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File WWR [redacted]

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PROJECT

[redacted]

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J.B.Miles

Date March 29, 1943

Subject Weekly Report for Period Ending 3/27/43

By Technical Division

To

Before passing this document, sign and date below

Name	Date	Name	Date

INV. 9-27

Classification Cancelled and Changed to

DECLASSIFIED

By Authority of DOC MAY 1973

SPECIAL RE-REVIEW FINAL DETERMINATION DECLASSIFICATION CONFIRMED BY JP Derouin DATE 2-3-82

JE Savely 3-20-03

JA Ahrens 4/21/03

APPROVED FOR PUBLIC RELEASE

DJ Brown 4-26-02

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March 29, 1943

WEEKLY PROGRESS REPORT - TECHNICAL
FOR PERIOD ENDING MARCH 27, 1943

W. E. Kirst

Manual

A considerable amount of additional material was added during the week. The work has progressed to a point where several days could be spent profitably at Chicago next week. During this visit, the sections covering Health, Shielding, Pile Theory and Control, and Fission Products will be checked with the proper parties for accuracy and completeness. An attempt will also be made to obtain answers to many of the questions which have been accumulated. A first-hand picture will also be obtained of the pile and the status of the separation study.

Barytes in Shielding Concrete

It is now proposed to construct the shield of 1 ft. thick walls treated on the inside surfaces with bitumin or the equivalent and fill the center portion (5' thick) with the following mixture:

658#	cement/cu. yd.	15.0%
693#	Haydite (sand size)	15.8%
2560#	Barytes (1 ½" ¼")	58.5%
466#	Water (56 gals.)	10.7%
4377#		100.0%

wt./cu.ft. 162" est. vs 150 normal concrete.

The total amount of barytes is estimated at 1660 short tons, costing $17 delivered or $28,000. The net added cost deducting normal aggregate at $3/ton will be $23,000. The barytes will have the following analysis:

$BaSO_4$	84-90%
Fe_2O_3	5-15%
MnO_2	0-2%
SiO_2	1-5%

[redacted]

W. R. Kirst (Cont'd.)

A sample (2 cu. ft. or 280#) will be at the Delaware Testing Laboratory, Dover, Delaware, Monday, March 29. This will be used to make cylinders for standard crushing tests and also samples for evaporation loss. These latter will be sent to the Experimental Station where they will be held at room temperature 50° and 100° C. and weighed daily for loss in weight. These will be compared for moisture loss with similar samples of normal concrete made at the same time.

Water Tubes in X Pile

The Engineering Department is preparing sketches for comments. The installation of these tubes brings up several design problems, the most serious of which involves changes to the proposed facilities for scanning the exit tubes to determine cooling failures.

K. C. Jones

Work on hot dip and electroplated coatings was reviewed at Grasselli Laboratories in Cleveland on Monday, March 22. Hot dip coatings of zinc containing 6% and 15% aluminum have been fairly successful on small samples when tested at 200°C. in air, but larger specimens, approximating actual size, have failed in a short time.

The only electroplate coating left that shows any promise consists of flash coatings of nickel and copper overlaid with a heavy coat of lead. These samples, however, have not yet been tested over a long enough period of time to make a definite conclusion possible.

Microscopic examination has shown that inclusions on the surface of the base metal (presumably oxides) cause discontinuities in both types of coating. Pickling treatments to remove these inclusions have not been successful and we do not believe that a sound coating can be obtained unless they are removed. The microscope also revealed that in many areas the electroplated coatings were not in contact with the base metal. Thus, a pinhole failure could allow penetration over a considerable portion of the specimen, causing rapid failure.

Since time is short and the coating program obviously does not look too promising, an alternative method was sought. Aluminum "cans" or aluminum tubing drawn over metal slugs such as contemplated for Site W offer a good possibility.

