CENTRAL RESEARCH LIBRARY
DOCUMENT COLLECTION

[redacted]

ORNL 859
Progress Report
Reactors 9A

DECLASSIFIED
CLASSIFICATION CHANGED TO:
BY AUTHORITY OF: TID-1113 10-24-56
BY:

MARTIN MARIETTA ENERGY SYSTEMS LIBRARIES
3 4456 0360835 3

LABORATORY RECORDS
1954

DOE 1979 REVIEW OF
DECLASSIFIED REPORTS
This Document is Properly Declassified.
Reviewed by P. S. Baker
ORNL Classification Officer

MATERIALS TESTING REACTOR PROJECT PROGRESS REPORT FOR THE PERIOD ENDING AUGUST 31, 1950

CENTRAL RESEARCH LIBRARY
DOCUMENT COLLECTION
LIBRARY LOAN COPY
DO NOT TRANSFER TO ANOTHER PERSON
If you wish someone else to see this document, send in name with document and the library will arrange a loan.

OAK RIDGE NATIONAL LABORATORY
U.S. ATOMIC ENERGY COMMISSION

OAK RIDGE NATIONAL LABORATORY
OPERATED BY
CARBIDE AND CARBON CHEMICALS DIVISION
UNION CARBIDE AND CARBON CORPORATION
UCC
POST OFFICE BOX P
OAK RIDGE, TENNESSEE

[redacted]

[redacted]

ORNL 859

This document consists of 29 pages.
Copy 9 of 130 Series A

Contract No. W-7405, eng. 26

MATERIALS TESTING REACTOR PROJECT PROGRESS REPORT for the Period Ending August 31, 1950

M. M. Mann, Project Engineer

DATE ISSUED: NOV 6 1950

OAK RIDGE NATIONAL LABORATORY
operated by
CARBIDE AND CARBON CHEMICALS DIVISION
Union Carbide and Carbon Corporation
Post Office Box P
Oak Ridge, Tennessee

[redacted]

MARTIN MARIETTA ENERGY SYSTEMS LIBRARIES
3 4456 0360835 3

[redacted]

TABLE OF CONTENTS

SUMMARY 5

DESIGN 7

- Reactor Structure 7
- Reactor Tanks and Components 7
- Beryllium Reflector 7
- Control Elements 8
- MTR Parts Procurement 8
- MTR Flange Mock-up Test 9

EXPERIMENTAL 10

- MTR Mock-up - Critical Experiment 10
  - Neutron and gamma flux measurements 10
  - Temperature coefficient 19
  - Effect of water flow 22
  - Effect of empty experimental thimble 23
  - Safety rod electromagnets 23
- MTR Control Instrumentation 23
  - Status of individual instruments 23
- Corrosion Resistance of Extruded and Hot-Pressed Beryllium 24
  - Testing on MTR beryllium reflector pieces 24
  - The effect of aluminum content on the corrosion resistance of extruded beryllium 25
  - The effect of copper and chloride ions on the corrosion resistance of beryllium 25

METALLURGY AND FABRICATION 27

- Beryllium Production for MTR 27
- Melting and Rolling 27
- Fabrication 28

[redacted]

[redacted]

LIST OF FIGURES

Fig. 1	Vertical Gamma Attenuation in Water MTR Mock-Up	11
Fig. 2	Horizontal Gamma Traverses in Water above Lattice in MTR Mock-Up	12
Fig. 3	Chamber Elevations for Horizontal Gamma Traverses and Relative Locations of Graphite, Air and Concrete in MTR Mock-Up	13
Fig. 4	Heat Production in Barytes Concrete Block	15
Fig. 5	Neutron Attenuation in Paraffin Behind the Thermal Shield	16
Fig. 6	Horizontal Traverse Between Paraffin and Steel	17
Fig. 7	Vertical Traverse Between Paraffin and Steel	18
Fig. 8	Thermal Neutron Flux in Midplane of Active Lattice	20
Fig. 9	Thermal Neutron Flux in Top Plane of Active Lattice	21

[redacted]

[redacted]

SUMMARY

This will be perhaps the last formal report on project progress at ORNL until the reactor is completed.

With the start of MTR construction at the Idaho site and the acceleration of detailed engineering design at Blaw-Knox, a large share of ORNL work on the MTR is drawing to a close. A small group, perhaps five persons, will remain actively engaged on the project until the reactor has been put into operation.

Design work by ORNL on the MTR is gradually drawing to a close. All major components to be supplied Idaho by ORNL are detailed and are either on order or on requisition. Only the special handling tools and the re-designed shim-safety rod element remain to be detailed. Vendors are actively engaged in fabrication of MTR parts, and from present indications parts delivery will allow shipment of the aligned components from ORNL to Idaho in April, 1951.

Operation of the MTR Mock-up as a low power reactor continued during June, July and August. The assembly has been brought to "critical" 325 times and power outputs as high as three kilowatts successfully attained. All experimental work required for the MTR had been completed by August 28. The several remaining days of the quarter were spent making preparations for a few hours operation at approximately 100 kilowatts, to be accomplished early in September.

An experimental comparison has been made between the heat generated in graphite by pile gamma rays and the ionization in a small graphite chamber filled with CO_2. The measurements confirm the validity of heat distribution calculations based on ionization measurements in the mock-up.

Design of all reactor instrumentation is essentially complete. Arrangements have been made whereby ORNL will construct for the Idaho Operations Office all special control instruments and associated circuits. Delivery to Idaho will be made concurrently with tanks and components mentioned above. Information is being transmitted to Blaw-Knox regarding physical dimensions of instruments and type and location of connectors.

By the end of August about 60% of the (hot pressed) rough-machined beryllium had been received from Brush Beryllium by the Y-12 Machine Shop. Rejections have been very low.

[redacted]

Machining of beryllium at Y-12 is about 20% complete.

It has been decided that MTR fuel units will be produced at ORNL during fiscal years 1951 and 1952. Production plans are already well underway.

During the past three months, twenty-four rough-machined MTR beryllium reflector pieces were subjected to an accelerated corrosion test. All of these pieces were accepted for final machining. A stainless steel flow-system was assembled for the low temperature testing of finish-machined pieces. Twelve A pieces have received an exposure of two weeks in this test.

Short-term tests on extruded beryllium containing aluminum in the range of 0.03 to 1.24 percent indicated no corrosion damage attributable to the presence of this element. Tests of beryllium exposed to distilled water containing additions of Cu and chloride ions indicate that these constituents decrease corrosion resistance. To prevent heavy corrosion attack, the Cu and chloride concentrations should not exceed 0.05 and 0.2 ppm, respectively.

DESIGN

REACTOR STRUCTURE

Comparatively little work has been required on the reactor structure during the past quarter. The fundamentals of the structure were established earlier, and with occasional consultations with ORNL, Blaw-Knox continues detail design within the structure.

It was decided to insert a number of the thermocouples within the reactor structure to determine temperatures and thermal gradients during operation. Forty-seven locations have been established in CF-50-7-142; each location will be provided with two independent permanently imbedded thermocouples.

Schematic layouts of the various start-up plugs which are the responsibility of ORNL have been transmitted to Blaw-Knox. Detail drawings, from which vendors will fabricate the plugs, are being prepared by Blaw-Knox.

REACTOR TANKS AND COMPONENTS

Design of the reactor tanks and their associated components is complete. Drawings have been transmitted to the several vendors and fabrication is in progress. It now appears that this equipment will be delivered in December as scheduled.

BERYLLIUM REFLECTOR

Detail drawings of the reflector are complete and have been transmitted to the Y-12 beryllium shop. Machining of the metal is progressing satisfactorily with only minor difficulties. The job status is summarized as follows.

Total number of beryllium pieces in reflector	133
Number of rough beryllium pieces received from Brush Co.	94
Number of completed pieces (finish machined)	40

The 40 finished pieces are all *A* type pieces, and while this represents about 30% of the reflector in terms of pieces, it represents only about 15-20%

of the man-hours required for completion of the reflector. It is still planned that machining be completed in early February, 1951.

