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PHYSICAL TESTS ON CORE DRILLINGS FROM THE ORNL GRAPHITE REACTOR SHIELD

THEODORE ROCKWELL III

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Technical Division

Section IV, Engineering Materials

F. Kerze, Section Chief

PHYSICAL TESTS ON CORE DRILLINGS FROM THE ORNL GRAPHITE REACTOR SHIELD

Problem Assignment No. TD-24

Theodore Rockwell, III

Period of Test: Mar. 15 to Nov. 15, 1948

Date Issued

MAR 1 1949

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PHYSICAL TESTS ON CORE DRILLINGS FROM THE ORNL GRAPHITE REACTOR SHIELD

ABSTRACT

At the request of the Operations Division, three cores approximately four inches in diameter were cut with diamond core drills completely through the west face of the concrete shield of the ORNL graphite reactor. These cores were tested for compressive strength, density, water content, chemical composition, and residual induced radioactivity, all as a function of position in the shield. Temperatures were also taken at various positions along the core plug, with the reactor operating and shut down, and radiation intensity through the shield is also shown from data by the Operations Division and experiments by the Shielding group.

It is concluded that:

(1) The radiation has apparently had very little effect on the concrete.

(2) The special haydite-barytes concrete has three-to five-fold higher water content than normal concrete, but somewhat less than the 10% specified.

(3) The specific gravity of both the special and the normal concrete is quite low, ~2.2.

(4) The strength of the special concrete is well up to specifications, ~2500 psi.

(5) The strength of the normal concrete is quite low, ~1800 psi.

(6) The asphalt layer enclosing the special shield appears to be intact, but apparently did not prevent loss of water at the inside face.

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INTRODUCTION

During March, 1948, L. B. Emlet, General Superintendent of the Operations Division of ORNL, requested that the feasibility of boring core holes completely through the concrete shield of the ORNL graphite reactor be studied, indicating that there were several incentives for such a venture:

(1) Direct information on the physical condition of the shield could be obtained. The appearance of cracks in the shield and the apparent suction of dust into these cracks had given rise to some concern over the structural strength of the shield.

(2) Fundamental data on the effects of very long term irradiation could be obtained.

(3) Considerable throught was being given to the possibility of providing a larger shield testing facility in the ORNL reactor, and this would mean cutting into the reactor shield, either to enlarge a present hole or to cut a new one. Such a move had to be preceded by calculations based on known strength data for the shield.

(4) A check could be made on the composition and other properties of the shield and these could be compared with specifications for future reference.

(5) Better radiation attenuation measurements could be taken through the shield. These with 4 above, would give a good check on attenuation theories.

(6) More experimental facilities with some unique features would be provided.

It was decided to make the study and the writer approached D. G. Hill, a man locally available (Y-12) and with considerable core-drilling experience. He visited the location, studied the prints, and recommended that Joy Manufacturing Company (Knoxville office) be consulted, stating that he foresaw no unusual obstacles. They and several other engineers studied the problem,and on April 19, 1948 a request was made to the ORNL Engineering Division to undertake the job. Construction request CR-17, authorizing the project, was issued May 27, and the job was begun early in June.

[redacted]

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Figure 1 shows the drilling rig in place in the balcony at the West face of the pile. The aluminum pipe emerging from the center of the water tank at the lower right of the picture is on the East-West axis of the pile. The tank itself is the water tank in the shield testing facility (now being replaced by the "lid tank" facility). Just to the left of the tank is a core hole (designated below as "hole number 3") being drilled, with the drill in place and the temporary catch basin and drain clearly visible. Two feet to the left of this hole is "hole number 2", plugged with a concrete-filled iron-lined plug, containing a bolt to facilitate removal. Note the marks where the catch basin has been located. Some six feet further to the left are two grouted-in spots where holes were started but transverse reinforcing steel caused trouble. "Hole number 1" is out of sight below the balcony. Note that the hole being drilled goes through an extra six-inch concrete pad, alluded to below. Figure 2 shows a close-up of the hole with the drill removed and the aggregate clearly visible.

DRILLING THE CORES

The ORNL reactor shield consists (on the sides and back) of one foot of ordinary Portland cement concrete enclosing five feet of special concrete. The latter is a Portland cement concrete containing barytes ($BaSO_4$) and haydite (a calcined shale) in place of the usual rock and sand aggregate. A more complete description and specifications can be found in M-4191 (T. Rockwell 12/23/47) and the ORNL Shielding Symposium Notes (ORNL CF #48-10-44), pp. 233-7. Drawings are on file with the Operations Division.

The holes resulting from the drilling operation were required to have longitudinal steps to prevent radiation leakage and it seemed convenient that these changes in diameter should occur at the interfaces of the two kinds of concrete, since the cores would probably break at these planes anyway. Considerable thought was given to the question of core diameters.

(1) Expense increases rapidly with increasing core diameters.
(2) The larger the core diameters, the fewer the test specimens which can be cut from the core, since there is a minimum length-to-diameter ratio recommended for compression test cylinders. A smaller number of cylinders results in fewer data.

but:

(3) There is a minimum ratio of cylinder diameter to maximum aggregate diameter, below which compression tests become increasingly unreliable.

Several reputable engineers were consulted on this question, e.g. Mr. P.J. Freeman, head of TVA Testing Laboratories; Prof. H. B. Aikin, head of the University of Tennessee's Civil Engineering Department; and assuming (from specifications) a maximum aggregate size of 3/4" core

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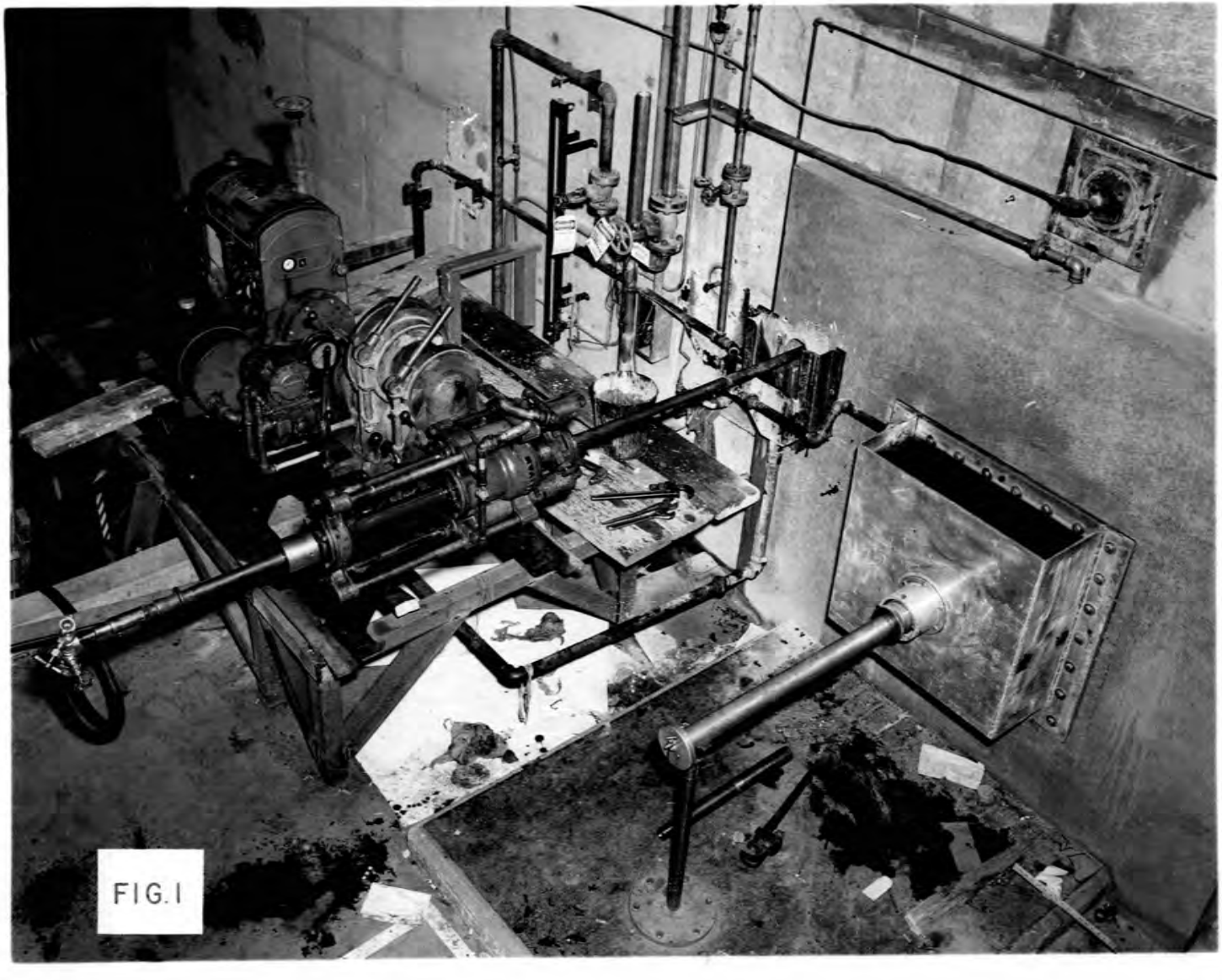

