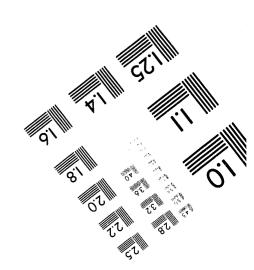
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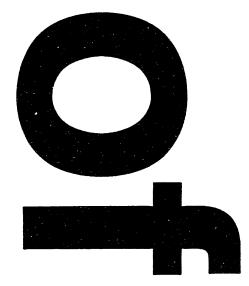


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K AREA HOT TEST HOLE TEMPERATURES

J. H. Cox
Battelle-Northwest
Pacific Northwest Laboratories

August 4, 1965

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K AREA HOT TEST HOLE TEMPERATURES

INTRODUCTION

The test reported here had the following objectives:

- 1) Find the temperature range within a graphite sample carrier.
- 2) Find the temperature range within a solid graphite bar.
- 3) Find the temperature range within a test hole.
- 4) Determine the temperature difference between the old and new graphite sample boats.
- 5) Compare the temperature of a sample load and a solid bar in the same location.
- 6) Find the temperature range in which the graphite samples are irradiated in all test holes.

Two thermocouple boat designs have been employed in the K reactor to monitor hot test hole temperatures. The K reactor hot test holes are 3-3/4" x 3-3/4" bare channels at right angles to the fuel channels; the test holes are at reactor ambient temperature and utilize reactor atmosphere. The temperature recording was started in November 1964 and is to be continued, at least, until January 1966. Data from the first 6 months are reported in this document.

The thoria charge in the K reactors caused some concern from a standpoint of perturbing both the fast flux (E > 0.18 MeV) and temperature in adjacent graphite boat positions. Estimates were 50% fast flux perturbation in a



test hole adjacent to a thoria column. As a result, the samples boats were all discharged from 3CKW for the duration of the thoria charge.

Adjacent tube rows (29 and 30) in KE reactor were not charged with thoria; the sample boats in KE are at least one lattice until away from the thoria. The thoria column nearest a thermocouple boat is 3053 KW which is directly over position 1, 3CKW.

SUMMARY

- 1) All samples within a boat are in a 15 C temperature range.
- 2) The temperatures in an uncooled reactor size solid bar are in a 20 C range.
- 3) A test will be run to determine the complete temperature profile, from side to side, in the 3AKE to evaluate the effect of tube loading, rod placement and splines.
- 4) There is less than 20 C temperature difference between the old boat design and the one presently used.
- 5) The temperatures of samples in a boat are from 5 to 20 C above the maximum temperature in a reactor size solid bar in the same location.
- 6) All test holes in the K reactors lie in the temperature range of 500 750 C except positions 1, 2, and 3AKE, which lie in the range 450 600 C.

The test holes will continue to be monitored by one thermocouple boat in each test hole. The temperature will be recorded once per day; all test holes will be monitored at the same time each day. The program will continue, at least, until January 1966.



EXPERIMENTAL PROCEDURES

Boat Design - The graphite sample carrier, commonly called a boat, presently used is shown in Figure 1. The 0.426" x 4" samples are stacked longitudinally in each end of the boat. Two thermocouples boat designs are employed. In the first, shown in Figure 2, a sample loading is contained in the hollowed out end of the boat and the four thermocouples are placed in drilled out samples.

The second design, shown in Figure 3, used six thermocouples. Three thermocouples are stacked vertically to provide a temperature profile of a sample loading; the thermocouples are placed in drilled out graphite specimens. The other three couples are placed 1) to give skin temperature of a solid graphite bar, 2) to give center temperature of a solid graphite bar, 3) in a graphite specimen placed in a 0.5" dia. hole in the solid section of the boat; this couple is used to simmulate the old type boat design.

Thermocouples - The thermocouples are Geminol couples used for the reactor graphite stringers. Procurement specification HW-55995 was used. All couples were calibrated at 100, 200, 400, 600, 800 and 900 C with an allowed accuracy of - 0.75% at the calibration temperature. Graphite screws hold the thermocouples both in the small samples and in the boats at the locations shown in Figures 2 and 3. Radiographs of the completed boats were taken to insure that the thermocouples were located as planned; an example of the radiographs is shown in Figure 4.

Monitoring - All thermocouples in each boat are continuously monitored on multipoint recorders. During the first six months all thermocouple charts were read three times daily to determine the solid bar temperature profile and the sample stack profile; each outage was recorded hourly both



on shutdown and startup. After the initial six months, only the hottest thermocovple in each boat is recorded once each day at the same time.