CONTROL ELEMENTS

Design of the MTR control elements is finished with the exception of the re-designed shim-safety rod element. Final drawings of the top-plug wiring have yet to be made. Otherwise the various components are on order and are in process of fabrication.

Considerable effort has been directed toward simplification of the shim-safety rod elements as built for the Mock-up. The rods as now built are not altogether satisfactory and have proved very costly. It is recognized that these parts are "expendable" in the same sense as a fuel assembly; the new studies were therefore directed toward conception of a mechanically sound assembly which might be built in production quantities at one-third or one-fourth the cost of Mock-up parts.

These studies have produced a new design which will overcome many of the undesirable characteristics of the present design. It features extruded aluminum sections with welded rather than screwed joints. All of the steel has been removed from the upper end of the rod, excepting the magnetic coupling armature, and the lower end of the rod is weighted with lead to give a total assembly weight of about 100 lbs. The rod has not yet been detailed, but the preliminary layouts and discussions with the fabricators indicate that the new design is feasible and promises to be distinctly less expensive than Mock-up rods.

It is now planned to proceed with the new design and to fabricate rods for test in the Mock-up at an early date.

MTR PARTS PROCUREMENT

As was mentioned earlier, all major components of the MTR to be supplied by ORNL are on order or are in process of being placed on order. The few remaining parts yet to be ordered will in all probability be fabricated either by the ORNL or Y-12 shops. It is doubtful that any future purchases will be required from outside vendors.

Considerable follow-up and consultation is expected with outside vendors in the next quarter. Later, some attention will be required in arranging shipments of the more vulnerable parts to Oak Ridge. Otherwise, the procurement job is considered about 95% complete.

MTR FLANGE MOCK-UP TEST

All materials have been received, or have been shipped by the vendors, for performance of the flange and gasket tests. A test program has been outlined and the equipment on hand is being erected in Y-12 for the tests. It is anticipated that the tests will be initiated about September 20.

EXPERIMENTAL

MTR MOCK-UP - CRITICAL EXPERIMENTS

Neutron and Gamma Flux Measurements.

Attenuation Inside Reactor Tank. The top plug of the MTR tank is designed so that it can be filled with lead to a maximum thickness of ten inches, although the exact thickness required for shielding at 60,000 kw was thought to be less than ten inches. An estimation of this thickness has been obtained from measurements of gamma ray attenuation in the mock-up tank with the active lattice operating at approximately 270 watts.

Attenuation measurements were made with sensitive watertight ion chambers along two vertical lines above the active lattice. Data are plotted in Fig. 1 and indicate a factor of e reduction in 29.5 cm. The discontinuity of the curves, beginning at approximately 70 inches above the fuel, was studied further with three horizontal traverses plotted in Fig. 2. Traverse Number 1 clearly indicated an additional gamma source on the north side of the tank. This source is explained by the construction of the graphite reflector and the concrete shield as shown in Fig. 3. The graphite and the air space above permit a high thermal flux to exist up to the 111-inch elevation. The capture of these neutrons by the steel tank sections provides the additional gamma source which disrupts the attenuation curves of Fig. 1.

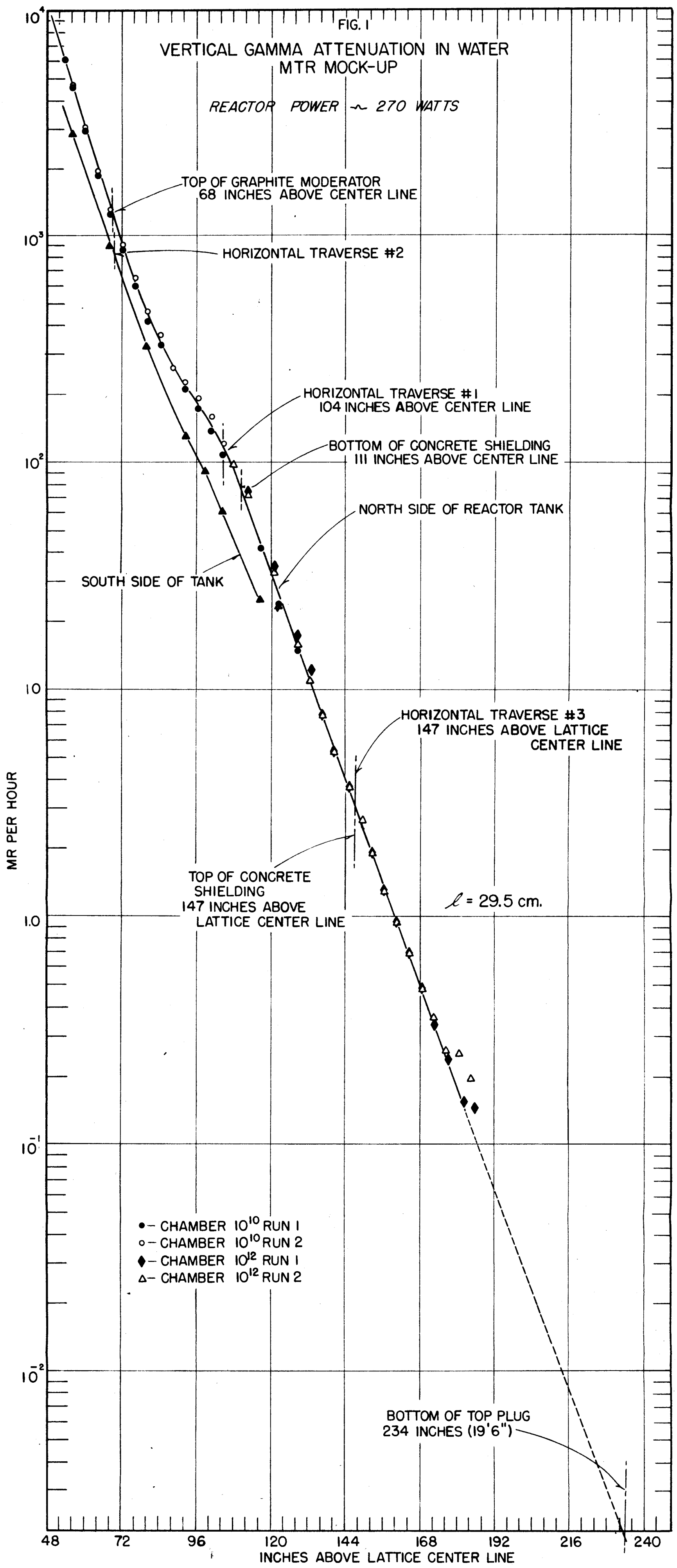
With these measurements it was possible to extrapolate the attenuation lines to the top plug (elevation 234 inches). Normalization of this point to 60,000 kw indicated approximately 500 mr/hr, requiring a six-inch thickness of lead shot in the top plug for adequate protection.

Neutron flux measurements have been completed from the center of the lattice up to a point approximately nine feet above the fuel center. These and other miscellaneous findings will be included in the final report of flux measurements in the MTR Mock-up, now in preparation.

