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March 9, 1949

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6 pages. No. 24

RECOMMENDATIONS FOR SEPARATIONS PROCESSES PROGRAM

Reference: (Letter, A. B. Greninger - C. N. Gross COPY 1 OF 1.
to R. C. Muir, December 9, 1948,
HW-11823)

During the past several months, many questions have been raised concerning the advisability of continuing the presently scheduled Redox design and construction program in preference to other uranium recovery processes. In order to answer these questions properly, an extensive re-examination of the Redox process objectives and status and a careful study of other possible alternative uranium recovery processes have been carried out by the Hanford Works. This survey has included consideration of both existing process and facilities for plutonium separations, the Redox process, the Carbide and Carbon Uranyl Ammonium Phosphate process, uranium solvent extraction alone, and various combinations and couplings of parts or entities of the above. Comparative evaluation has been based on the relative assurance of obtaining both plutonium and uranium production; recovery of both "aged" and "current" metal wastes; timing for development, design, and construction; economics of capital investment and operating costs; and process complexity, adaptability, and safety. This survey has resulted in conclusions and recommendations for a unified program of separations process development, design, and construction. It is the purpose of this letter to present these conclusions and recommendations, together with a brief summary of the reasons leading to their establishment.

A. OUTLINE SUMMARY OF SURVEY

Considerable detail has been developed on comparative process design arrangement, scheduling, capital cost, and operating cost for eleven different uranium recovery process schemes. The large accumulation of facts assembled by this survey has been presented in the following documents: HW-12348, HW-12495, HW-12496, and HW-12581. In the course of developing final comparisons, it was found possible to narrow the number of candidates for development down to two processes. These were as follows:

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Two completely new Redox process installations, each simultaneously recovering the plutonium and uranium from one and one-half metric tons of pile discharge uranium per day, as well as recovering one metric ton of buried waste uranium per day. The recovered uranium to be delivered from these plants is to be decontaminated from fission products by at least 3×10^5 and the plutonium content reduced to less than 1×10^{-8} parts. Sufficient in-line process equipment would be included in design to insure this performance.

2. Two Uranyl Ammonium Phosphate process installations, one installed in U-Plant and one completely new plant in the East Area, each having a simultaneous capacity for one and one-half metric tons of pile discharge uranium per day, with two-year "cooling" between first and second U.A.P. precipitations, and one metric ton of buried waste uranium per day. In addition; T and B-Plants would be revised to accommodate the precipitation of one and one-half metric tons of uranium per day as uranyl ammonium phosphate, for two-year storage before blending into the buried waste metal processing. The recovered uranium to be delivered would be expected to be decontaminated from fission products by 10^3 and from plutonium approximately ten-fold. Completion of the decontamination would be obtained by "hot" fluorination at another site, most probably the Carbide and Carbon K-25 Plant, for which new facilities would have to be designed and constructed. Decontamination and recovery of plutonium would continue by the present BiPO_4 process.

Costs. The difference in capital investment for the construction of the two types of plants and their associated waste tankage has been calculated to be of the order of \$40,000,000, in favor of the U.A.P. installation. The difference in annual operating costs after Redox completes aged waste recovery (U.A.P. continues to operate with a two-year interim storage) is approximately \$2,500,000 in favor of Redox, however. In addition, the increased plutonium yield expected from the Redox process

This makes a net annual operating costs in favor of Redox, which eliminates the investment cost differential in a ten-year period.

Relative Timing. The U.A.P. process as it now stands has not been adequately demonstrated to provide a basis for process and engineering design. The earliest time by which it is believed that the presently assumed process design might be substantiated by currently scheduled testing at Oak Ridge is in the early fall of 1949. In contrast, the Redox process has four years of process development and one and one-half years of process and engineering design background. This background has provided a firm basis for Redox process design. The present status of Redox engineering design, however, is such that unnecessarily expensive construction may result if an adequate interval between design studies now in progress and the start of construction is not provided. In any case, it is believed that the continuation of Redox design and even slightly delayed construction will result in metal recovery production operations at an earlier date than the chain of U.A.P. development, design, and construction which has currently reached only the development stage.

Process Technology Comparisons. The U.A.P. process has an advantage over the Redox process in that the equipment required for its technology is simpler and closely related to the type of equipment currently in use in the BiPO₄ process. This permits a prediction that U.A.P. process equipment maintenance requirements should be less heavy than those of Redox and of a nature closely similar to present equipment maintenance requirements; thus, continuity of operation is more readily assured with the U.A.P. process than with the Redox process. In addition, the lack of inflammable solvent vapor hazards in the U.A.P. process should be recognized as a further advantage. In order to eliminate these differences so far as possible, a strong effort will have to be made to intensify the development of simple types of mechanical auxiliaries and refinement of all available solvent safety techniques in Redox design. On this basis and despite its present lack of establishment, the U.A.P. process is an attractive alternative in the event of the appearance of major unforeseen Redox difficulties and its planned development should be continued as uranium recovery insurance.