FIG. I

FIG. 2

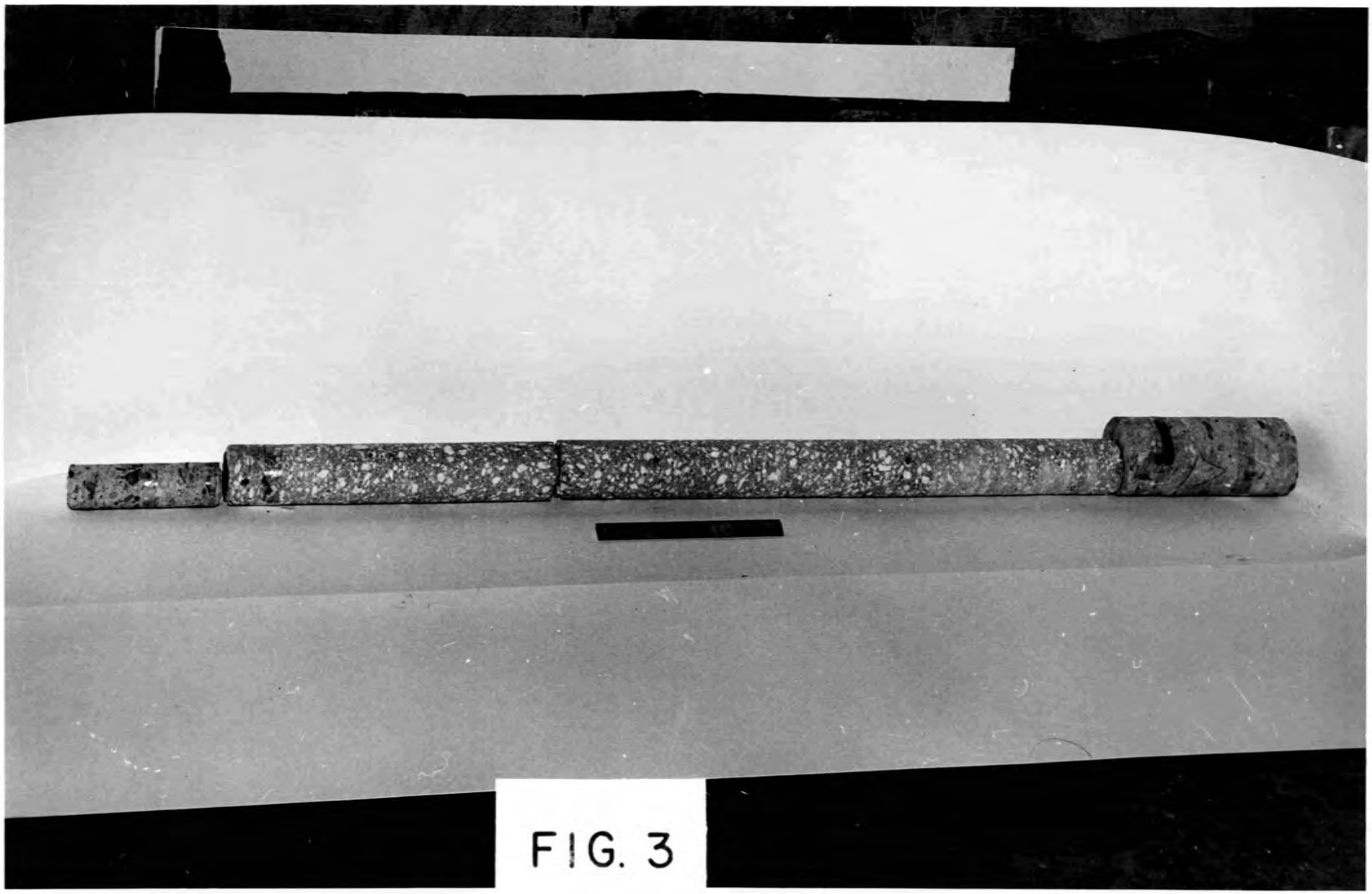

FIG. 3

[redacted]

diameters of 3, 4, and 5 inches were chosen. The actual core diameters differed from the above figures for reasons of mechanical expediency. Special diamond bits were made up for the job. Figure 3 shows a typical core, lying in front of the blotter-lined lead-brick temporary "coffin" in which it was placed immediately upon removal from the shield. A pair of reinforcing rods are seen to intersect at the surface of the outside core (far right).

The drilling procedure was as follows: First, the 12 inch layer of ordinary concrete was bored, the core broken off and placed in the coffin, during which time the pile was operating. Then a smaller core-bit was installed and the five foot section of special concrete cut nearly through. At this point the pile was shut down and the remaining few inches of the five foot section were cut and the core removed. The smallest bit was then installed and the final section cut nearly through. The lubricating water was then shut off and the last inch drilled through. The core was removed and a steel-jacketed concrete plug inserted into the hole. Tolerance time, looking directly at a slug with the pile down for an hour, was several minutes.

Considerable difficulty was experienced from several angles. First, the reinforcing steel, which was shown only sketchily on the few drawings which showed it at all, proved to have tie-rods in addition to the expected matting networks. These tie-rods ran parallel to the drilling axis and when one appeared in a core (and their location could not be predicted) removal of the core was exceedingly difficult and its value as a compression cylinder negligible. An example of this is shown in Figure 4, where a tie-rod enters from the left into the inner normal-concrete core, and emerges at the upper part of the surface shown, looping over a second rod (shown cut transversely) and ending at the large piece of aggregate just above the caption. This core section was later cut into halves one of which is shown in Figure 5 (left). This sample gave a satisfactory compression test, failing in the traditional conical fragments indicative of a satisfactory test. The other half, containing the rod through the center, failed in shear and the result was therefore discarded.

A second problem concerned the absorption by the core of the lubricating water, in that this could result in erroneous water content analyses. This did not appear to introduce appreciable error as the drilling period was short; the graph on the next page indicates that considerable time is necessary for water to penetrate to the center core portions from which the water analysis samples were taken.

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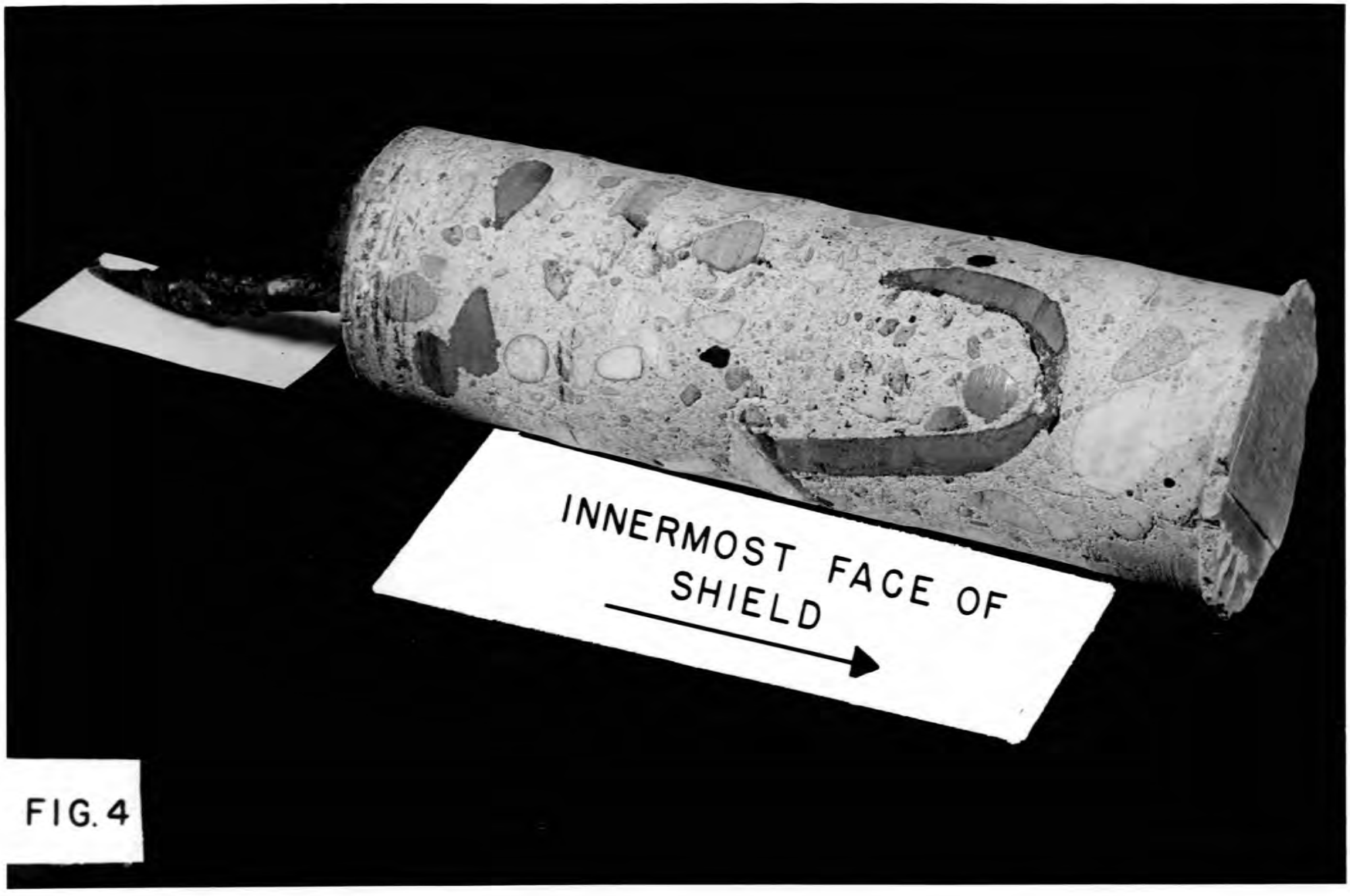