Heat Generation in Concrete Shield. The determination of the heat production in the MTR concrete shield, outside the thermal shield, has been attempted by two methods. In the first experiment, considered most likely to yield a direct answer, a twenty-inch thick section of barytes concrete block ($\rho \cong 3.5$) was stacked behind a four-foot square of eight-inch thick

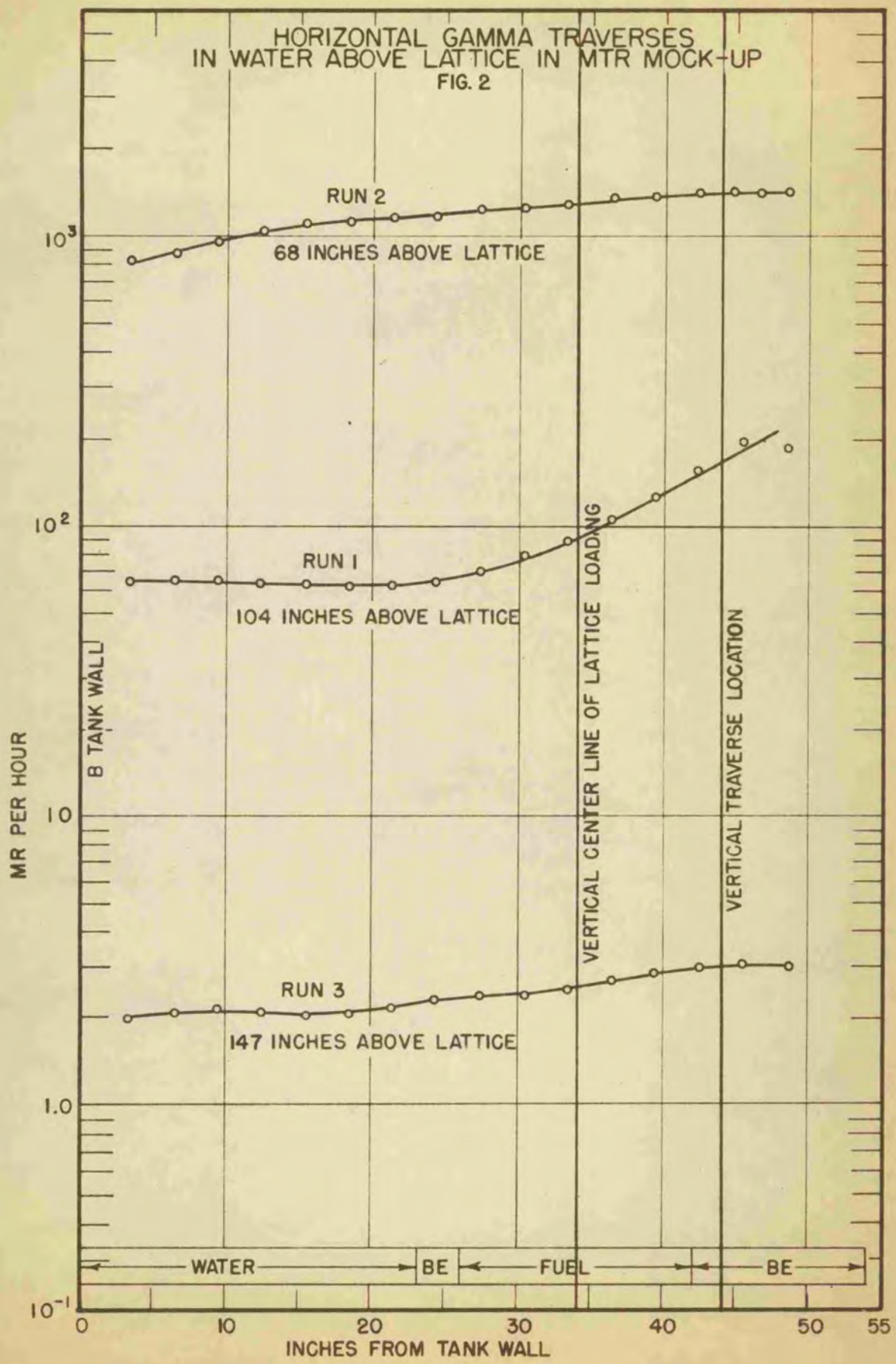
[redacted]

DWG. 9401



[redacted]

DWG. 9402



[redacted]

DWG. 9404

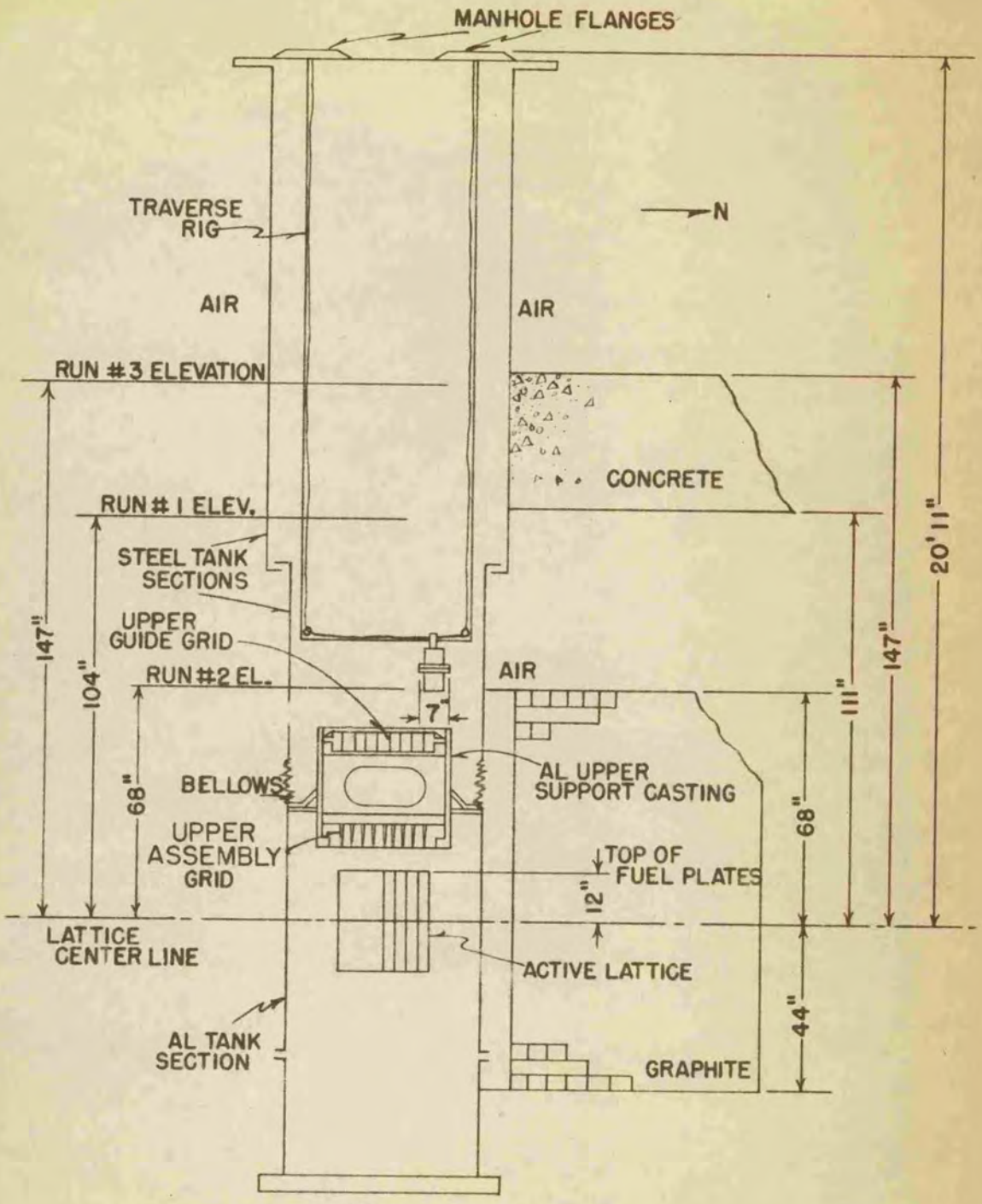


FIG. 3

CHAMBER ELEVATIONS FOR HORIZONTAL GAMMA TRAVERSES AND RELATIVE LOCATIONS OF GRAPHITE, AIR AND CONCRETE IN MTR MOCK-UP

steel thermal shield. Large, thin walled (0.030 inch) ion chambers were placed in small cavities in the concrete and the ionization measured at several points. These data are plotted in Fig. 4.

Neutron measurements in this same arrangement of barytes concrete and steel were unsuccessful because of low foil activations, so that one cannot be certain of the magnitude of leakage from outside the stack, although the concrete was surrounded by 1/4-inch boron plastic and eighteen inches of paraffin.

The data of Fig. 4 are a measure of the total heat generated in the concrete shield by photons originating in the fuel lattice, the graphite, the thermal shield, and the concrete. The dotted line of this figure was calculated before measurements were begun in the Mock-up on the basis of total heat produced by gamma rays from the fuel, graphite, and steel thermal shield.