B. PROCESS CHOICE CONCLUSIONS

On the basis that an immediate decision is required, the course of action to follow in the interest of obtaining the best process for uranium recovery in the shortest time possible is to continue the Redox development, design, and construction program. This conclusion is supported in the main by the following reasons:

1. Dual Purposes. The Redox process is capable of recovering both "aged" and "current" metal wastes; thus, one Redox plant could perform the functions requiring two separate plants for any other process combination.
2. Economic. Within the limits of reasonable errors in calculation, the Redox process installation will be no more expensive in capital investment plus ten-year operating cost total than any other process capable of current consideration.
3. Timing. Due to its more advanced stage of process development and design, the Redox process is believed to be capable of earlier production installation than any other alternative uranium recovery process.
4. Plutonium Yield Advantage. The Redox process is the only uranium recovery process under current consideration which simultaneously offers, in addition to uranium recovery, a potential for a significant plutonium yield increase above the present process performance.

C. RECOMMENDATIONS

In order to obtain the most effective execution of a program based on the conclusions listed above, the following recommendations are made:

1. As a dual-purpose plant for both "aged" and "current" metal waste recovery, the design basis of the Redox Production Plant metal recovery cycles should be immediately readjusted to handle one and one-half tons of pile discharge uranium per day and one ton of buried waste uranium per day.

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2. Construction of the first Redox Production Plant should start only when the engineering and design has proceeded far enough to permit both design and construction to continue in an orderly and efficient manner, insuring maximum operability at the earliest possible date and at lowest cost. It is estimated that this will require approximately 50% completion of design. Construction of the second Redox Production Plant required has not yet been scheduled.
3. The Redox Production Plant start-up and subsequent operation should be carried out in the following sequence:

(Note that the first uranium to be recovered in this program will come from current BiPO_4 waste.)

- (a) Start-up operation of uranium processing equipment with "cold" or unirradiated uranium.
- (b) Operation of uranium processing equipment with tracer activity.
- (c) Operation of uranium processing equipment for metal recovery from pretreated unneutralized metal waste from BiPO_4 process (8-3-W).
- (d) Start-up operation of plutonium processing equipment with tracer activity.
- (e) Full plant operation with simultaneous recovery of uranium and plutonium from pile discharge metal.
- (f) Full plant operation plus concurrent recovery of uranium from buried waste.

Redox Test Plant

1. The General Electric Company's recommendations for changes in the Redox Test Plant project are contained in a letter, G. R. Prout to F. C. Schlemmer, dated February 25, 1949. In brief, this letter recommends cancelling of the Test Plant if six months or more of delay may be taken between the end of construction and beginning of effective production operations for the first Redox main plant.

Oak Ridge National Laboratory

If the Test Plant project is to be cancelled, arrangements should be made to obtain the following co-operative Redox assistance from the Oak Ridge National Laboratory:

1. The "hot" pilot plant should be available for Redox testing at top priority through at least January, 1951.
2. Equipment for carrying out a Redox second plutonium cycle should be installed in the X-10 pilot plant.

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3. Assistance in "hot" semi-works testing of a coupling process for BiPO_4 metal waste solvent extraction pretreatment, when developed, should be requested.

Kellex Metal Recovery Project (Job 11)

1. The Kellex Metal Recovery Project (Job 11) should be abbreviated to contain only development of a process and design of equipment for removal of buried waste from underground and preparation of a solvent extraction feed from this waste. The remainder of the currently scheduled Kellex project can be accomplished by adjustment of Redox process design to include both current and aged waste recovery.
2. The portion of the Kellex Metal Recovery Project retained should be placed under direct contract with General Electric, with General Electric having full authority to direct the nature and distribution of process development and engineering design.

Carbide and Carbon Urvyl Ammonium Phosphate Process Development

1. Carbide and Carbon should continue the development of the U.A.P. process under direct A.E.C. contract to a point where firm process and engineering design could proceed, if ever required. Because of the present manpower shortage, General Electric cannot at this time participate in this program beyond continuing its liaison activities.

Uranium Metal Pilot Production

1. Arrangements should be made with the Mallinkrodt St. Louis Works to pilot the processing of special batches of UNH obtained from Redox decontamination of full-level Hanford slugs at the ORNL pilot plant, to produce uranium metal for purity and activity measurements as well as to uncover any salt-to-metal processing difficulties.

General Electric Process Development and Design

The General Electric Company should continue "cold" semi-works development and "hot" laboratory and pilot plant development at both Hanford and Schenectady. If the Test Plant is cancelled at Hanford, a major part of the process testing and personnel training program planned for this facility will have to be accomplished through a more extended use of the SPRU installation at Schenectady. In addition, the General Electric Company should undertake the following:

1. Develop a chemical coupling step for preparing a solvent extraction feed from the BiPO_4 unneutralized metal waste (8-3-W).
2. Carry out the engineering design to accomplish the coupling of the unneutralized BiPO_4 metal waste (8-3-W) to Redox.
3. Assume the direction of the Kellex buried waste removal and pretreatment project, as described above, and assume part of the process development and engineering design load for this project.

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4. If the Test Plant project is cancelled, request an expansion of "hot" experimental facilities at Hanford, in order to provide at least minimal facilities for Redox studies supporting Redox production operations at this site.
5. Re-evaluate the Redox and U.A.P. processes in the fall of 1949, or before the beginning of major Redox construction.

A. B. Greninger
A. B. GRENINGER, MANAGER
TECHNICAL DIVISIONS

C. N. Gross
C. N. GROSS, MANAGER
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