FIG. 4

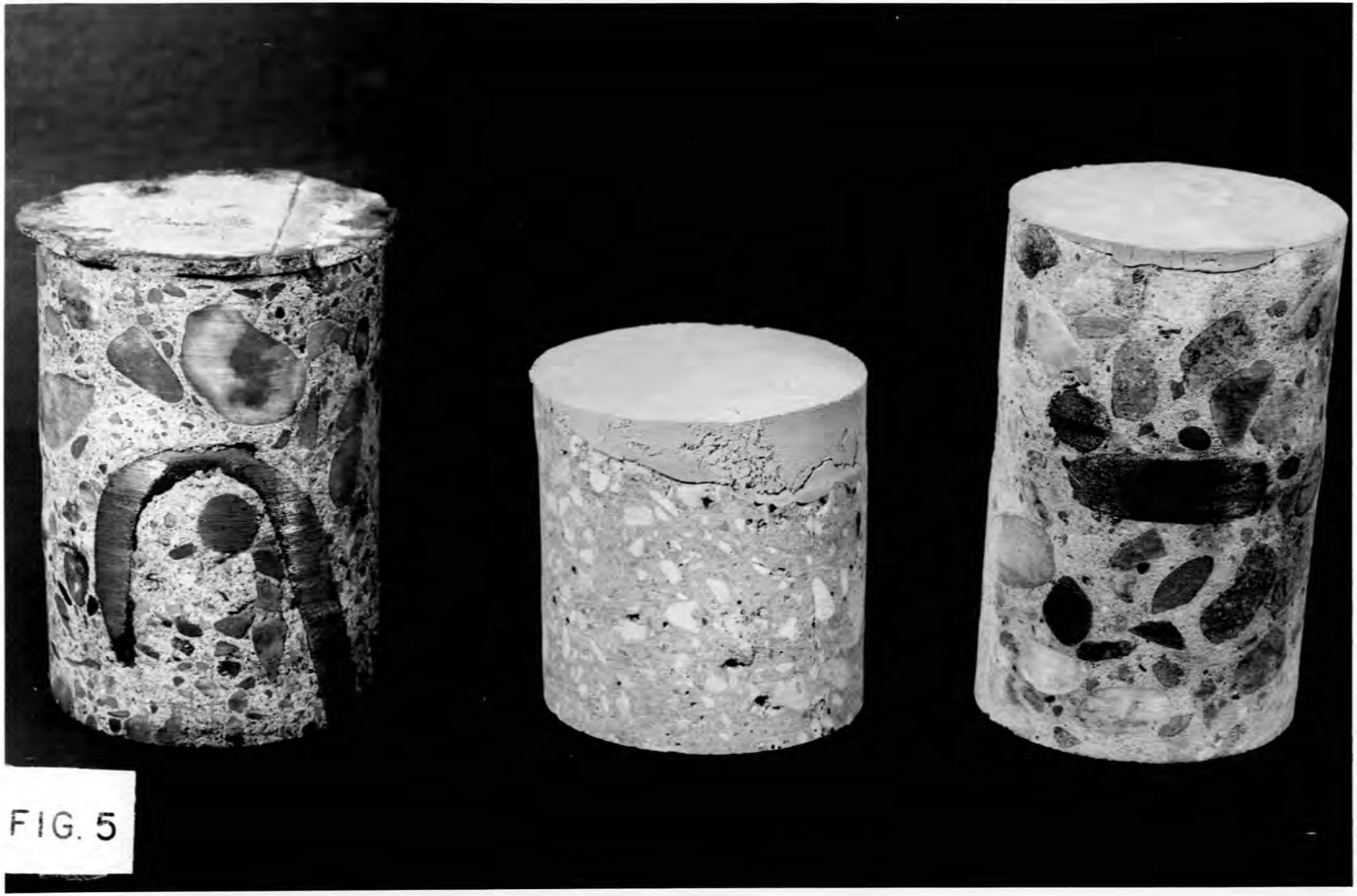
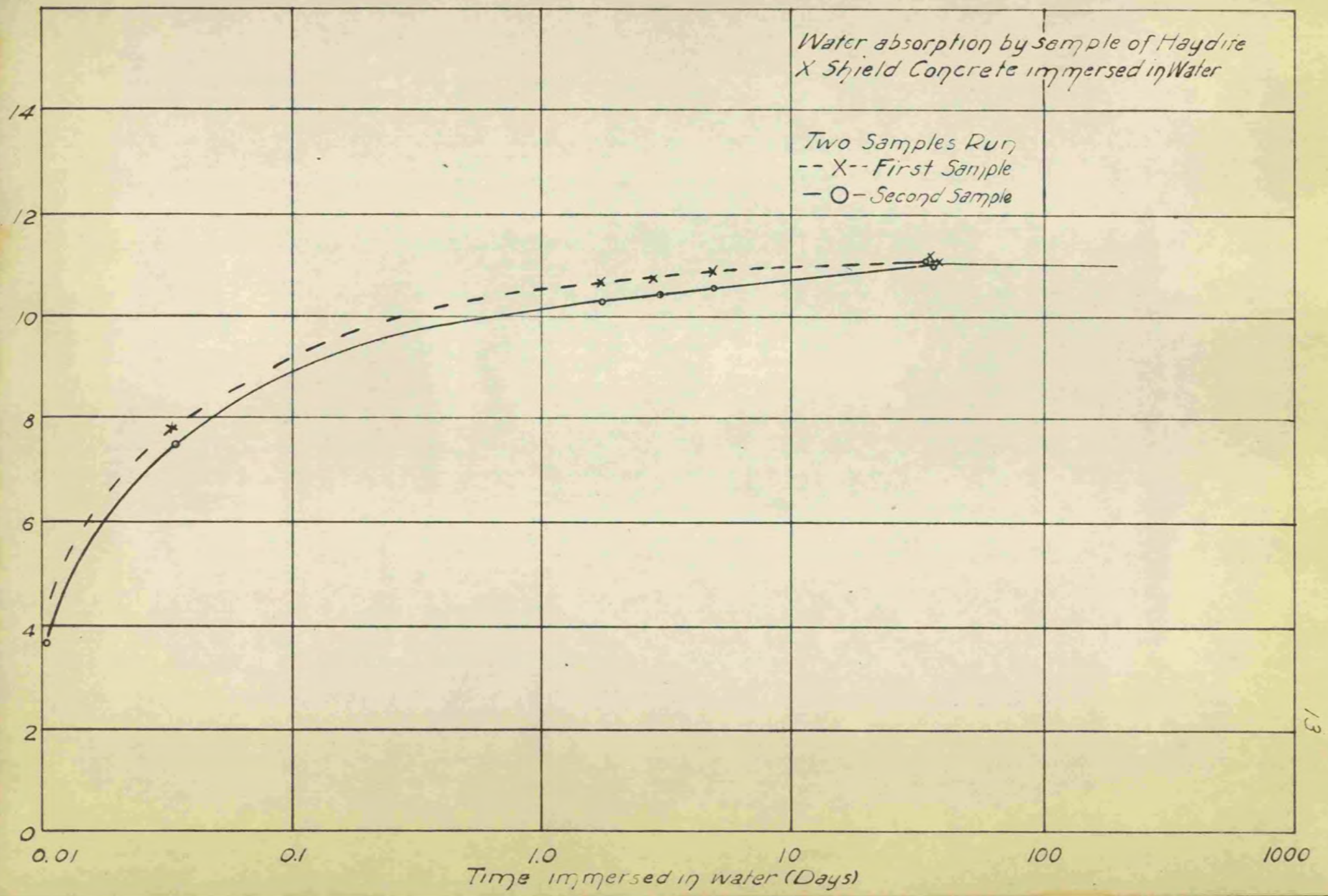


