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Date March 16, 1943

Subject Technical Division Report for
Week Ending March 13, 1943

J. B. Miles, Jr.

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By Technical Division

To [redacted]

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March 16, 1943

M E M O R A N D U M

REPORT FOR WEEK ENDING MARCH 13, 1943

FROM: TECHNICAL DIVISION

W. E. Kirst

Manual. Material is being accumulated at a fairly satisfactory rate and all that available has been checked with interested parties and retyped into two complete copies. The lists of questions are now being edited.

Use of Barytes in Concrete. Arrangements have been made for samples of this material in the sizes in which crushed stone and sand are used in concrete. When received, tests will be made to determine crushing strength, this being one of the chief criteria. Estimates of the total yardage of shielding concrete at X and W are being obtained as a measure of the barytes required.

Petroleum Asphalts. The use of these is being considered as an ingredient in a composite shield. Several samples have been obtained and more are expected. Representative ones will be submitted to Chicago shortly for evaluation.

Granular Iron. This is being considered for the formation of a matrix by the use of pressure and temperature, which matrix would be impregnated with petroleum asphalt. Samples of several grades of ground cast iron have been obtained from Master Builders Co. for evaluation by Moraine Products Co. at Dayton.

K. G. Jones

A trip was made to Moraine Products Division of General Motors at Dayton, Ohio, on Monday, March 8. This firm specializes in pro-

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ducing small articles by powder metallurgy technique. The density of these parts may be as low as 50% that of iron, and it was thought that iron "bricks" made in this way and then impregnated with an organic material high in hydrogen might serve as a radiation shield for the pile.

Since their source of iron powder was extremely unreliable, it was planned to use turnings and borings rather than powder. Mr. Koehring has only experimental data on this procedure, however, and considerable research would have to be carried out before a decision was made.

Further investigation at Wilmington revealed that the Master Builders Co. at Cleveland produce iron powder in sufficient quantity to meet our requirements. Samples of this material have been received and will be shipped to Dayton for Mr. Koehring's experiments.

The procurement of large presses and furnaces for sintering would also be somewhat of a problem if the above method is used.

During the week a memorandum was written for G. E. Graves comprising information received during the visit to the Aluminum Co. Research Laboratories and other pertinent data regarding the tubing and coating for Site A. At present, indications are that the tube will be made of aluminum 2 S and the coating will be a jacket of the same material or a suitable aluminum alloy. It is felt that a test program for this problem should be started as soon as sufficient data are available.

Conferences were held during the week with J. A. Grady and T. W. Hauff regarding operating conditions in Site A piles.

At the request of C. E. Daniels of the Construction Division, a meeting was attended where Mr. Daniels reviewed the Site A extrusion, machining and coating program for J. A. Burns and other interested members of the Engineering Department.

Wood Worthington

A set of arrangement drawings of the Site W pile were taken to Chicago for review. The results of the review were discussed with Burns, Wherrett, and Bunker of the Design Division and will be reported in detail elsewhere.

The effect of tolerances on the centering of the metal in the aluminum tubes of the Site W pile has been further studied on the basis of drawings supplied with Lockhart's letter of March 12 to Greenewalt. Centering can be improved by making the ribs of unequal length.

T. B. Drew

With W. K. Woods, studies of the pressure losses and heat transfer conditions for nonboiling water-cooling at a 250,000 kw. load and a 8-3/8 spacing were continued. For a 35 mm. rod within a 39.4 mm. tube and a water rate of 1.93 lb./sec. (13.3 ft./sec.) entering at 20°C. the following results are found:

Exit temperature - 100°C. for central tube
Pressure through tube proper - 110 lb./sq.in.
Over-all pressure drop, header to exit - 130 lb./sq.in.
Variation in header pressure across face of pile for design of Dwg. 3111-025 - 2 to 5 lb./sq.in.

The currently discussed tentative tolerances on the rod and its enclosing tube are equivalent to a + 23% uncertainty in the pressure through the tube proper. Consequently to ensure the above stated flow the over-all pressure drop must be taken as 155 lb./sec. This corresponds to a flow of 14.7 ft./sec. in a nominal tube. For a fixed pressure drop the same variations in dimensions will result in only about 10% variation in mean flow which, because of the pressure drop in the length of tube in the downstream shield, will not be sufficient variation to admit of boiling within pile proper.

To avoid overheating it is most important so to design the ribbing of the enclosing tube that the rod is kept approximately centered. Otherwise boiling will almost surely occur in the confined space beneath the rod. This question is still under discussion with Worthington and Lockhart.