At a meeting in Pittsburgh on March 23 with Aluminum Company representatives, the problem of jacketing was discussed in detail. The Aluminum Co. is to start a development program immediately to decide the best method of jacketing and end closure. This program will be closely followed by us and Chicago will supply them with a number of actual metal samples. When these are successfully jacketed, they will be returned to Chicago for test.

DuH-10,161

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K. G. Jones (Cont'd.)

Ribbed tubing for Site W was also discussed at this meeting. Some doubt was expressed as to the possibility of manufacturing a tube having the tolerances specified, but experiments will be started to determine the limitations involved. Aluminum 28 ST or harder will be specified for the present.

The results of the Cleveland and Pittsburgh meetings were written up in detail and the information obtained was also discussed at several conferences with interested members of TSX Division.

Hood Worthington

During the past week the Westinghouse flowmeter for measuring the flow of water to individual tubes in the pile has been revieved with the representatives of the Westinghouse Company and with members of the Operating Division. It was decided not to proceed with the manufacture of similar instruments until a proposal had been received from Minneapolis Honeywell or other similar instrument company.

The presence of excessive quantities of chloride in recent analyses of Columbia River water led to a review of methods of protecting the aluminum in the pile from chloride corrosion. The question of methods of sampling and of check analyses was taken up with the Operating Division and the Engineering Department. With W. K. Woods a preliminary report on the boiling disease was completed. The system for circulating helium in the pile for detecting the presence of leaks was revieved with the Design Division who proposed that the level of impurities be allowed to rise to perhaps 10% and kept at this level by purging.

T. B. Drew

With W. K. Woods the pressure requirements for forcing water through the tubes at W have been re-estimated in the light of current ideas on probable tolerances. The tolerances assumed were: on O.D. of tube, ± .0025"; on wall thickness, ± .003"; on slug, ± .002". It was assumed that the tubes would be manifolded on the discharge end. On account of the unpredictable behavior of the flow through such a header system when partial vaporization occurs, it has seemed advisable to choose a design exit temperature low enough so that flashing in the header would be impossible. The calculations are not yet quite complete, but the following figures are approximately correct for 250,000 KW and 1500 tubes:

Upstream Header Pressure	350 lbs./sq.in.
Max. Operating Pressure Inside Cold End of Tube	200 lbs./sq.in.
Flow in Worst Tube	2.4 lbs./sec.
Exit Temp. from Worst Tube	94°C. for inlet at 20°C.
Flow in Mean Tube	2.5 lbs./sec.

[redacted]

T. B. Drew (Cont'd.)

Constrictions in the form of nozzles or small tubes must be inserted between the upstream header and the tubes in order to stabilize the flow and prevent the development of boiling. Without the restrictions, stable operation can be secured only by operating with a pressure of 300 lbs./sq. in. inside the cold ends of the tubes. For a factor of safety of 4, the safe operating pressure in aluminum tubing of the gauge considered is about 200 lbs. If the constriction is a nozzle, its diameter should be 0.22" and the jet velocity will be 150 ft./sec.

The effect on the graphite temperature of malcentering of the tubes in the holes through the graphite blocks was computed and found to be negligible. Such effect as this is beneficial in that the temperature of the graphite is lowered. The thermal resistance of a uniformly distributed insulation is, in general, greater than that of the same quantity of insulation non uniformly distributed.

Approximate calculations have indicated that there is unlikely to be a high enough temperature to cause alloying of U and Al at the ends of adjacent aluminum coated slugs, if the coating at the sides is sufficiently tight for the system to be operable. These calculations are being refined.

D. F. Babcock

The heat produced in W control rods, if made of boron steel, will be so great that cooling must be provided. There is an outside possibility that the heat produced in a cadmium or cadmium-steel rod would be enough smaller that cooling could be dispensed with. This subject will be investigated further.

Requests by Kirst for data on the Site X manual have been filled. Also, a memorandum was written describing just which columns of metal would be discharged from a power pile after various periods of operation. This memorandum should issue March 29.