FIG. 5


Water absorption by sample of Haydite
X Shield Concrete immersed in Water
Two Samples Run
-- X -- First Sample
— O — Second Sample
14
12
10
8
6
4
2
0
0.01
0.1
1.0
10
100
1000
Time immersed in water (Days)

[redacted]

A third problem was the removal of the last core section. A core-retaining bit was not available, and the core tended to flare out as the last section broke through. This made the core difficult to pull back through the hole and therefore complete cores were not recovered from holes one and two. Finally, the aggregate turned out to be considerably larger than expected and this, combined with the problem of included reinforcing rods, made core removal more difficult and compression tests less reliable than had been anticipated. Another factor tending to reduce irregularly the compressive strength of the individual core sections was the fact that twisting and jerking of the cores by the drill was required in order to break off and remove the cores. This was further aggravated by the fact that the reinforcing iron cut through with less clearance than the concrete and bound the drill. After two attempts had failed to produce a complete innermost core section, it was decided to try a third hole with a step only at the outside concrete interface, running the four inch bit through the special and innermost layers. This proved to be successful, as shown in Figure 4.

PREPARING THE CORES

After the cores had cooled radioactively for two weeks, they were sawed on an abrasive cut-off wheel into sections for compression tests. These sections were then capped (both ends when required) with neat Portland cement, according to ASTM procedures. Figure 5 shows typical specimens from each of the core sections (left to right: inner, middle, and outer). Weights and volumes for specific gravity of the sections were taken after capping, since it was felt that this would be more accurate than trying to approximate the volumes of the uncapped sections. These samples were compressed to failure on a standard Baldwin-Southwark tensile-compression testing machine. Samples were taken from the center of each broken core-section, placed immediately into a weighing bottle and labeled for analysis.

The size and variation of size of the aggregate made the compression cylinders too small to be good random samples. It was therefore decided to crush the samples taken as mentioned in the previous paragraph, in such a way as to recover only the cement phase of the normal concrete, and the cement-plus-haydite phase of the special concrete. These contained essentially all of the water in the concrete, and were finely-enough divided so as not to vary (presumably) throughout the immediate region of the sample. From assumed ratios of cement to aggregate, obtained from specifications and checked by total analyses, the water in the hydrogenous phases could be converted to water in the concrete, as explained below.

[redacted]

[redacted]

INTERPRETATION OF RESULTS

The following pages contain:

(1) A tabulation of the data obtained.
(2) A chart of the total integrated radiation received at each point in the shield during the life of the shield.
(3) The temperature through the shield, both during operation and shutdown.
(4) The compression strength of the concrete through the shield.
(5) The density of the concrete, expressed as specific gravity.
(6) The water content through the shield.
(7) The effect of temperature on water content of Portland cement and concrete.

A few remarks on each of these is in order.

The total radiation curves were calculated from a total kilowatt-hours figure obtained from the Operations Division and a curve of flux variation through the pile to the inside edge of the shield, obtained from the same source. The relaxation lengths and cadmium ratios are from the radiation attenuation testing group, from experiments in the West face shield testing facility, where the nv: γ ratio measurements were also made.

$$\int_{\text{start-up}}^{\text{June 26, 1948}} nv\,dt = 1.2 \times 10^{11} \text{ watt-hours} \times 2.8 \times 10^{5} \frac{\text{neutrons}}{\text{cm}^2\text{-sec-watt}} \times .01 \frac{\text{edge flux}}{\text{center flux}}$$

$$\times\ 3.6 \times 10^{3} \frac{\text{sec}}{\text{hour}} = 10^{18} \text{ nvt at inside of shield}$$

checking: Have measured 10^{10} nv at shield; $\times 10^{5} \frac{\text{sec}}{\text{day}} \times 10^{3}$days (full power) $= 10^{18}$

Gammas: With 10^{10} nv, get 10^{4} roentgens per hour of γ's

$$\frac{10^{10} \times 3600}{10^{4}} = 3.6 \times 10^{9} \text{ nvt/r}$$

$$\frac{10^{18}}{3.6 \times 10^{9}} = 3 \times 10^{8} \text{ r of } \gamma\text{'s } (\sim 3 \times 10^{17} \text{quanta/cm}^2)$$

The temperature readings were made by taping with transparent tape to the core plug a series of copper-constantan, 30 gage, duplex, glass and asbestos insulated thermocouples, ten along each plug. The plugs were then inserted into the core-holes, the crack calked up at the outside to prevent flow of air over the thermocouples, and the readings taken after several hours had been allowed for equilibrium to be established.

[redacted]

[redacted]

The compression tests were made as mentioned above essentially by ASTM standards, except that the aggregate to-cylinder-diameter ratio was too large and the cylinders were not the standard 6" diameter by 12" length. The former condition lead to scattered readings, as shown, but this situation could not be improved. The ordinate of the chart is the compressive strength, the abscissa is the distance of the entire cylinder from the inside face of the shield, and of course must be represented as a horizontal line, since the compression value represents that whole section. The ASTM has found that the strength of a specimen is a definite function of its length to diameter ratio and all of the specimens tested were corrected by this function to be equivalent to the standard 6"x12" cylinder.

The density computations were made from simple weight and volume measurements, made directly on the specimens. It was felt that more accurate methods were not justified.

The water content was computed from the analyses of the hydrogenous phase, as noted above. The analyses were run by the standard technique of ignition in a tube furnace at 1000°C, continuously flushing the equipment with dried nitrogen and weighing a water trap. The conversion of these values to $\%H_2O$ in the concrete was performed as follows:

Let: W = weight fraction water in concrete
H = " " haydite " "
B = " " barytes " "
C = " " cement " "

Then:

(1) $\frac{W}{W+H+B+C}$ = W, the desired answer, the water in the total concrete

and:

(2) $\frac{W}{W+H+C}$ = A, the analytical result, the water in the hydrogenous phase

Known are:

$\frac{H}{C}$ & $\frac{B}{C}$, from the specifications (checked by analysis)

From this, $\frac{W}{C} = \frac{B}{C}\left(\frac{A}{1-A}\right)$ which was plotted as $\frac{W}{C}$ vs. A

Then, from eq'n. (1) above:

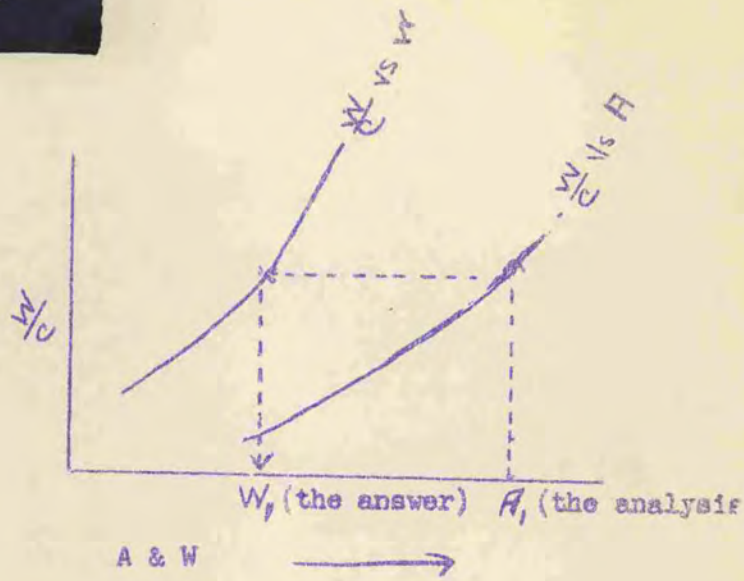
$$W = \frac{\frac{W}{C}}{\frac{W}{C}+\frac{H}{C}+\frac{B}{C}+1}$$, which was plotted on the same graph

Then, for a given value of A, one could read up to the first curve, across to the second, and down to the abscissa for the final answer without solving for $\frac{W}{C}$.

[redacted]

[redacted]

A similar pair of curves were drawn for ordinary concrete.



The water content vs. temperature curve was obtained from measurements made for other studies. It is included to show that probably most of the decrease in water content toward the inside of the shield can be accounted for by the temperature increase. The temperature also may account for the slight decrease in strength and density toward the inside.

[redacted]

Tabulated Data, X-Shield Concretes

Core sections are numbered from outside of shield inward. Core 1 is the outside foot (ordinary concrete), core 2 is the center five feet (haydite-barytes), core 3 is the outside foot (ordinary concrete).