To ensure absence of boiling, to help distribute the water among the tubes, and to prevent evolution of possible dissolved gases, it is recommended that a back pressure of 75 to 100 lb./sec. be maintained by placing an orifice or nozzle at the exit end of each tube. The diameter of such a nozzle is about 1/5 in.

Substantial reduction of the mean graphite temperature by circulation of helium from face to face of the pile through interstices at the corners of the graphite blocks has been calculated to be practicable. The necessary pressure drop is 9 inches of water. About 50 H.P. (theoretical) is needed for pumping. Discussion with Wheeler makes it doubtful if this type of cooling is desirable, because it is accomplished by lowering the temperature of the graphite only at points remote from the rods and not in their vicinity. It appears that what is advantageous is to steepen the temperature gradient in the graphite. From this point of view, the use of 4-inch blocks with ribbed surfaces is most desirable.

Miscellaneous heat flow calculations chiefly concerned with heat liberation in the shield have been made.

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D. F. Babcock

Calculations on the controls for W indicate that the maximum change in K that can be obtained with one rod will be about 0.0015 as compared with twice this figure for X. Thus 8-10 safety rods will be required to take care of a 1% change in K that might be expected should the water suddenly boil out of the pile. The questions raised in a conference on March 5 on the subject of controls for Site X were answered in a memorandum to Graves dated March 10.

During the next period consideration of the controls for W will continue. Also calculations will be made to determine the probable temperatures that will be reached by metal discharged from W and stored under various conditions.

C. W. J. Wende

Water requirements for the storage basin at Site X have been estimated to be about 500 gallons per minute on the assumption of 10% failure of coatings. This flow of water would permit a man either to swim in the effluent water for eight hours a day or to drink a single gallon of it (letter to M. D. Whitaker, 3/15/43). Revised designs for cell covers in the separation plant, showing 3/4" openings at the joints instead of the previous 3/16" gaps, appear to be satisfactory from a protection standpoint (letter to R. P. Genereaux, in press).

Items receiving current attention include (1) shielding against scattered radiation in the Site W separation plant; (2) shielding of air ducts and fan house at Site X; (3) shielding at various points on the separation line at Site X.

John A. Wheeler

Limitations on the amount of 94 safe against a chain reaction have been discussed with Notman, Wyatt, and Frankenberry in two conferences, and a memorandum has been issued listing the factors which determine whether or not a given geometrical arrangement is safe.

Radioactive heat generated by the fission products produced by operation of the pile at a given rate for a given length of time followed by a given decay period can now be determined quickly by means of a chart which has been prepared and several photostatic copies of which have been issued to interested persons.

A general discussion of the factors determining the ability of various forms of matter to shield against

1. Gamma Rays
2. Slow Neutrons
3. Neutrons of Intermediate Energy
4. Fast Neutrons

has been prepared for Kirst's manual.

A design of the water-cooled plant in which there is a gap of the order of 1/2" between the aluminum tube and the surrounding graphite has certain advantages in improving the multiplication factor and in simplifying the removal of heat from the graphite by helium flow, but has the disadvantage of not giving the aluminum adequate backing, as brought out in a discussion of this question with Worthington, Drew, and Kelly. In the same discussion it was pointed out that there is an advantage in having the graphite far from the uranium hot, while the graphite close to the uranium is cold. The neutrons then travel rapidly and are absorbed with the decreased probability in the great bulk of the carbon. They slow up when they approach the uranium and are absorbed there with increased probability. The possibility of a convenient means to obtain this differential heat effect was discussed and one tentative solution advanced by the group.

Present knowledge of the radiations from 93-239 are reviewed in a memorandum to Greenewalt.

Mrs. Monk has located references and prepared curves for that section of the manual on principles which deals with beta rays.

It is planned to spend Thursday, Friday, and Saturday of next week in Chicago reviewing the present status of shielding and other questions of nuclear physics.

L. Squires

Design Division. Two conferences were held with members of the Design and Operating Divisions on problems relating to Site X separation plant. The equipment arrangement in Cell 5 and Room L was reviewed based on recent recommendations of the Metallurgical Laboratory. It was decided to provide an additional cell to take care of future alternate separation processes to be installed after the plant is in operation. In this way the continuity of operation can be maintained while the equipment for the alternate process is being installed.

Metallurgical Laboratory. The Metallurgical Laboratory was visited on March 18 and 19 to review recent progress on the phosphate process and the work on metal solution. These two topics are covered in a separate memorandum.

It is proposed to visit the Metallurgical Laboratory next week to obtain information on the specifications required for the final product of the W separation plant.

M. F. Aeken

At Chicago during the past week the following developments of general interest were observed:

1. Semiworks development on the wet fluoride extraction process was at a standstill during the week because of the necessity for immediate recovery of the 94 from the St. Louis cyclotron material. All of the 94 in the greater part of the St. Louis material was recovered in the semiworks equipment by coprecipitation of the 94 with bismuth phosphate. The precipitate thus obtained was sent to the laboratory for extraction of the 94.