J. N. Wilson

During this period efforts were continued to complete the instrumentation list for Site X. Assistance was given to S. J. Bugbee in completing his memorandum to M. D. Whitaker of March 23, 1943 on the Instrumentation for Site X Pile Area. The instrumentation needed for the chemical separation building is still undefined.

The latest proposal for the radiation meter to be placed on the crane at the Site W separation plant was reviewed with D. O. Notman and V. F. Hanson. The conclusions reached were written up as a letter to H. T. Daniels on March 26, 1943.

Some problems which might be improved by calling in outside help were reviewed in a memorandum to C. H. Greenewalt on March 25, 1943.

Two memoranda were written to W. E. Kirst on the general description of Ionization Chambers (3/26/43) and Beta Ray Counters (3/27/43).

C. W. J. Wende

[redacted]

Detailed calculations on the shielding of the separation plant at Site W have been revised and will be reported shortly. It has been found that the scattering of radiation of 1 Mev or less may present a considerably greater hazard than the scattering of 2 Mev radiation. The spectral distribution of the source must therefore be considered in the design of such items as labyrinths or pipes through walls.

Calculations on metal handling buckets and air ducts (letters to J. P. Sinclair, 3/25/43); and on the by-product storage tanks at Site X (letter to W. C. Kay, 3/27/43) have been reported.

J. A. Wheeler for Week Ending March 20, 1943

Safe Distance for ½ Ton Batch Radioactive Sodium in Cooling Water Shield of W Pile

A half ton batch of metal freshly dumped from the pile at Site W and accidently spread out so every piece is visible a half mile away will not give an observer at that point as much as a tolerance dose of gamma radiation, according to the result of calculations made at the request of D. O. Notman.

Radioactive sodium formed by the reaction

$$n^1 + Al^{27} \longrightarrow (Al^{28}) \longrightarrow He^4 + Na^{24}$$

will be ejected from the aluminum liners into the cooling water by fast neutrons during the operation of the pile at W. Its effect has to be taken into account along with the activity produced in the water itself.

Calculations on the energy to be dissipated in the shield of the pile at Site W and its distribution among gamma rays and fast and slow neutrons were carried out in collaboration with T. Drew and reviewed with E. P. Wigner and F. Friedman. If one hydrogen atom is liberated for every ion pair formed in rosin by a fast neutron, the gas evolution will be of the order of 0.3 cm^3 of hydrogen per cm^2 of shield per day in one type of shield at present under consideration. Burton is now carrying out an experiment to test whether the gas release per ion pair may not be much smaller than the very conservative figure assumed. This and other points in connection with the shielding problem will be reviewed in Chicago on Monday and Tuesday.

J. A. Wheeler for Week Ending March 27, 1943

Work on nuclear physics in progress at Chicago was reviewed on a trip there March 22 and 23.

The problem of controls was discussed with Murray. In conjunction with Teller, he has developed methods for determining:

Du 4-10, 16

a. the effectiveness of a control rod as a function of its degree of insertion;

b. the distribution of heat production along the length of the control rod; and

c. the effect of the control rod upon the rate of production of heat in portions of the pile near the control rod.

The methods and some typical results are now available for use here.

Mulliken arranged a conference on the subject of manuals now in process of preparation. An agreement was made for the interchange of figures and charts between the various manuals in preparation in accordance with the plan for making each chart as generally useful as possible.

In a discussion with Seaborg on the problem of setting specifications for the final product, it was brought out that there is no point in reducing the beta and gamma ray radioactivity of the associated fission products to a level very much lower than that corresponding to the natural gamma ray radioactivity due to element 94 itself. The fact that the latter activity is not yet measured, therefore, makes necessary some care in specifying the desired reduction in activity for the product.

A second physiological factor in determining the degree of purification to be required for the final product is the dosage due to neutrons generated by alpha particle impact on nuclei such as those of lithium, beryllium, and fluorine. The chloride would be much preferable to the fluoride from the point of view of neutron generation.