Boat Location - Graphite sample boats are located in eleven positions in each test hole as shown in Figure 5. Thermocouple boats are placed in:

3AKE Position 1 Position 11

3BKE Postion 1

3DKE Position 1

3CKW Position 1

All boats in position one are of the four couple design, Figure 2. The boat in position 11 3AKE is the only six couple design, Figure 3, used.

RESULTS AND DISCUSSIONS

The following results are based on the first six months (November 1964 - April 1965) data:

- 1) All samples in each boat are in a 15 C temperature range. This verifies that all samples irradiated in a common sample boat will have the same irradiation temperature history.
- 2) The temperatures in an uncooled reactor size solid bar are in a 20 C range; as a result, there is no need for a temperature correction on any uncooled bar cross-section.
- 3) The sample temperatures in a boat loading are from 5 to 20 C above the maximum temperature in a reactor size solid bar in the same location. As a result, a sample temperature history may be used as a solid bar temperature history in the same location.
- 4) There are no temperature differences (i.e. <20 C) between the old boat and the one presently used (Figure 1). Therefore, there are no boat temperature corrections to be considered when comparing data compiled before 1961 to present data.





5) All samples now in the K reactor hot test holes are irradiated in a 500 - 750 C temperature range except positions 1,2, and 3AKE which lie in a 450 - 600 C range. A breakdown of the recorded temperatures, for each position monitors, are given below.

Dates	Average Temperature	Operating Days Recorded	Temperature Range °C
3AKE Position 11:			
Nov 6 - Jan 31 Jan 31 - Feb 28 1/2 Thoria Charge	607 668	69 24	510 - 675 610 - 715
Mar 1 - April 8	688	32	640 - 740
3AKE Position 1:	·		
Nov 6 - Feb 28 1/2 Thoria Charge	530	91	450 - 630
Mar 1 - April 8	546	28	500 - 600
3BKE Position 1:			
Feb 1 - Feb 28 1/2 Thoria Charge	606	23	560 - 650
Mar 1 - April 8	607	28	560 - 680
3DKE Position 1:			
Nov 6 - Feb 28	610	94	510 - 720
1/2 Thoria Charge Mar 1 - April 8	594	28	550 - 660
3CKW Position 1:		•	
Nov 13 - Nov 29	678	17	660 - 700
1/2 Thoria Charge Dec 6 - Jan 3	600	29	540 - 670
Full Thoria Charge Jan 3 - April 18	628	75	540 - 690

Based on the above data, the thoria charge does not appear to have any large effect on the test hole temperatures. The 3CKW thermocouple boat has thoria charged in the adjacent tube row; all KE thermocouple boats have

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thoria charged in the second row, below. There are no sample irradiations being made in the 3CKW concurrently with the thoria charge.

Test hole 3AKE, position 1, has been consistently colder than the others. It was recently discovered that there is a spline inserted in 2953 tube under the boat at 3AKE, position 1. This spline has been continuously inserted and, therefore, explains the low temperature at that point. For the present, it should be assumed that this spline is effecting the first three positions of 3AKE. A control rod placement schematic is shown in Figure 6, based on the recorded temperatures, the rods do not appear to have a great effect on the test hole temperatures (e.g., test hole 3BKE).

In the near future a thermocouple boat will be slowly drawn through the 3AKE test hole to determine a temperature profile from rod-room side to x-level side. This profile should show how the rods are effecting temperatures near the center of the test holes, and give the exact effect of the spline in 2953.

Recent flux transverse data⁽²⁾ agree quite well with the temperatures for the same period. The flux run was in 2BKE and temperatures were recorded in 3AKE. Adjacent tube powers and adjacent rod placements were similar in both cases.

Normalized average fast flux (E > 0.18 MeV) and normalized average temperature values for the period of the flux measurement (Dec. 4 to Dec. 17, 1964) are given below.