Hole 1 - West face, opposite charging hole No. 2079

Core	Section	Length	Diam.	Crushing Strength#	Sp. G.	%H_2O (Wt.) Cement	%H_2O (Wt.) Total	Temp. °F (Pile on)	Radiation, 2 wk. After Removal
1 ~5-3/8" dia.	All	12.06"	5.75"	1720 psi	2.20	10.7	1.5	77	<1 mr/hr
2 ~3-13/16" dia.	A	4.25	3.86	2592	2.10	16.2	8.6	77	
	B	4.25	3.84	2682	2.27	17.5	9.4		
	C	4.25	3.84	2130	2.27	16.1	8.5	77	
	D	6.69	3.86	2775	2.28	18.2	9.8		<1 mr/hr broken here*
	E	4.20	3.84	3300	2.29	18.0	9.7		
	F	4.31	3.85	2479	2.23	14.9	7.9	81.5	
	G	4.15	3.87	3160	2.15	17.9	9.5		
	H	4.31	3.88	2799	2.18	14.2	7.5		
	I	4.25	3.87	2889	2.22	16.6	8.7	86.0	
	J	5.25	3.85	2574	2.14	19.4	10.5		<1 mr/hr broken here*
	K	8.00	3.82	3108	2.16	16.6	8.7		
	L	4.25	3.83	2421	2.16	17.2	9.2		
	M	4.38	3.81	1847	1.96	9.5	4.8	95.0	3 mr/hr
3 ~2-13/16" dia.	I	3.00	2.85	2490	2.21	9.1	1.3	98.5	12 mr/hr
	II	2.75	2.81	2850	2.30	10.0	1.4		(contains reinforcing iron)
	III	3.38	2.81	2060	2.11	9.7	1.4		
	Remainder (inside 2-7/8") lost							162.0	

*The cores were sawed into test cylinders, capped with neat cement by ASTM procedure, and the extra length obtained by adding the lengths of all of the capped cylinders and subtracting 60", is subtracted in quarters from either side of the two breaks (four surfaces)

#Corrected for L/D variation by ASTM C42-31

[redacted]

[redacted]

Hole 2 - West face, opposite charging hole No. 2666

Core	Sect.	Length	Diam.	Crushing Strength #	Sp. G.	%H_2O(Wt.) Cement	Total	Radiation, 2 wk. After Removal
1	All	12.00"	5.31"	1800	2.35	14.1	2.0	<1 mr/hr
2	A	2.44	3.83	-	-	-	-	
	B	4.19	3.81	2110	2.18	12.7	6.7	
	C	4.19	3.85	2440	2.18	-	-	
	D	4.31	3.86	2448	2.20	11.95	6.2	
	E	4.13	3.87	2700	2.28	-	-	
	F	4.25	3.87	2619	2.23	10.74	5.5	
	G	4.19	3.87	2835	2.25	12.21	6.4	
	H	4.19	3.87	2520	2.22	-	-	
	I	4.31	3.87	2064	2.18	13.04	6.8	
	J	4.19	3.87	1800	1.97	12.84	6.7	
	K	Broken in half and used for water immersion test						Broken here
	L	4.31	3.87	1984	2.14	10.81	5.6	
	M	4.19	3.87	2259	2.14	-	-	
	N	4.31	3.87	1872	2.07	7.77	3.9	
	O	5.44	3.87	1402	2.12	6.28	3.0	18 mr/hr
3	All	2.50	2.83	1280	2.09	-	-	20 mr/hr
		inside 9½" lost						*

*two pieces of structural steel from this section read 17 & 22 mr/hr

Hole 3 - West face, opposite charging hole No. 2366

Core	Sect.	Length	Diam.	Crushing Strength #	Sp. G.	%H_2O (Wt.) Cement	Total	Temp °F On (Pile)	Off
1	A	6.38	3.88	1235	2.24	16.59	2.6	78.5	78.0
	B	5.94	3.88	1435	2.14	16.69	2.7	78.5	78.0
2	This section was so badly broken & scattered that no attempt was made to identify pieces								
3	A	6.50	3.88	NG	2.38	12.65	1.8	96.0	85.0
	B	5.69	3.88	1620	2.22	8.19	1.1	167.0	85.0
Outside Pad	All	6.500	3.81	2120	2.13	9.07	1.3		

Corrected for L/D variation by ASTM C42-31

[redacted]

[redacted]

Composition of X-Shield

Haydite-Barytes Section, Hole 1

% by Weight Analyzed	% by Weight Calculated	Element	"Molarity": moles/liter or mg-moles cc Analyzed	"Molarity": moles/liter or mg-moles cc Calculated
1.7[2]	0.34	Fe	0.67[2]	0.154
0.91[4]	1.1	H	20.	28.
31.	27.	Ba	5.1	4.6
-	0.24	Mg	-	0.25
7.0	12.0	Ca	3.8	7.6
8.1	9.3	Si	6.3	7.3
7.8	6.5	S	5.3	5.0
39. (diff)	40.	O	54. (diff)	63.

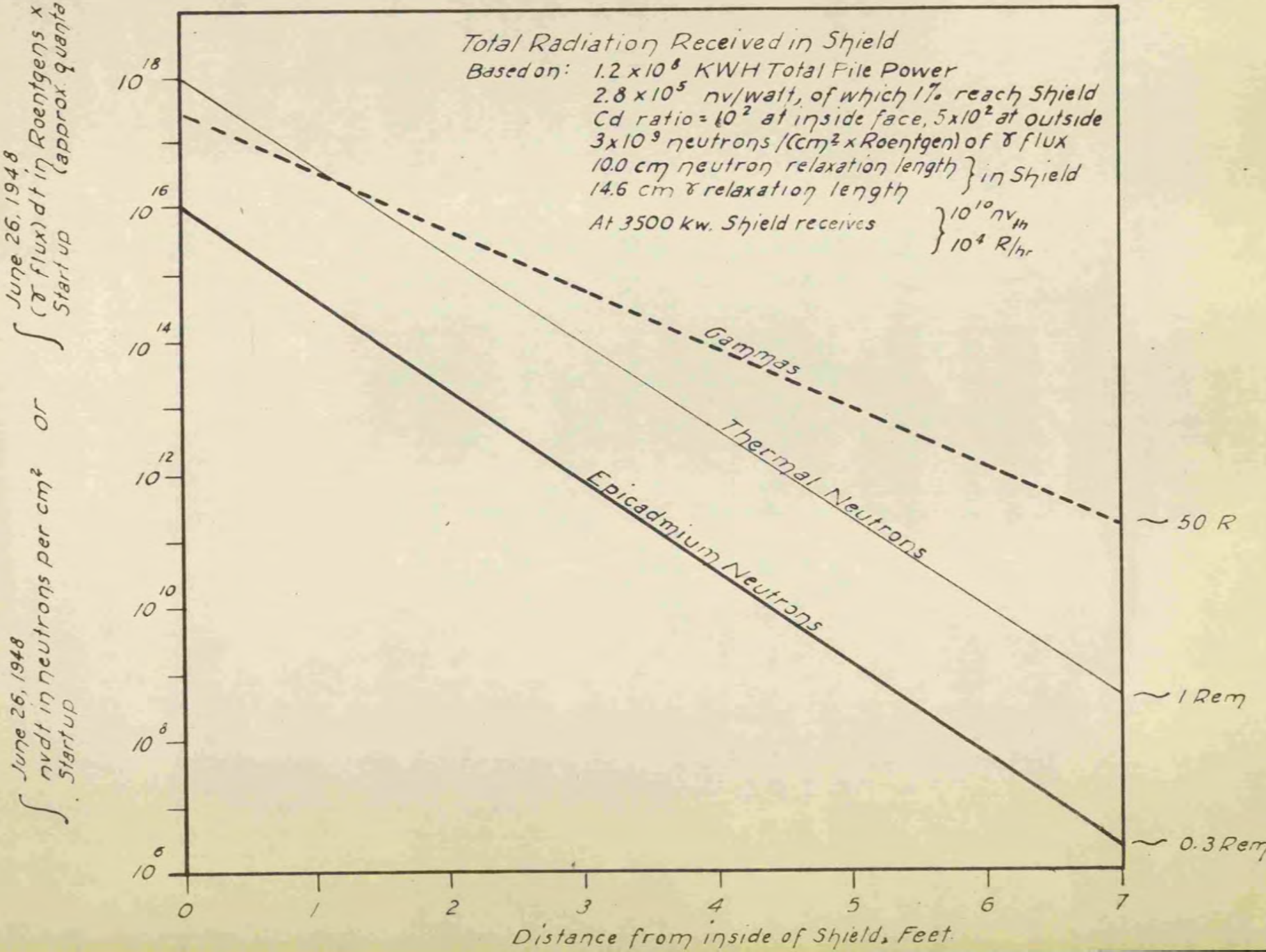
1. Two large samples were crushed & ballmilled, analyzed separately and averaged.