A third aspect of the specification problem is the possible danger of a chain reaction in the product. This possibility puts limitations on the amount of product which can be collected together at one time, except when the material is sufficiently diluted with water. Under this condition, safety against a chain reaction is guaranteed: addition of more water only makes the multiplication factor lower, quite in contrast to the case where the product is not in solution and where the addition of water or the approach of wood or other hydrogen containing material may bring the system into a chain reacting state.

The problem of reflection of gamma rays from walls has been further analyzed with the help of Mrs. Monk. The dosage due to diffuse reflection of 2 million volts gamma rays from an extended surface, relative to the dosage due to the incident beam is given in the following table for 3 different angles of incidence of the primary beam:

Angle of Incidence	Indirect Dosage / Direct Dosage
0° (perpendicular)	0.0078
45°	0.0133
84° (grazing)	0.0323

The given figures apply to a wall of low atomic number. In the case of a material like lead, the coefficient of reflection is increased by the mechanism of formation and annihilation of positrons.

The excess leakage of radiations from the water cooled pile due to cracks between the boron steel blocks was analysed in collaboration with Worthington. With 1/16" cracks between 1" boron steel slabs overlaid with another layer of 1" boron steel slabs, the cracks in the 2 layers being out of phase with each other, it was estimated that the leakage would be increased by the factor 1.5 over the normal value, except at the intersection of cracks in the 2 layers where the tiny channel would let through a radiation 1.7 times as great as that penetrating a solid 2" boron steel slab. The results are only approximate but indicate that a tolerance of 1/16" or less is adequate to maintain the designed level of protection..

L. Squires

The current status of the bismuth phosphate process was discussed with members of the Sites W and X Operating Division on 3/22-3/23. It was concluded that process as now visualized could be operated in the equipment being installed at X for the wet fluoride process if:

a. Cell #4 is used .

b. the volume of wash water reduced to about 10 times the centrifuge calculated volume; and

c. a "milking" precipitation used to reduce the total precipitate volume prior to solution and transfer to Cell #5.

There is reason to believe that all these conclusions can be met and therefore that the phosphate process can be considered for immediate use at X, if this is required.

The Metallurgical Laboratory was visited on March 24, 25, and 26 to attend a discussion with the Operating Division and the Chicago chemical engineering group on Site X facilities. The following points were covered:

1. Ionization meters. One ionization meter will be permanently installed in each cell to obtain the general intensity level therein and to indicate whether it is safe for a man to enter the cell for a detailed monitoring of intensity. One meter

will be permanently mounted on each operating gauge board in the control gallery and near the precipitator in Room D. Three portable meters for general area monitoring will be provided.

2. Waste Disposal. Present plans for these facilities were revieved and agreement reached with the exception of arrangement of the "dry wells" for checking tank leakage. A modified arrangement will be submitted to the Design Division.

3. Loading Mechanism for Dissolver. Proposed design seems satisfactory. It was suggested that a television transmitter be located so as to observe the actual loading of the dissolver.

4. Specifications for Process Chemicals. Specifications obtained from Purchasing were discussed and recommendations from the Chicago chemical groups obtained.

5. Cell #5 Arrangement. A detailed layout of the equipment in Cell #5 was made for one complete wet fluoride decontamination cycle (one oxidized and one reduced precipitation). Four equipment pieces are required, a precipitator, a centrifuge catch tank, a "skimming" tank (all 3' x 5' tanks) and a 26" centrifuge. As noted above this equipment can also be used for the phosphate process.

6. Sampling and Analysis. The results of the discussion on this subject are summarized by Greagor.

M. F. Acken

Much time was spent in preparing a revised material flow sheet for the metal solution and wet B extraction steps. The necessary data were also obtained at Chicago for the preparation of a similar detailed flow sheet for the wet F decontamination process.