2. Considerably greater interest is now being shown in the bismuth phosphate process due to the successful precipitation of the 94 with bismuth phosphate in the semiworks equipment. Furthermore Sutton's group have successfully extracted 94 on a laboratory scale using the bismuth phosphate technique throughout.

3. No important new developments have occurred in so far as adsorption separation processes are concerned but an extensive experimental program has been formulated and equipment is now being set up for further evaluation of the various proposed adsorption methods.

4. Much additional data concerning the problem of metal solution has been obtained by Sutton's group and small-scale work along this line is now virtually completed.

Considerable time was spent with Dr. Coryell in connection with the organization of data concerning the radioactive decay of the various fission products. Peery's data on the radiation from the various precipitates and solutions obtained in the wet fluoride separation process are now complete through a 32-day decay period. This information will be included in the Site X manual.

J. A. Collins

Monday and Tuesday were spent in Wilmington and Wednesday through Saturday at the University of Chicago. While in Wilmington, a meeting was attended in which problems associated with the wet fluorine separation processes were discussed. One point which was brought out was that the fume disposal stack in the 200 Area would handle fumes at temperatures ranging from 350 to 500°F. This new service condition eliminates the possibility of using Carbo-Vitrobond which was originally recommended for this service. The cements now being

considered are Vitrex manufactured by Atlas Mineral Products and Penchlor manufactured by Pennsylvania Salt Co. Three acid-resistant bricks are being tested for this service: Duro, Wylam, and Hanley.

Dr. M. H. Brown at the Experimental Station was contacted in relation to the testing program he is carrying on evaluating construction materials. They now have their gas generator in operation and have completed an initial short period evaluation of Monel, Inconel, nickel, copper, aluminum, 18-8 stainless steel, and SAE 1020 steel in F_2 and HF at 500, 550, and 600°C. These data are being checked on a second run and will be available shortly. A series of tests are being started to evaluate the resistance of various protective paints for concrete and structural steel to the waste liquors from the separation plant. Materials being tested include Bitumastic #50, Elaterite, Ucilon, Du Pont A & A, Dulux metal-protective finish, Alkacite A, and Tygon. Additional tests are being made to evaluate the resistance of 25-12-8-Cb, both wrought and cast, to waste solutions (1% HF - 3% HNO_3) at 50 and 80°C. and also to strong HF in HNO_3 mixtures.

At Chicago, W. Q. Smith and Dr. Garrison were contacted in reference to the tests Garrison is carrying on to evaluate the effect of radiations on electrical insulations and gasket materials. Initial tests have been completed on three samples of Koroseal and a limited amount of data is available on PTFE. These tests show that the amber Koroseal type 117 is superior to the black type 116 and additional tests which more closely simulate conditions to be expected in the plant are being made on the former. The next materials to be tested are (1) KL- and (2) glass insulation for motors.

Cannon of Burton's group has completed initial tests evaluating the effect of radiation and the corrosion resistance of 25-12-8-Cb to solutions similar to those which will be encountered in dissolving the metal for product separation. These tests show little or no effect and are being repeated.

In a meeting with G. T. Seaborg and members of his group, and J. B. Sutton, J. H. Balthis, F. Vincent, and W. Q. Smith, the bismuth phosphate separation process was discussed. At this time it was decided to evaluate the resistance of metals and alloys to the following solutions:

1. 6 n-HCl saturated with $BiPO_4$
2. 2 n-HCl saturated with $BiPO_4$
3. 6 n-HCl saturated with $BiPO_4$ and .05 molar in $K_2Cr_2O_7$
4. 2 n-HCl saturated with $BiPO_4$ and .05 molar in $K_2Cr_2O_7$

Tests will be made at 50 and 80°C.

DuPont-10,118

In a later discussion with J. B. Sutton, it was learned that they are using a small amount of mercury to accelerate the removal of aluminum from uranium. It was decided to carry out the following tests to evaluate the effect of mercury (present in small amounts) in nitric acid on the corrosion resistance of 25-12-3-Cb. Tests are also to be made to evaluate the resistance of 25-12-3-Cb to the various solutions which are used in the adsorption process. This will include evaluations in

1. 0.25 molar H_2SO_4
2. 0.2 molar H_3PO_4 and 2.0 molar HNO_3
3. 0.1 molar H_3PO_4 and 2.0 molar HNO_3

Additional samples were transmitted to W. A. Smith to evaluate the resistance of various protective materials and coatings for structural steel and concrete to radiations.

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