Recently gamma fluxes in the graphite have been measured and found to be somewhat lower than was thought at the time of the calculations. The concrete heat measurements bear this out and also indicate that the contribution from capture gammas in the concrete is not serious.

The gamma relaxation length indicated by Fig. 4 is 7.5 cm whereas a length of 10 cm was used for shielding calculations. Thus the ion chamber measurements in the barytes concrete indicate a factor of safety in the design of the concrete shield from both the heat production and gamma attenuation standpoints.

A second method of estimating heating in the concrete was suggested by the shielding group. It consisted of replacing the barytes block with paraffin so that one might measure as thermal neutrons all the neutrons penetrating the thermal shield. Sides of the paraffin stack were covered with 1/4-inch thick boron plastic and great care was exercised to eliminate all side leakage. Figures 5, 6, and 7 show the results of the paraffin measurements, which have been transmitted to the shielding group for analysis.

Calorimetric Calibration of Small Graphite Ion Chambers. An experiment has been made to compare the heat generated by pile gamma rays in a sample of graphite and the ionization in a small graphite chamber filled with CO_2. The graphite sample was placed in a liquid nitrogen calorimeter and the assembly lowered into hole 12 in the X-10 graphite reactor. When the rate of heat absorption from the gamma rays had been established, the calorimeter

DWG 9787 [redacted]

FIG. 4

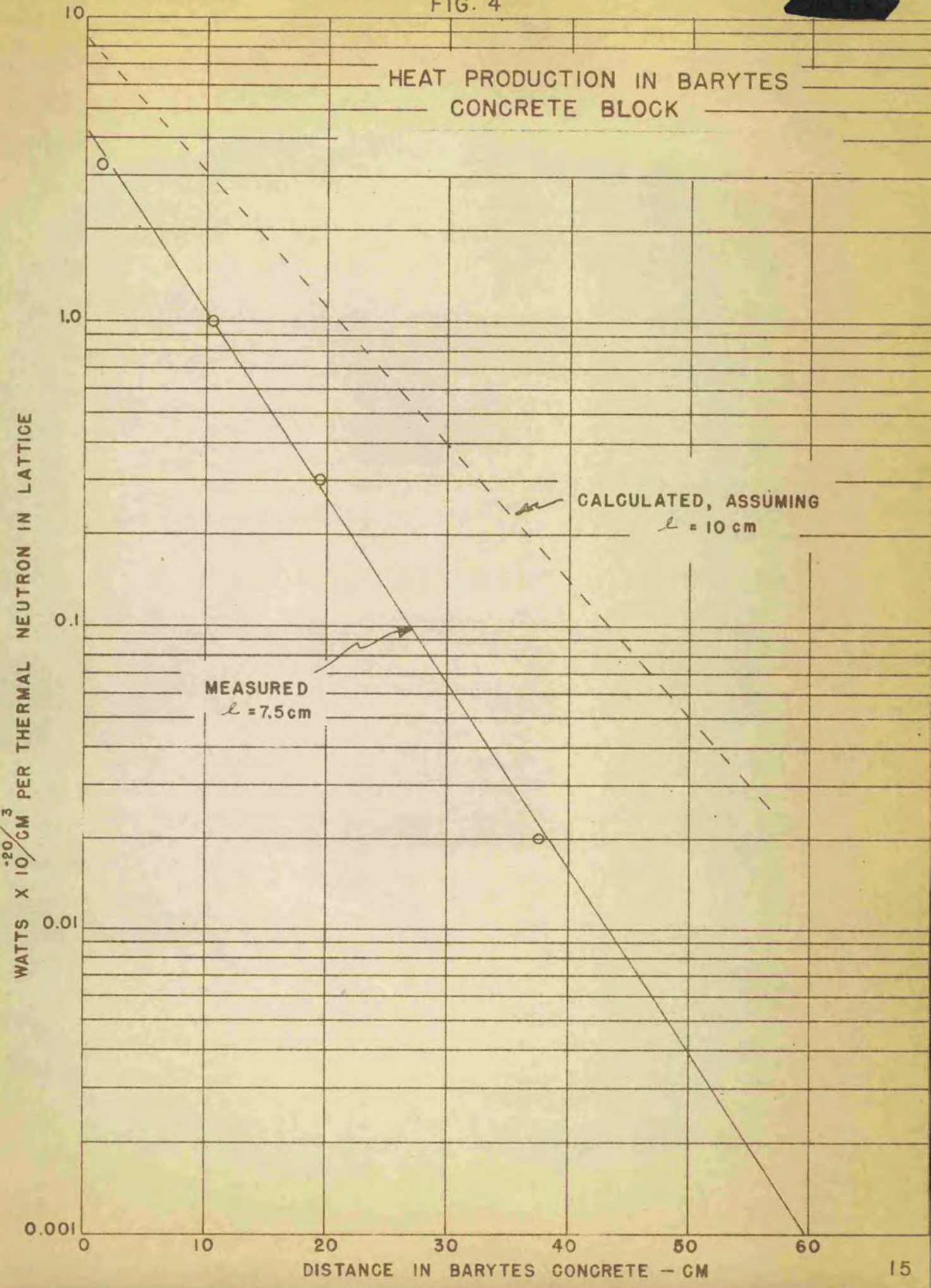


Figure 5

NEUTRON ATTENUATION IN PARAFFIN BEHIND THE THERMAL SHIELD

Points are As vs Thickness of Paraffin behind 8 in. of steel
Foils are Indium, 25 cm sq, 0.005 in. thick
Reactor Power ~ 2 KW
NV(th) = As(th) X 0.13