The semi-works group at Chicago under Smith have confined their work during the past week to the wet B extraction and decontamination steps. Further work by Sutton'sgroup has made the $BiPO_4$ process look very attractive. The experimental program on this process will include the following:

1. Effect of a second oxidation - reduction cycle on the reduction of fission activity associated with the product.

2. Study of methods to effect a reduction in volume of solutions used. This is important from the standpoint of adapting the $BiPO_4$ process to the Site X equipment designed originally for the wet B process.

3. Control of particle size to effect faster filtration of the slurry obtained by precipitation from the reduced solution.

4. Investigation of decantation as an alternative to filtration or centrifuging.

5. Demonstration on a semi-works scale of the process steps following the initial $BiPO_4$ precipitation.

[redacted]

H. F. Ashen (Cont'd.)

Further work by Sutton's group on the Boyd adsorption process has revealed the necessity for developing a more satisfactory support than glass wool for the $Zr_3(PO_4)_4$ adsorbent. This development has established the $BiPO_4$ process as the chief candidate for immediate displacement of the wet B method. Adsorption methods still appear desirable, however, from a long range standpoint and experimental work will go forward as planned.

James A. Collins

The Metallurgical Laboratory was visited March 24 and 25 to contact the engineering and chemical groups in relation to the status of the testing program in which the resistance of construction materials to chemical corrosion and decomposition by radiant energy is being evaluated.

Chemical Tests

M. D. Peterson and W. W. Armstrong have continued their investigation of the solution of uranium in nitric acid. In their runs, samples of 18-8-S-Cb, 25-12-S-Cb and 25-20-S were inserted in the solution tank. These tests should be completed shortly and the corrosion data available.

Arrangements were completed with J. V. P. Torrey to supply M. E. Brown of the Technical Division of the Engineering Department with three 2-liter samples of liquors containing aluminum and mercury ions which are typical of conditions expected in the solution tank when dissolving jacketed metal canners. These will be used to evaluate the effect of mercury and aluminum on the rate at which 18-8-S-Cb and 25-12-S-Cb are attacked by the solution liquors.

Due to an oversight, corrosion samples were not inserted in the semi-works equipment when runs were in progress and no new results are available. These semi-works data are urgently needed as checks on synthetic laboratory tests and arrangements were made to have samples inserted in the equipment in all runs.

The testing program at the Experimental Station is going forward. Evaluations have been completed on acid resistant brick and recommendations made to the Design Division for construction materials for the fume disposal stack in the 200 area.

Radiation Tests

The originally selected wire samples to be used for evaluating changes in electrical resistance with exposure to radiant energy do not lend themselves to examination and strip samples have been requested. The suppliers of the wire samples will be contacted as soon as possible to get insulation in strip form.

DuH-10,161

[redacted] A. Gelling (Cont'd.)

Initial tests evaluating the effect of radiation on the physical properties of Saran, and further tests on Kerosseal and PTFE are in progress. In these tests, the use of intense beta radiation resulted in considerable heating of the specimens and it was felt that this heat may have affected the samples as much as or more than just the radiation. Inasmuch as the beta ray generator could not be operated at the low energy levels desired (which would not produce heating), it was decided to supplement these tests with extended exposures to less intense gamma radiation which would not cause heating. However, it was not possible to operate the gamma ray generator (X-ray tube) continuously at the power level desired. Another potential source of low energy radiation is the large Coolidge cathode-ray tube of the Chicago Tumor Institute and they are being contacted in reference to use of this equipment. As soon as the necessary arrangements can be made, these low energy, long-time tests will be carried out.

O. H. Greager

Analytical requirements for process control at Site W, based on the wet B separation process, have been obtained from the operating group. Preliminary discussions on sampling techniques and laboratory methods were held with the Site X group at Chicago the latter part of the week.

Sutton's group at the Metallurgical Laboratory has had poor results with $Zr_x(PO_4)_4$ - glass wool adsorbent when scaled up to a 12" column. They have not been able to prepare a well packed, uniform column with this material, and have encountered further difficulty in segregation and layering of the phosphate component. This group plans to evaluate other supports and principal adsorbents as they are made available by the scouting work of Boyd.

/11