Variable	Test Hole	Tube Column	
	-	52	82
$oldsymbol{ar{\Phi}_{F'}}$	2BKE	1	1.178
ጥ	ЗАКЕ	ı	1.198





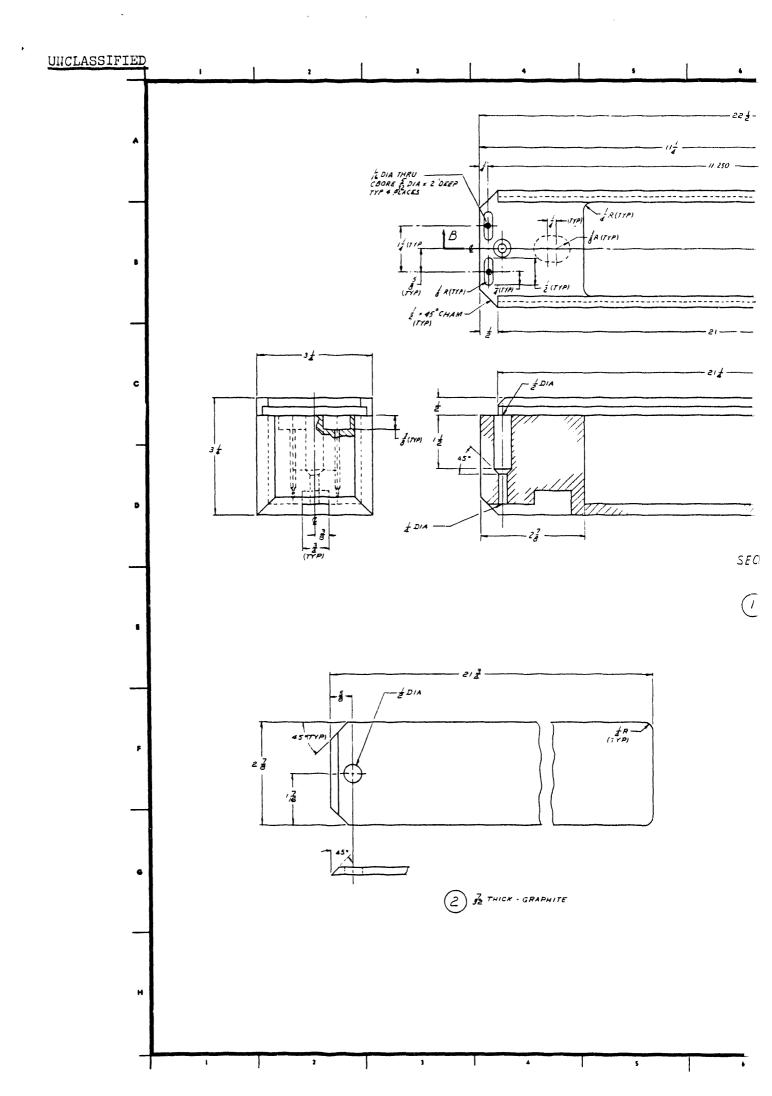
As a result, it appears that if the fast flux profile is known for a test hole and the temperature is known for one position, temperature estimates may be made for other positions within the same test hole. Additional flux and temperature data will be evaluated to verify this.