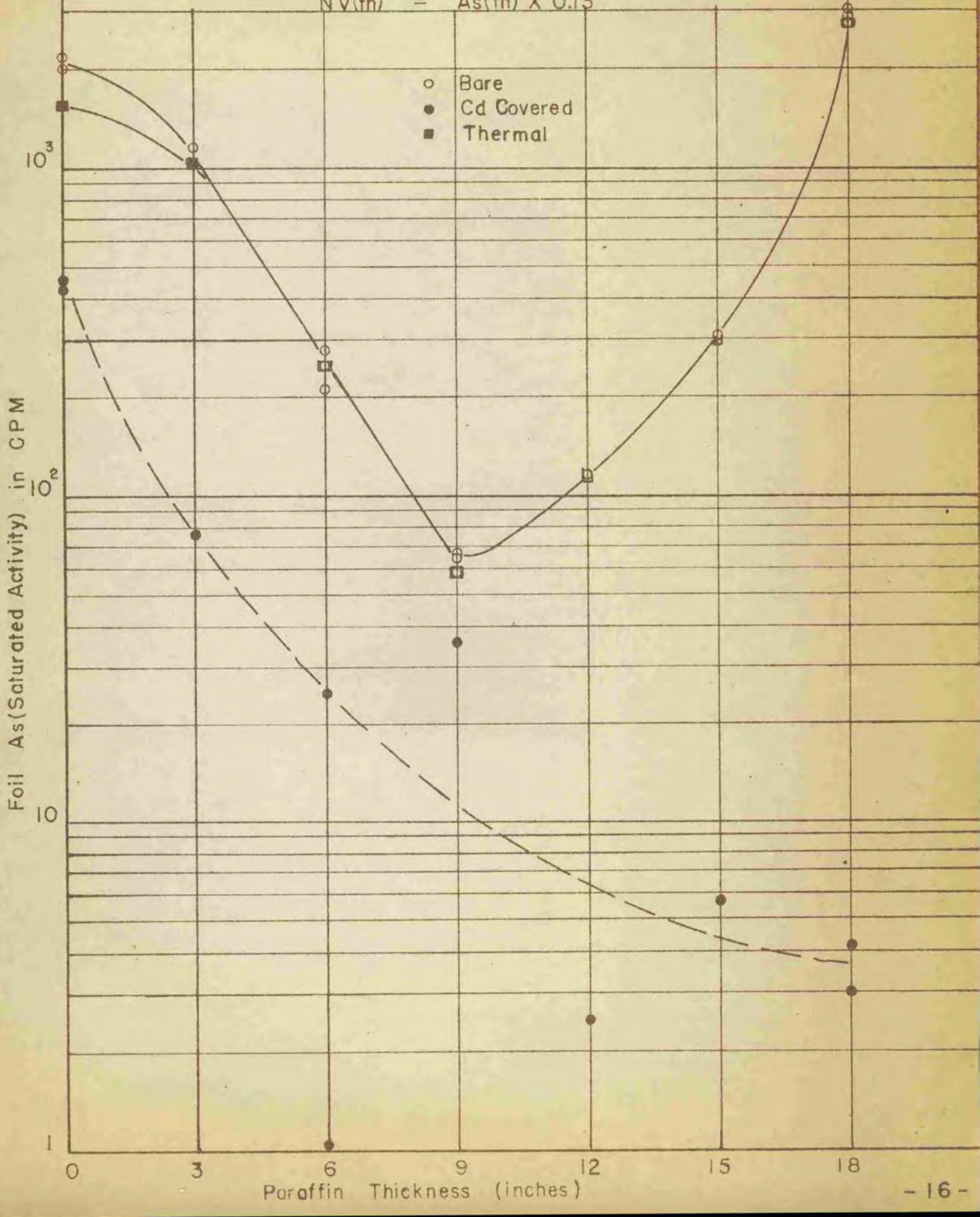


Figure 6

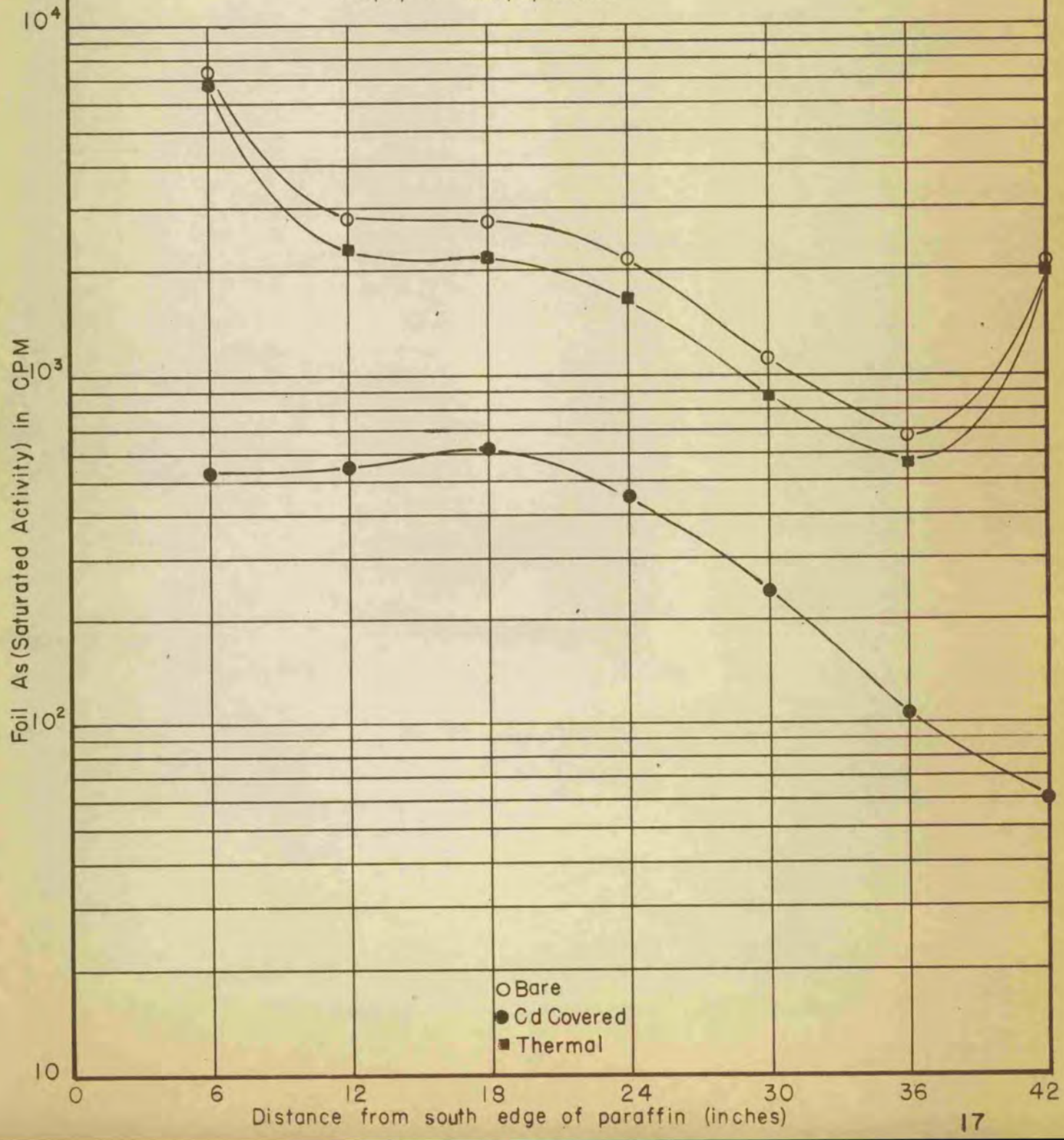
HORIZONTAL TRAVERSE BETWEEN PARAFFIN AND STEEL

Points are saturated activity vs distance from the south end of a block of paraffin placed behind eight inches of steel.