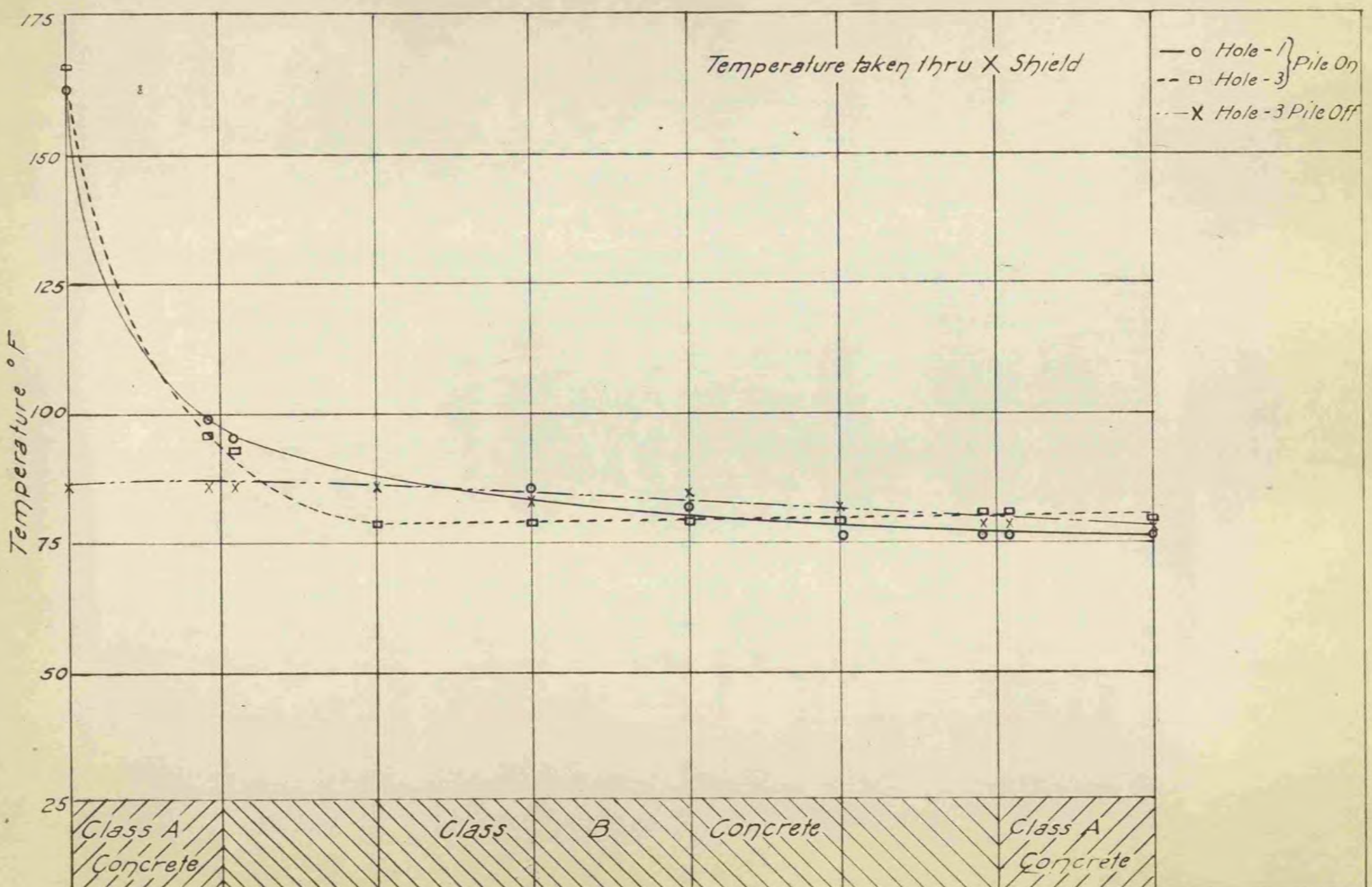
2. Probably some Fe contamination from balls.

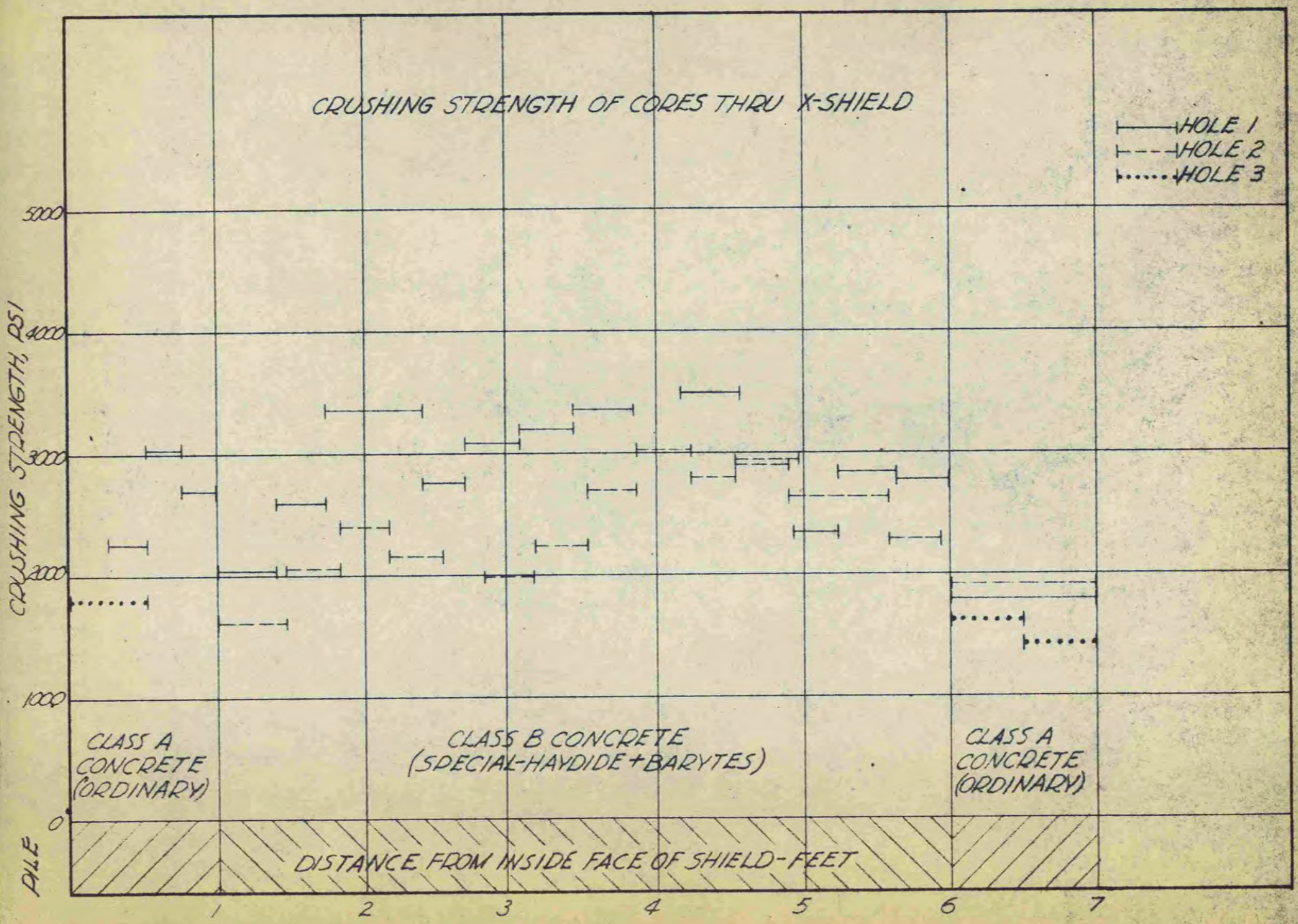
3. From Report M-4191, T. Rockwell (12-23-47) based on Dupont Specs. (Ltrs: Kirst 5/11/43 & Daniels 6/1/43): 10% bound water, total density 2.5, given ratio of barytes, haydite, and cement, and assumed analyses for these.