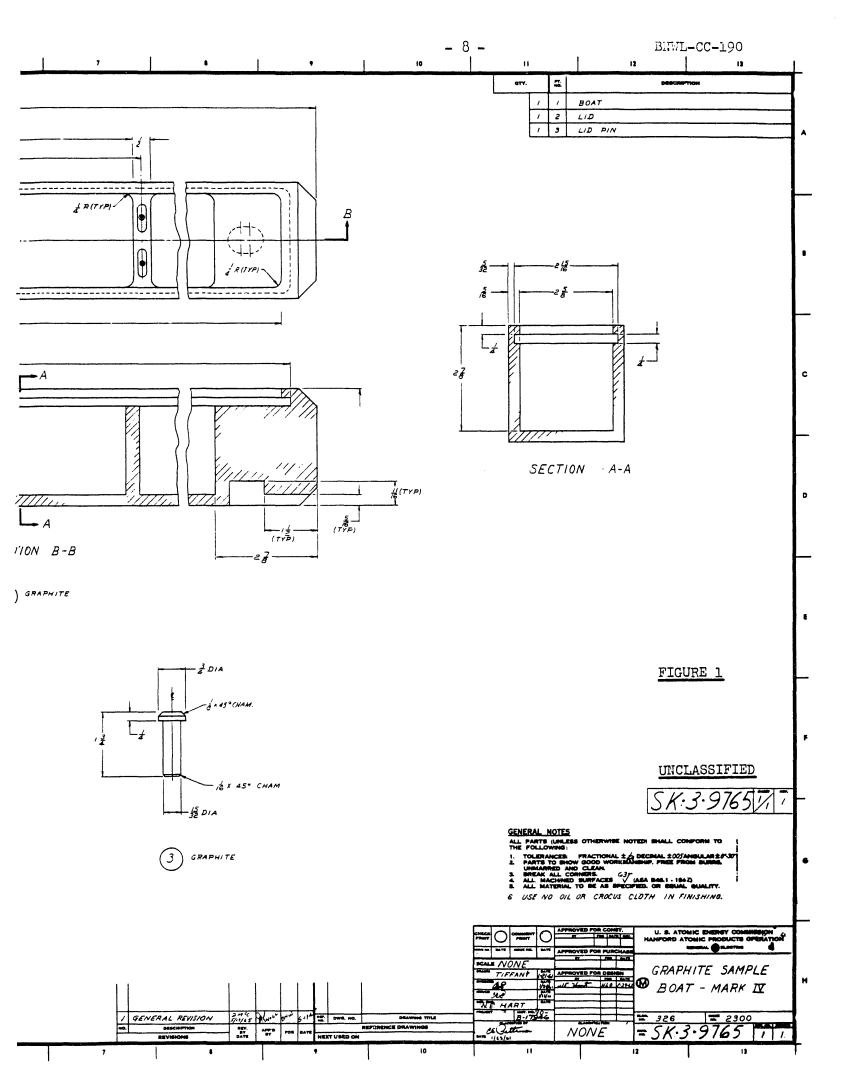
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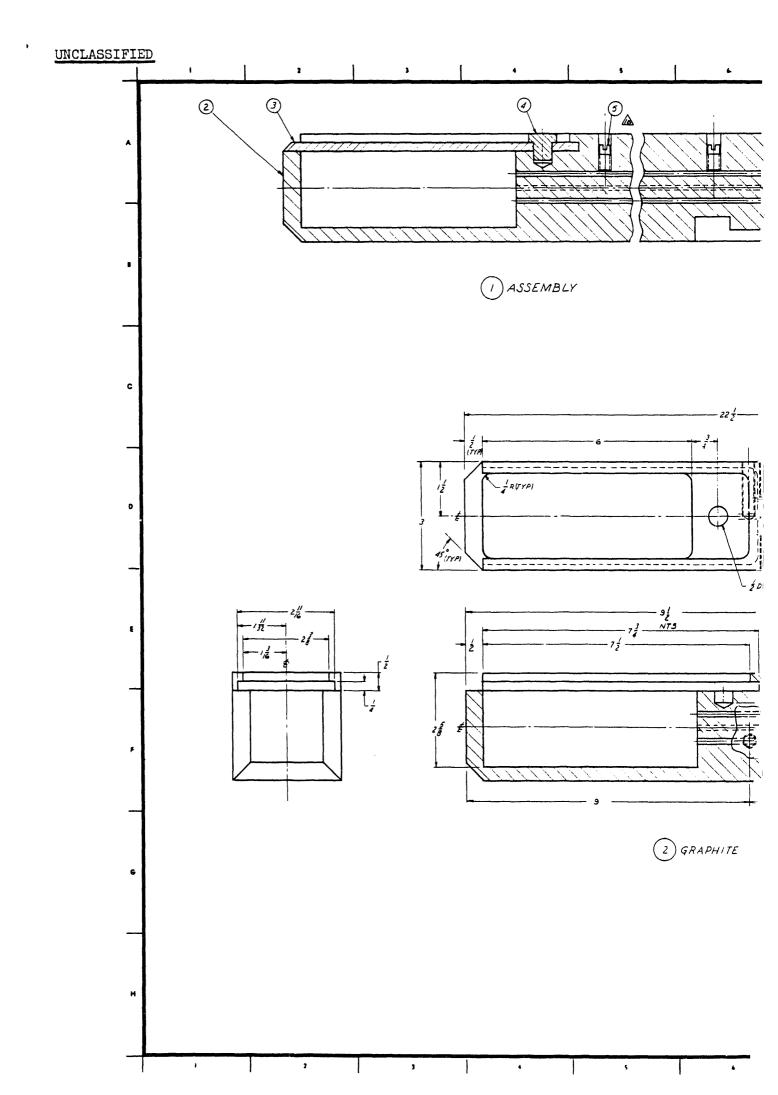
Thanks go to E. M. Woodruff who initiated the program and has been very helpful in the analyses of the data which have evolved. Thermocouple boat fabrication was handled by A. J. Jervis, Jr. The data were compiled by J. C. Knoll.