Foils are Indium, 25 cm sq, 0.005 in. thick,

Reactor Power ~ 2 KW

NV(th) = As(th) X 0.13



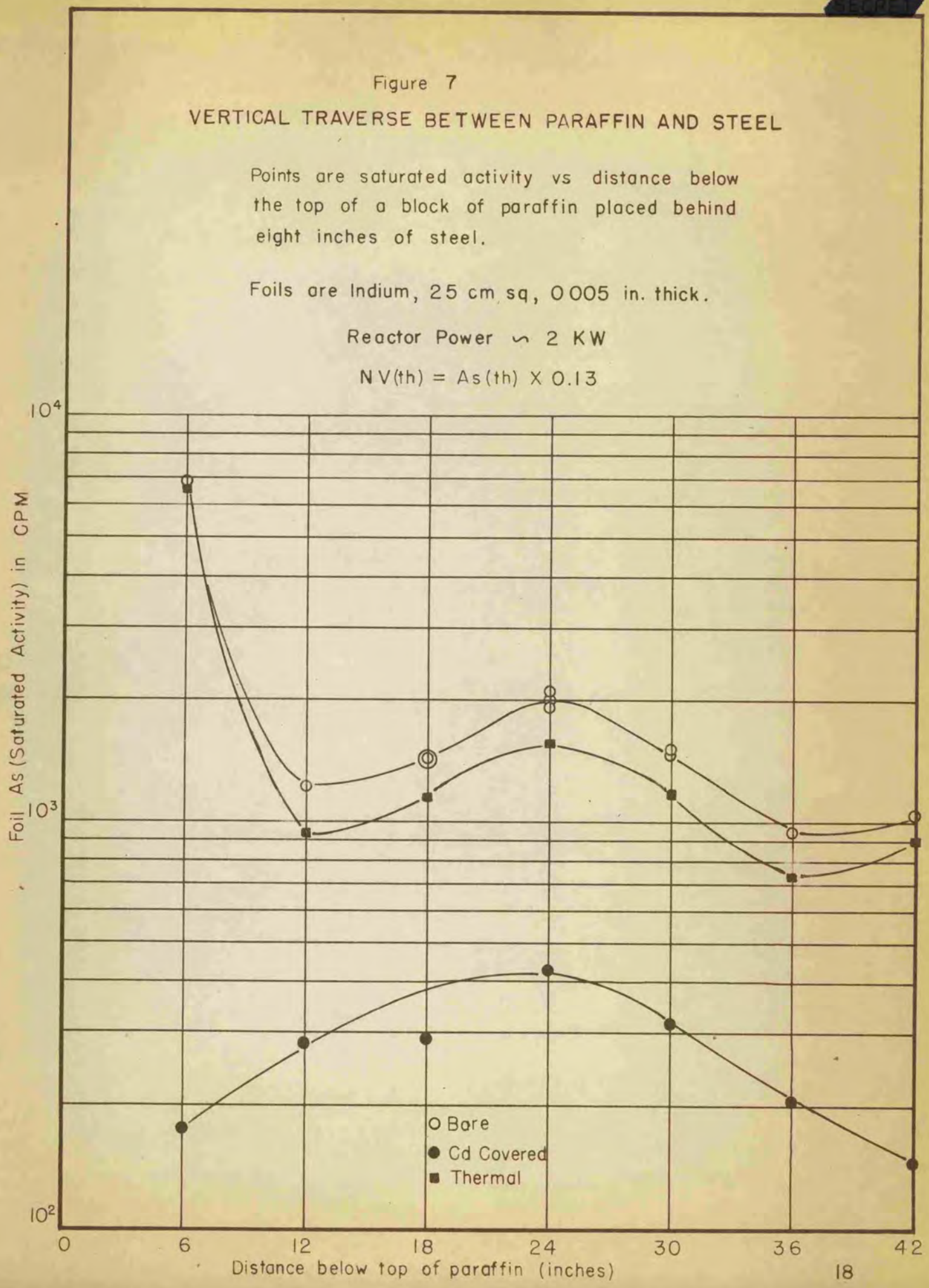


Figure 7
VERTICAL TRAVERSE BETWEEN PARAFFIN AND STEEL
Points are saturated activity vs distance below the top of a block of paraffin placed behind eight inches of steel.
Foils are Indium, 25 cm sq, 0.005 in. thick.
Reactor Power ∽ 2 KW
NV(th) = As(th) X 0.13
Foil As (Saturated Activity) in CPM
10⁴
10³
10²
0
6
12
18
24
30
36
42
Distance below top of paraffin (inches)
O Bare
● Cd Covered
■ Thermal

was replaced by a graphite wall ionization chamber similar to those used to determine gamma distribution in the graphite reflector of the mock-up. The measurements indicate that about 32 electron volts of energy are required to form an ion pair in CO_2. This agrees with other published data and confirms the validity of heat distribution calculations based on ionization measurements in the mock-up. The energy per ion pair has also been measured in several other gases and this will be the subject of a forthcoming report by G. H. Jenks, W. M. Breazeale *et al.*

Correction for Cadmium Covered Gold Foils. Earlier reports on the neutron fluxes measured in the active lattice with gold foils have carried a note that the saturated activity of cadmium covered gold foils was multiplied by 1.1 to correct for the epicadmium neutrons absorbed in the cadmium. This value was assumed until the true effect of the cadmium could be measured, since no information was available except that such a correction was necessary for cadmium covered indium foils.

The data presented in Table I show no significant decrease in saturated activity with increasing cadmium thickness after the thermal neutrons are cut out, so the 1.1 correction has been dropped. The resulting new values for neutron flux and cadmium ratio are shown in Figs. 8 and 9.

TABLE I

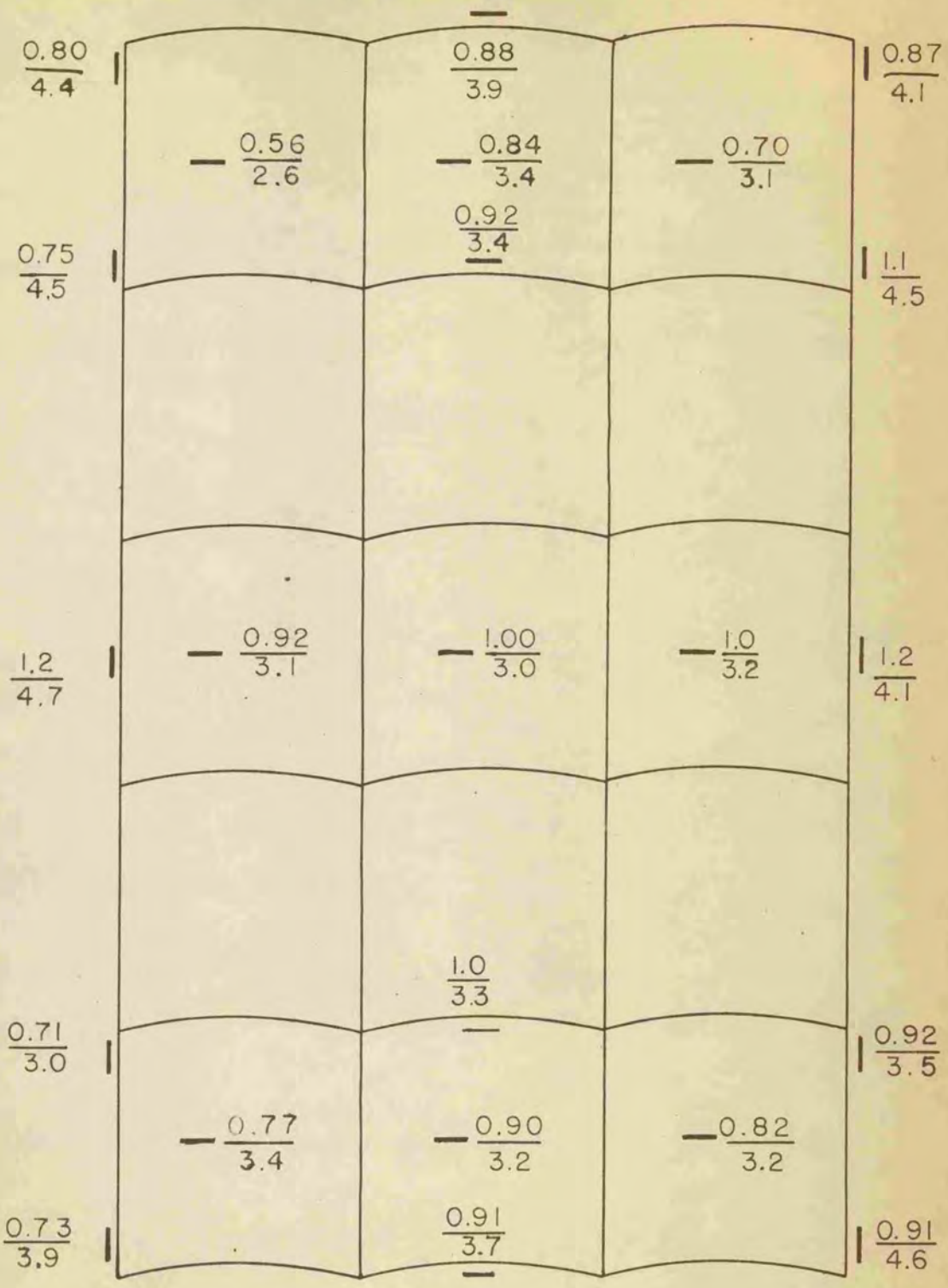
Saturated Activity of Cadmium Covered Gold Foils (1 cm^2, 5 mils thick); Exposed in a Standard Graphite Pile

CADMIUM THICKNESS (in.)	A_s (cpm)
0.0085	447
0.020	396
0.041	385
0.062	385

Temperature Coefficient. The temperature coefficient of the mock-up has been measured for various temperatures. The method employed was to heat the water surrounding the lattice to a desired temperature by running the pumps,