4. Corresponds to 8.19% H_2O

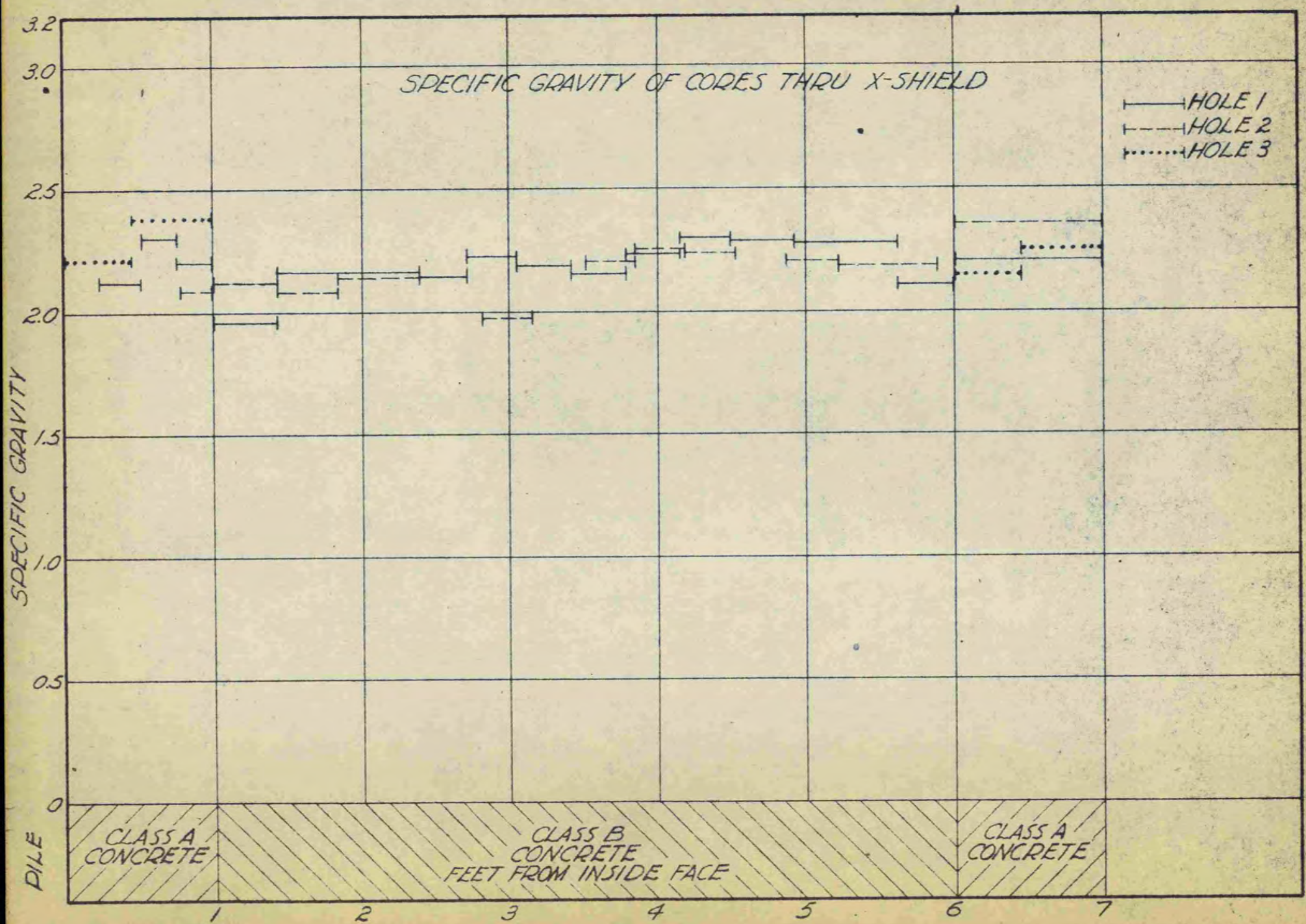
[redacted]


Total Radiation Received in Shield
Based on: 1.2 x 10^8 KWH Total Pile Power
2.8 x 10^5 nv/watt, of which 1% reach Shield
Cd ratio = 10^2 at inside face, 5x10^2 at outside
3x10^9 neutrons /(cm^2 x Roentgen) of γ flux
10.0 cm neutron relaxation length
14.6 cm γ relaxation length
} in Shield
At 3500 kw. Shield receives
10^10 nv_th
10^4 R/hr
Gammas
Thermal Neutrons
Epicadmium Neutrons
~ 50 R
~ 1 Rem
~ 0.3 Rem
∫ June 26, 1948 (γ flux) dt in Roentgens x 10^9 Start up (approx. quanta/cm^2)
or
∫ June 26, 1948 nvdt in neutrons per cm^2 Start up
10^18
10^16
10^14
10^12
10^10
10^8
10^6
0
1
2
3
4
5
6
7
Distance from inside of Shield, Feet


Temperature taken thru X Shield
Hole - 1
Hole - 3
Pile On
Hole - 3 Pile Off
Temperature °F
175
150
125
100
75
50
25
0
1
2
3
4
5
6
T - Feet from inside Pile Fac
Class A Concrete
Class B Concrete
Class A Concrete

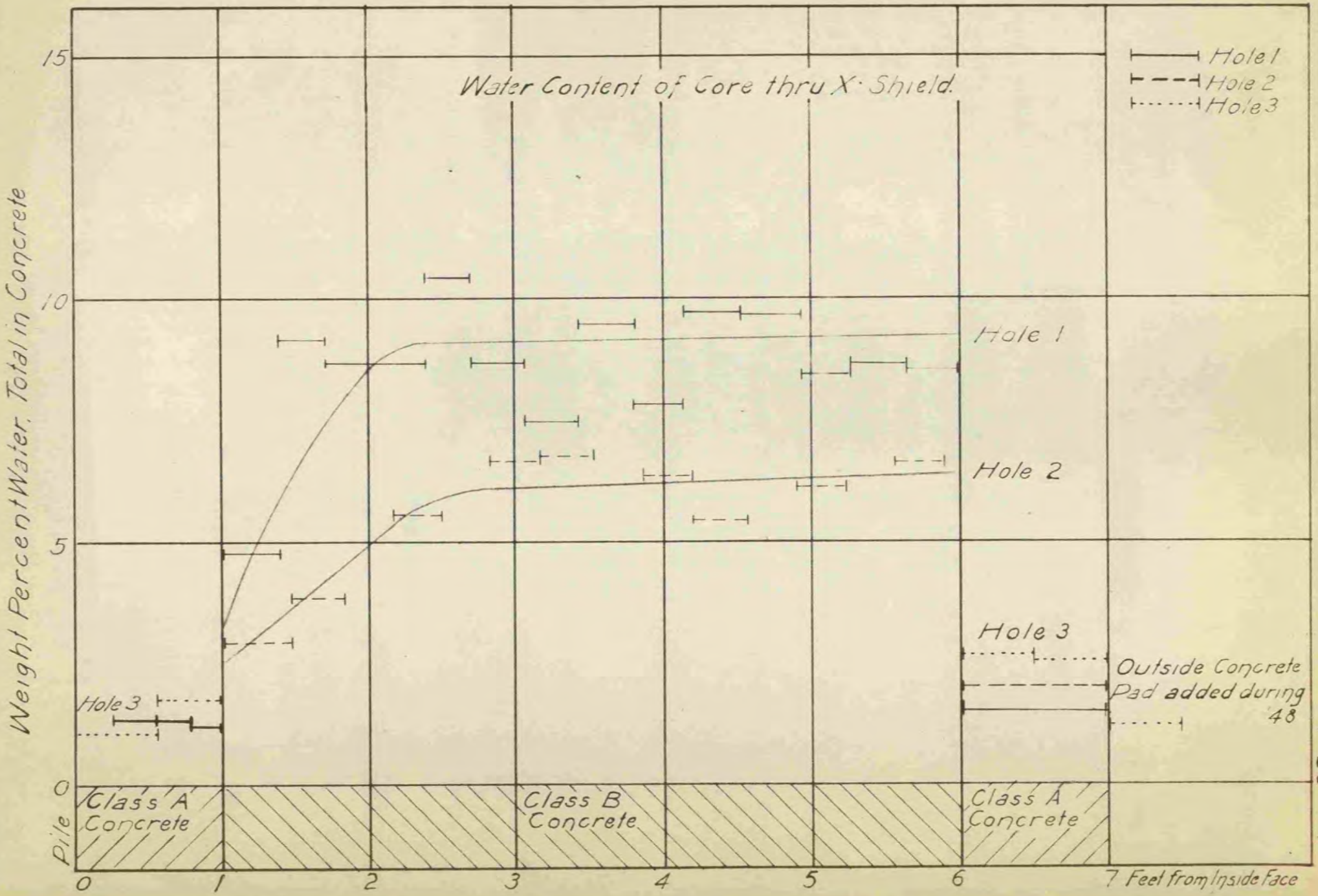

CRUSHING STRENGTH OF CORES THRU X-SHIELD
HOLE 1
HOLE 2
HOLE 3
CRUSHING STRENGTH, PSI
5000
4000
3000
2000
1000
0
PILE
CLASS A CONCRETE (ORDINARY)
CLASS B CONCRETE (SPECIAL-HAYDIDE + BARYTES)
CLASS A CONCRETE (ORDINARY)
DISTANCE FROM INSIDE FACE OF SHIELD-FEET
1
2
3
4
5
6
7