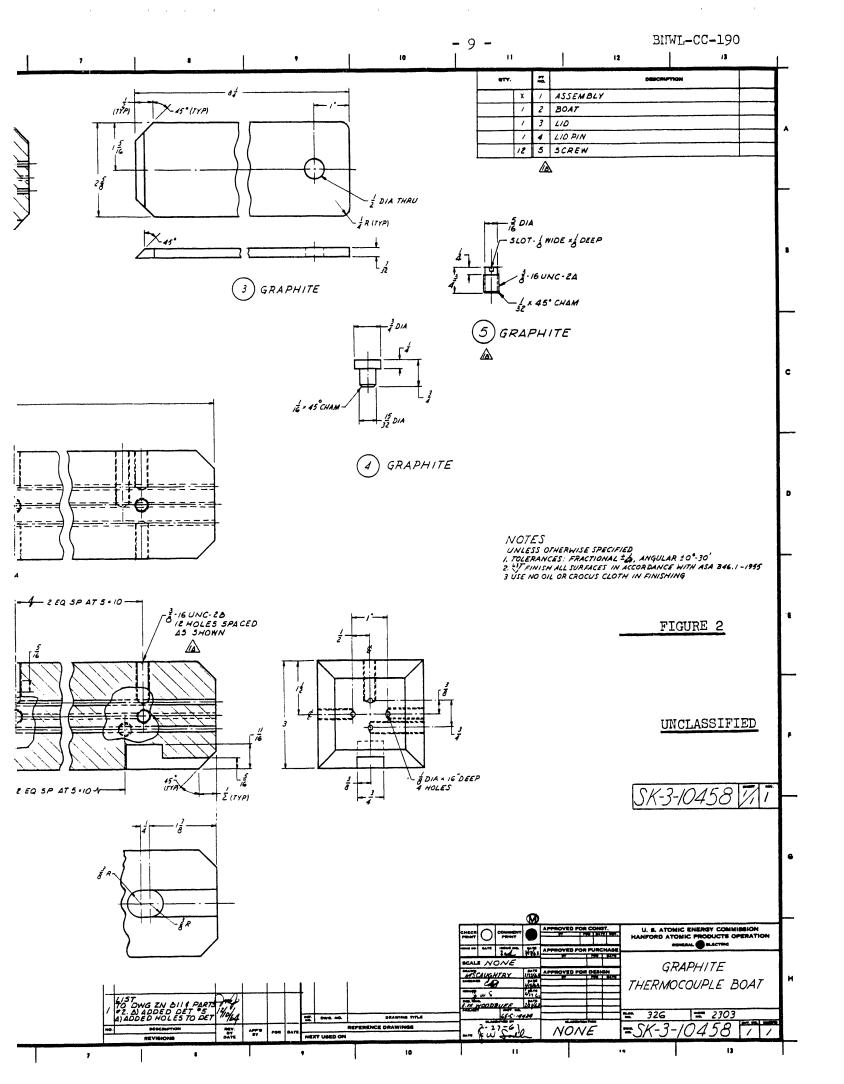
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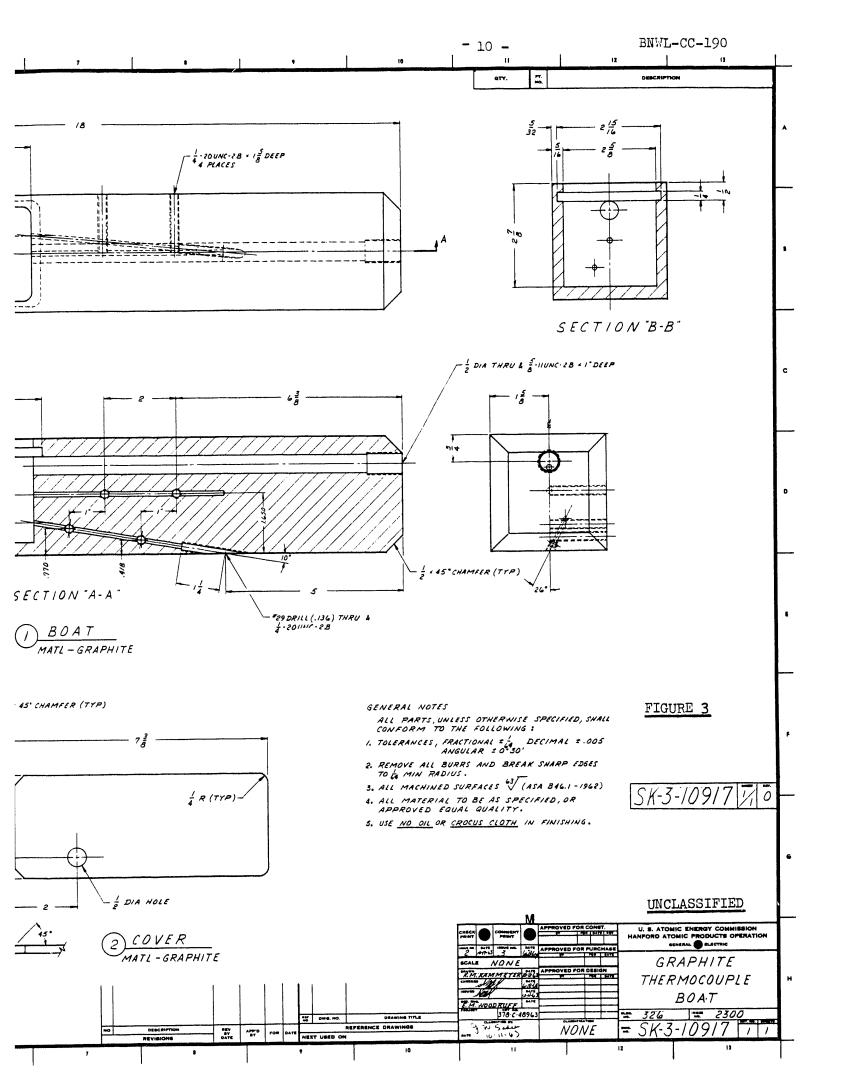
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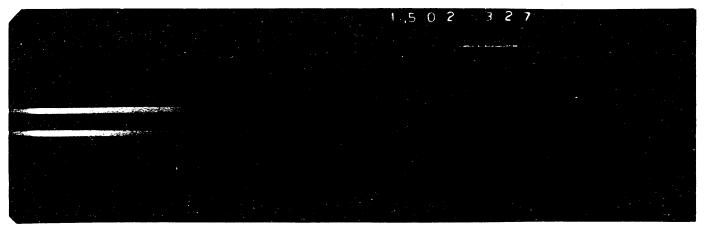