Fig. 8

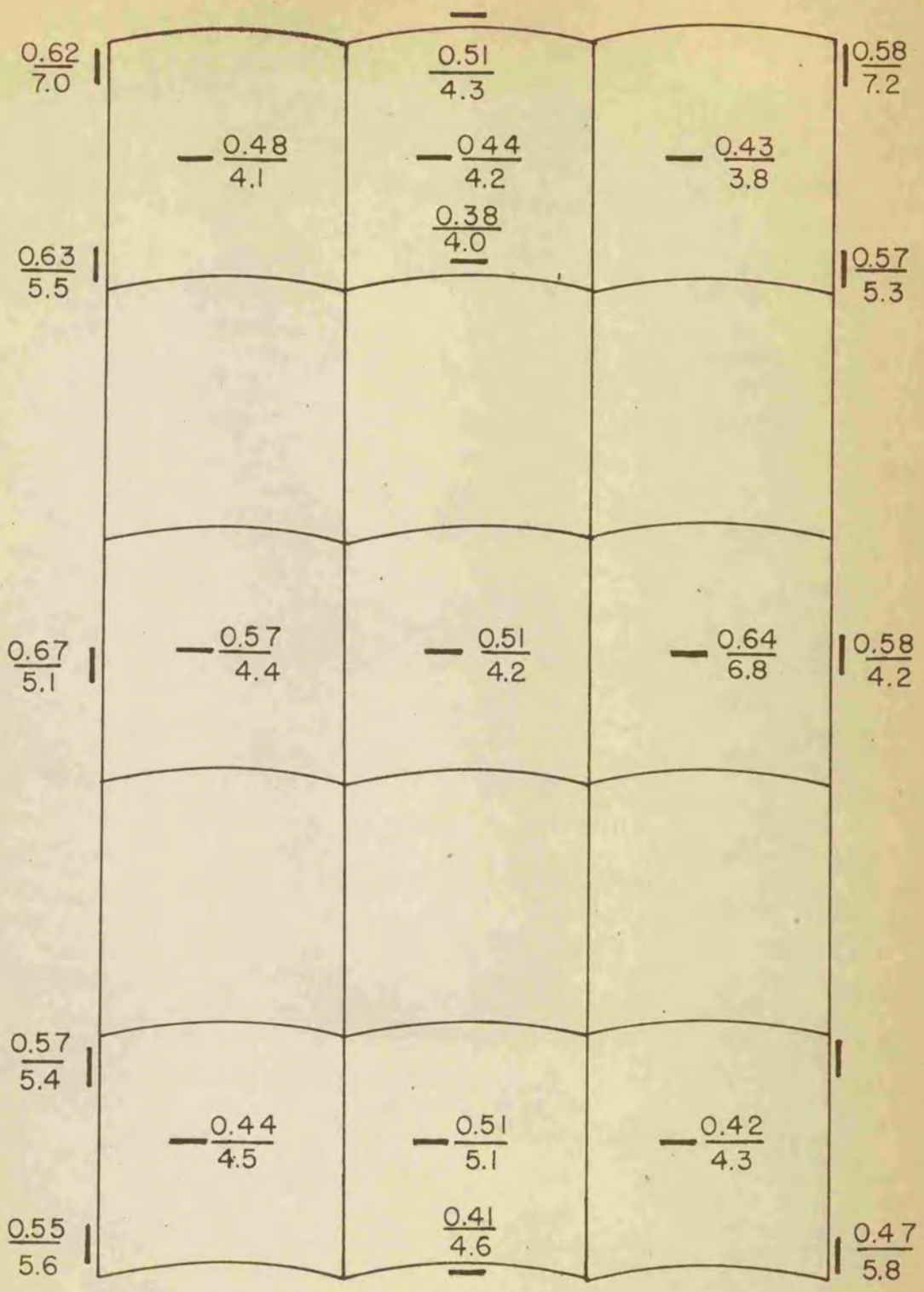
Thermal Neutron Flux in Midplane of Active Lattice



Numerator is NV_{th} Relative to NV_{th} at Center of Lattice

Denominator is Cadmium Ratio

Fig. 9
Thermal Neutron Flux in Top Plane of Active Lattice



Numerator is NV_{th} Relative to NV_{th} at Center of Lattice

Denominator is Cadmium Ratio

and to compare the position of the regulating rod, with the reactor critical, to its position at a different temperature. The change in reactivity due to the temperature change could then be determined from the $\delta K/K$ calibration of the regulating rod. The variance of the values in Table II is not great, considering the accuracy of the rod calibration. The average value of -0.013% $\delta K/K$ per °C compares favorably with the calculated value of approximately -0.015% per °C reported in MonP-272.(1)

TABLE II

Experimental Values for Temperature Coefficient

TEMPERATURE (°C)	PERCENT $\delta K/K$ EFF. PER °C
36.1	- 0.0128
37	- 0.0124
43	- 0.0118
45	- 0.0124
46.5	- 0.0136
48	- 0.0116
53	- 0.0136
54	- 0.0130
Average	- 0.0127

Effect of Water Flow. Mention has been made previously of the fact that small reactivity disturbances were apparent while operating the reactor with maximum water velocity (30 ft/sec) through the fuel elements. It was thought that these disturbances might be the result of fuel element movement (the mock-up elements are unconfined by the upper positioning grid because of the absence of the bevel rings and springs on the top end boxes of the fuel pieces), air bubbles in the water, or lateral movement of the regulating rod. Further study has shown clearly that regulating rod alone is responsible. Current from the servo ion chamber was recorded in a series of tests with and without water flow. With the regulating rod removed, the "noise" recorded was the same magnitude with and without flow. Also the noise with flow was

(1) Greuling, E., Soodak, H., and Weinberg, A. M., *Physics of the High Flux Pile-II*, MonP 272 (Mar. 27, 1947).

seen to increase in proportion to the inserted length of the rod. One may conclude that there is no measurable effect from movement (if any) of the fuel pieces or from uniformly distributed air bubbles in the cooling water.

The source of the regulating rod motion lay in the guide bearings. Two of the bearings were MTR spring-loaded test models, both poorly made; the third was a sleeve bearing of obsolete design. All permitted lateral motion of approximately 1/8 inch. Corrections have been made to eliminate this fault in the MTR bearings.

Effect of Empty Experimental Thimble. The effect of removing a beryllium plug from an experimental thimble, leaving the thimble empty, was determined to be a reduction in $\delta K/K$ eff of 0.6%. Replacing the beryllium with a paraffin plug resulted in a reduction of only 0.3% $\delta K/K$ eff. The values were measured by changes in regulating rod position for the various conditions. It should be noted here that the size of the mock-up core is only 5/9 that of full MTR slab loading, and the effects noted above will be smaller for the MTR.

Safety Rod Electromagnets. Electromagnets equivalent to the final MTR design have been in use for the past three months. An apparent reduction in holding force has been traced to misalignment of the magnet faces with the safety rod armatures. Re-design of the armature, incorporating a ball joint to prevent misalignment, restored the full supporting power of the magnets.

The new quick-disconnect feature of the electromagnets has been tested for operability and watertightness. Several improvements were included in the final design of the magnets, which have now been approved for purchase.

MTR CONTROL INSTRUMENTATION

Status of Individual Instruments

(1) *Differential Ion Chamber.* This instrument has been re-designed to overcome some difficulties encountered in the model designed by Eastman Kodak Company. The new chamber is now being tested and so far has proved superior to preceding models. The mechanical details have been much simplified and accordingly the unit cost should be nearly halved.

(2) *Three Inch P.C.P. Ion Chamber (Safety and Servo).* Design completed - models built and tested.

(3) *Fission Chamber.* Design completed - models built and tested.

(4) *Al and AlA Amplifier for Fission Chamber.* Standard equipment.

(5) *Logarithmic Counting Rate Meter.* Design completed circuit-wise -- needs to be put on a standard chassis.

(6) *"Sigma" Amplifier.* Prototype is essentially complete.

(7) *Magnet Current Amplifiers.* Drawings now being made preliminary to construction of a prototype. Circuits have been tested as far as possible without actual prototype equipment.

(8) *Log n and Period Meter Chassis.* Prototype now being built.

(9) *Period Amplifier.* Same as Item 7.

(10) *"Servo" System.* Circuits have been tested on a final experimental model. Drawings need to be made and a prototype constructed. F. Flader Company can apparently make a Log Potentiometer, and details are being discussed with them.

(11) *Differential Ion Chamber Power Supply.* Circuits have been checked and models made; a prototype needs to be constructed on a standard chassis.