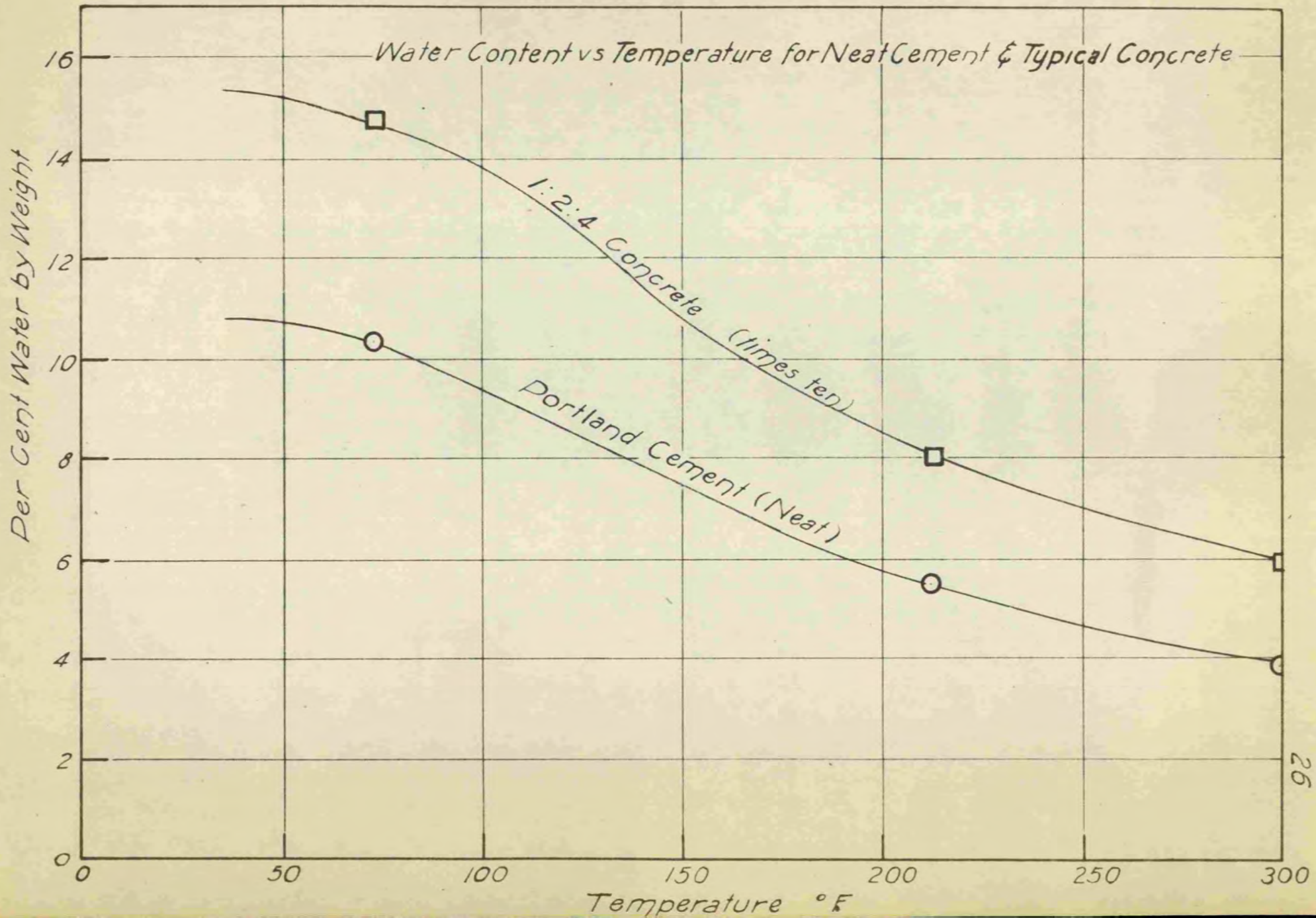
6374



6373

[redacted]


Water Content of Core thru X-Shield.
Hole 1
Hole 2
Hole 3
Weight Percent Water, Total in Concrete
15
10
5
0
Hole 1
Hole 2
Hole 3
Hole 3
Outside Concrete Pad added during '48
Pile
Class A Concrete
Class B Concrete
Class A Concrete
0
1
2
3
4
5
6
7 Feet from Inside Face


Water Content vs Temperature for Neat Cement & Typical Concrete
1:2:4 Concrete (times ten)
Portland Cement (Neat)
Per Cent Water by Weight
Temperature °F
0
2
4
6
8
10
12
14
16
0
50
100
150
200
250
300

ACKNOWLEDGMENTS

The cooperation and assistance of many persons is gratefully acknowledged. As noted, the Engineering Department handled the entire job of drilling the cores. The Operations Division suffered considerable disruption of facilities and schedules but continued to cooperate and supply information cheerfully for many hours at a time.

V. L. DiRito and J. B. Goodman cut and capped the cores and ran the compression tests and specific gravities. The temperatures were measured by DiRito and J. D. Averbach, on loan from NEPA. David Lavalle and P. Z. Westerdahl ran all of the analytical samples. Health Physics personnel were helpful with suggestions and measurements during the entire operation.

T. Rockwell

APPROVED:

F. Kerze

[redacted]

APPENDIX

INTER-COMPANY CORRESPONDENCE

Carbide and Carbon Chemicals Corp.

P.O. Box P
Oak Ridge, Tenn.

To J.C. Stewart

Date April 19, 1948

Subject Drilling Test Core Holes Through Pile Shield

Copy M.D. Peterson
Stuart McLain
J. A. Kyger
T. Rockwell

As per our phone conversation of today, we would like to get a group of core holes bored through the pile shield. This is for the purpose of determining the strength of the inside layers of concrete, and probably three to six holes, 3 inch diameter will be required. We have tentatively planned to cut two through the west face and two on top, but this will be subject to change. The holes should be stepped so that the outside third will be approximately 5 inch, the center third 4 inch diameter and the inside 3 inch diameter. The feasibility of this has been discussed in some detail with Mr. D. G. Hill of Y-12 (formerly TVA), and with Messrs. Bergman and Harlow of the Joy Manufacturing Company. The latter were willing to take the job but now find that men and equipment are not available.

Anything you can do for us along these lines will be greatly appreciated. Mr. Hill feels that the job probably could be done by TVA, but if you can have the job done by our men, that will, of course, be more satisfactory.

Theodore Rockwell

TR/reb

[redacted]

[redacted]

CODE NO. D50P-Z-40

PROJECT NO. CR-17

DATE May 27, 1948

TEST CORES FROM PILE BUILDING

I JUSTIFICATION

In order to carry out the programs outlined in Classified Document 48-4-333 of Oak Ridge National Laboratory, it is necessary to accumulate certain data on the concrete shielding of the Pile.

Data will be obtained from concrete core samples removed from the pile. Tests will be made on these samples to determine the mechanical properties of the concrete now shielding the Pile. It is known that the properties of this concrete has changed due to radiation, but the extent of this change is unknown.

II DESCRIPTION

It is proposed to drill two (2) stepped holes horizontally to obtain the necessary core samples. These holes will have a stepped diameter of three (3), four (4), and five (5) inches.

Diamond tipped core drills are commercially available in the 3-inch size, but the core drills and barrels for the 4 and 5 inch sizes must be designed and fabricated.

Special rigging and bracing must be used to drill these holes horizontally. All water for drilling, dust and chips, must be collected due to the radiation hazard.

III ESTIMATED COST

The total estimated cost of this work is $5,583.00.

IV REMARKS

This work is classified as Research and Development.

All work on this project is to be performed by Oak Ridge National Laboratory forces.

All materials for the completion of this project are available or will be purchased.

Under the provisions of Article VI-A of the Prime Contract W-7405-eng-26, the U.S. Government will supply the funds for all expenditures on this project.

Approved: C.H. Marsh, J.C. Stewart, S. McLain, C.N. Rucker, L. B. Emlet

[redacted]

[redacted]

May 26, 1948

Mr. F. W. Pardee
DuPont Design Division
E.I. DuPont de nemours and Company, Inc.
Wilmington, Delaware

Dear Mr. Pardee:

On April 6, 1948, I wrote you requesting information on the different aggregates of concrete which were used in the Oak Ridge National Laboratory pile shielding. As I mentioned at that time, we are interested in comparing the results of the original structural strength tests with the results from some core drillings which we are now taking. It is my understanding that the Delaware Casting Laboratories made a series of structural tests on the special aggregate composed of Haydite and Barytes. The results of these tests are not available here but Mr. J. P. Sinclair informed me that the DuPont Company should have them.

We would appreciate any help you can give us in this matter.

Very truly yours,

Original Signed by
L. B. Emlet
General Superintendent
Operations Division

LBE:wp

[redacted]