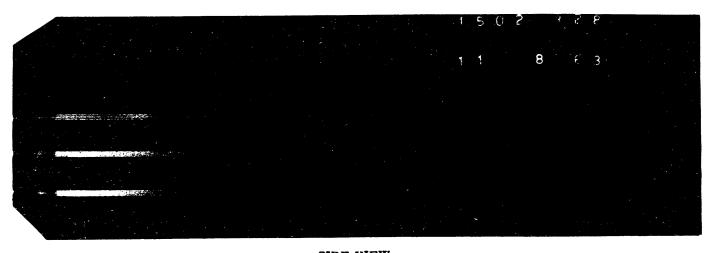








TOP VIEW



SIDE VIEW

FIGURE 4

Thermocouple Placement 3A KE Position 11

Tube Row 30 **Boat Position** Tube Row 29

FIGURE 5

Test Hole Boat Loading Pattern (All 3 Level Test Holes)

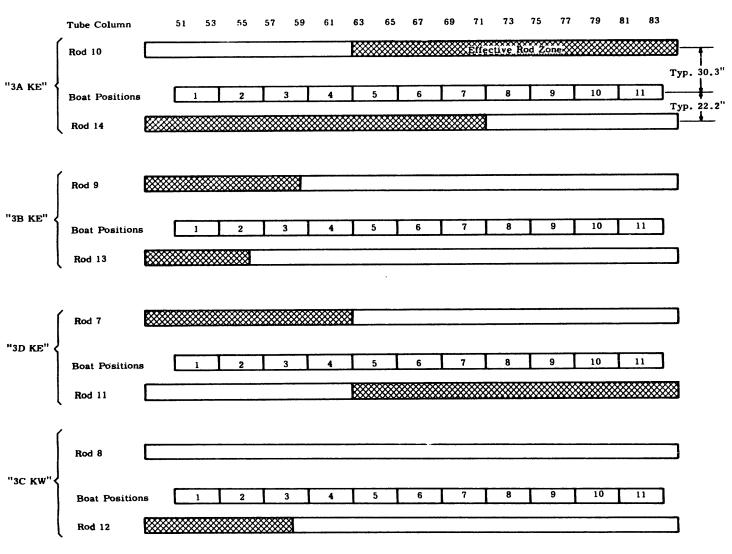


FIGURE 6

Normal Control Rod Placement (November 1964 to April 1965 Incl.)

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