CORROSION RESISTANCE OF EXTRUDED AND HOT-PRESSED BERYLLIUM

Testing on MTR Beryllium Reflector Pieces. Twenty-five rough-machined MTR beryllium pieces were received from the Brush Beryllium Company. The specified accelerated corrosion test of 96 hours of exposure to 250°C water revealed no metallurgical or chemical defects in the twenty-four pieces tested. One piece, designated C-2, was too large to test in the autoclave. It was accepted for final machining since other pieces cut from the same slab showed no defects.

All finish-machined pieces are to be subjected to a low temperature corrosion test prior to installation in the reactor as a final check against the use of poor corrosion resistant material. The duration of this test will be determined by the date the pieces are required at the reactor site. At the present twelve A pieces have received an exposure of two weeks.

For this test, a stainless steel flow system consisting of a 500 gallon capacity tank, a heat exchanger, and pump was assembled. The pieces of beryllium are arranged in the tank with 2S aluminum spacers such that water may circulate among them. The spacers are insulated from the stainless steel tank with polythene. Demineralized water is recirculated through the system at a rate of approximately 125 gal/min.

The Effect of Aluminum Content on the Corrosion Resistance of Extruded Beryllium. The effect of Al content on the corrosion resistance of extruded beryllium exposed to static distilled water (85°C, *p*H 5.5-6.5, 0.005 *M* H_2O_2) is being investigated. Test specimens were machined from billets in which various concentrations of Al were added to the raw metal charge. The billets were extruded at a ratio of 4.1:1 and at a temperature of 1800°F. Some of the specimens were annealed before final machining.

Corrosion results obtained from short-term tests of approximately two months duration indicate no significant difference in corrosion resistance attributable to Al content in the range of 0.03 to 1.24 percent. Calculated penetration rates, varying from 0.11 to 0.22 mils/mo, were comparable to those obtained for recent production hot-pressed metal tested under similar conditions. Corrosion data are given in Table I. Long-term tests are in progress.

Since it is difficult to evaluate the corrosion effects of one of several different impurities present in production beryllium, a series of cast specimens containing various concentrations of Al, Fe, Si, and Be_2C have been requested from the Brush Beryllium Company. All impurities are to be added to the same base material in order to minimize other chemical variations.

These short-term tests also indicate no appreciable difference in the corrosion resistance of beryllium in the annealed or unannealed condition.

The Effect of Copper and Chloride Ions on the Corrosion Resistance of Beryllium. Previous tests have indicated that the corrosion resistance of beryllium to aqueous media was greatly influenced by the presence of certain ionic constituents. The presence of the salts of heavy metals (especially copper) and chlorides are generally detrimental. In order to set MTR cooling water specifications, samples of metallurgical and chemically similar QRM samples are being exposed to distilled water containing additions of the most troublesome impurities. Tests containing copper and chloride ions have been completed.

Beryllium samples exposed for 75 days to distilled water (85°C, *p*H 5.5-6.5, 0.005 *M* H_2O_2) containing 0.1, 0.2, and 0.5 ppm Cu, added as $CuSO_4$, indicate this ion greatly accelerates corrosion, especially pitting. The average calculated penetration rates for the three Cu concentrations were 0.048, 0.053, and 0.11 mils/mo. The maximum pit depth obtained was 10.4 mils. These data are given in Table II.

Similar tests of 153 days duration containing additions of 0.5 and 1.0 ppm chloride, added as HCl, indicate this ion greatly stimulates pitting. The average calculated penetration rates were 0.137 and 0.381 mils/mo, respectively. These data are given in Table III. Most of the weight loss was caused by the formation of numerous shallow pits, accompanied by white oxide deposits on the metal surface. This oxide deposition was probably caused by the hydrolysis of soluble $BeCl_2$. The pits on the samples exposed to 1 ppm chloride grew in diameter to encompass the entire exposed surface.

Specimens exposed for two months to the same quality water, except containing no Cu or chloride additions (< 0.05 ppm Cu, < 2 ppm Cl), corroded at the calculated rate of 0.014 mils/mo. The pitting frequency was low; the maximum pit depth was 10.6 mils. These data have been reported previously. An examination of the data indicates that the higher corrosion rates caused by the presence of Cu and chloride ions are due mainly to an increase in pit densities and pit diameters rather than an increase in pit depths.

It has been tentatively recommended that the MTR cooling water specifications limit the Cu and chloride concentrations to the maximum values of 0.05 and 0.2 ppm, respectively. The results of these tests indicate these limits to be satisfactory; however, an effort should be made to maintain lower concentrations.

METALLURGY AND FABRICATION

BERYLLIUM PRODUCTION FOR MTR

At the end of August 3, 472 pounds of rough-machined beryllium sections had been received at the Y-12 Machine Shop from Brush Beryllium. Of this, three pieces with a total weight of 78 pounds has been rejected and returned to Brush. Two of these pieces were rejected because of cracks and one because of an internal pore visible by radiography. An estimated 5,870 pounds of hot-pressed rough-machined beryllium is required, and Brush plans to ship all of this material by early October. The six extruded sections requested have not been produced because of lack of success in producing sound billets.

Visual examination, radiography, microscopic examination, autoclave testing, and chemical analyses indicated that sound high-purity beryllium is being produced for the reflectors. The average TDS for the first eighteen pressings was 11.15 exclusive of boron and 14.09 inclusive of boron.

Machining at Y-12 is proceeding almost without difficulties, between 20 and 25 percent of the machine work on the reflectors having been completed by the end of August.

MELTING AND ROLLING

A series of 48 MTR fuel units are currently being fabricated for use in the Bulk Shielding Reactor now being constructed at ORNL. Yields of blister free plates continue to be high, averaging about 95%. A listing of individual yields for each run is shown in Table I.

TABLE I

RUN	NO. OF PLATES	BLISTERED PLATES	YIELD PERCENT
C37	58	3	94.8
C38	60	3	95.0
C39	60	3	95.0
C41	60	8	86.7
C42	60	2	96.7
	358	Avg.	94.7

Several basic changes in technology were made during the period. Previously the feed material to the metallurgical operation was the oxide, U_3O_8. It was pointed out by Mr. J. M. Herndon (Bldg. 9212, Y-12 Area) that metal is almost as cheap to make as U_3O_8. In addition, there is less danger of air contamination when metal is used. Therefore, it was decided to use the metal as raw material. Additional advantages of this change are as follows:

(1) Melting time is reduced by a factor of 4.

(2) Crucible life is increased by a factor of about 10 because lower melting temperatures can be used.

(3) Volume of wastes from the melting operation is reduced. When metal is used, no slag is necessary.

During this period, it was decided to use a one-pass uranium cycle in the MTR instead of the seven-pass cycle previously planned. Uranium recovered from spent assemblies will be recycled back to K-25.

A decision was made that fuel units will be produced at ORNL during fiscal years 1951 and 1952. A total of 138 fuel sections will be manufactured by July 1, 1951, the MTR start-up date. Production will then proceed at a rate of 2.3 per day.

FABRICATION

Experiments to determine the feasibility of eliminating the drying and/or preheating steps in fuel assembly fabrication have been discontinued because of the poor results obtained. It is possible to obtain good braze joints without the drying or preheating part of the cycle. However, it was found that blisters are produced in the active plates if either of these steps is omitted. Five assemblies (A15, A16, A17, A18 and A20) were brazed using the following cycle:

(1) Dry 2 hours at 302°C

(2) Braze 50 minutes at 1110°F.

All showed blisters after brazing. Nine additional assemblies were then brazed with the addition of the preheat step as follows:

(1) Dry 2 hours at 302°F

(2) Preheat 50 minutes at 850°F

(3) Braze 38 minutes at 1110°F.

[redacted]

None of these showed any blisters after brazing. Absolute humidity was uniformly high during this period, about 12×10^{-4} lbs/ft^3 H_2O.

It apparently is necessary to dry the flux thoroughly at an elevated temperature to eliminate the possibility of blistering during brazing.

[redacted]