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June 23, 1955

MEMORANDUM

TO: H. WORTHINGTON
FROM: V. R. THAYER *VR Thayer*

REDUCTION OF WASTE STORAGE COSTS

REVIEWED
S. A. V.

INTRODUCTION

Wastes from the separations process at Savannah River are now being stored in underground tanks. Cost of the present type storage facilities is about \$1.50 per gallon and at the present rate of operation, the annual cost of providing these facilities is about \$2,500,000. When the second separations area goes into operation this summer, the annual cost will jump to about \$5,000,000. If the level of operation is further increased, the costs for waste storage will rise correspondingly. From these figures, it is apparent that there is a major incentive to develop cheaper methods of disposing of radioactive wastes.

This memorandum covers the results of a study aimed at recommending a general course of action on waste handling and storage at Savannah River. It is the intent of the study to develop recommendations applying to the immediate needs for additional waste storage capacity, to plant tests of methods

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for reducing waste volume, to engineering design and development aimed at future economies, and to research on longer term phases of the program. It is further intended that steps recommended for the immediate future be such as to permit taking maximum advantage of later developments.

RECOMMENDATIONS

It is recommended that:

- 1) A prompt trial be made in the plant of the recovery of nitric acid from wastes of the first extraction cycle.
- 2) Design studies now in progress on additional tanks for F Area include serious consideration of the use of lower cost (Hanford type) tanks for low activity wastes, and transfer of such waste out of existing tanks as soon as new type tanks are available.
- 3) Cooling coils be installed in those existing tanks which do not now contain coils, so that all existing tanks will be suitable for storing high activity wastes.
- 4) Wastes segregation be changed, as follows (a) high activity fraction to be "head-end" cake plus waste from the first extraction cycle, (b) low activity fraction to be all others including residue from low activity waste evaporator.
- 5) Evaporators be installed at the tank farms, one in F Area and one in H Area.
- 6) A tank boil down test be made in one of the existing tanks containing low activity wastes.
- 7) Further engineering studies be made to develop a definitive estimate of the costs and feasibility of using a deep mine for waste disposal.
- 8) Study of the feasibility of seeping low activity wastes into the ground be continued.

GENERAL COURSE OF ACTION

The above recommendations are based on a general course of action which is discussed briefly in the following paragraphs.

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At the forecast rate of operations during the next two and one-half years, the plant is faced with the necessity of providing additional waste storage capacity in F Area to be available in 1957.

Engineering design work leading to the preparation of a project has already been started for additional storage tanks. Any steps taken to attain lower costs for this increment of waste storage capacity must, therefore, be started promptly and based on established techniques. Although it may become necessary to install additional tanks of the present design, until such a project is actually committed to construction, there is time to consider cheaper alternatives. One such alternative would be to build cheaper tanks for low activity waste, and reserve the existing tanks for high activity waste.

The Hanford type of waste tank is relatively low in cost, the estimated contract price per unit volume being in fact lower than the similarly estimated contract price for a mine. The Hanford tank may be more vulnerable to bomb damage and is more difficult to inspect for leakage than the existing Savannah River tanks. It is not unreasonable, however, that the Hanford tank might be considered adequate for storage of low activity waste. Such wastes would be stored as liquids on an interim basis with the expectation that later they would be concentrated to solids.

It is recommended, therefore, that consideration be given to using the Hanford type tank to fill immediate needs for storage in F Area, thus releasing existing tanks for high activity waste.

The most attractive means for reducing waste storage costs is to reduce the volume of waste to be stored. Two methods of reducing volume appear feasible for immediate exploration: 1) Recovery of nitric acid from wastes originating in the first extraction cycle and, 2) further concentration particularly of low activity waste, either by boiling in existing tanks or by use of an external evaporator. It is recommended that these approaches be developed concurrently. If results can be attained relatively soon, the decision date on new tankage at F Area might possibly be set back.

Although a deep mine is a possibility for ultimate low cost storage, it is estimated that about four years would be required to design and dig such a mine. Since additional storage capacity is almost certain to be required in F Area before a mine can be

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dug, the use of a mine will not relieve the immediate situation. Engineering design required to firm up the mine proposal, however, is recommended.

Seepage is obviously a very cheap method of waste disposal. Development work is required, however, to determine both the permeability and the adsorbing power of the ground available at Savannah for seepage. It is recommended that seepage studies now in progress be continued.

Summarizing, the recommended course of action comprises prompt effort toward reduction of waste volume, consideration of low cost tanks to fill immediate needs for additional storage, subsequent storage of low activity wastes either in a mine or in solid form in low cost tanks, and use of the existing tanks for the relatively small remaining volume of high activity wastes. After a decay period of years, the high activity wastes might eventually be moved to cheaper storage.

The combination of acid recovery, further waste boil down, and lower cost storage offers the possibility of reducing annual waste storage costs about ten-fold compared to present practice. Seepage remains for future consideration as an auxiliary method of disposal of certain low activity materials.

DISCUSSION

Our present philosophy in regard to disposing of wastes is that such materials shall be held in permanent storage so designed that there is no significant possibility of radioactive material getting into the environment.

A different approach to waste disposal is that of dilution, whereby radioactive materials are scattered to the environment in such a way that the concentration in the environment is tolerable. By this approach one can visualize seeping dilute solutions of radioactive material into the ground. Information presently available, however, as to the feasibility of seepage is insufficient to permit disposal in this manner of any significant quantity of the total radioactivity contained in the Savannah River wastes. The use of seepage, therefore, will necessarily be deferred until such information is available, and consequently our present course of action must be based upon containment.

There are two general lines of attack which offer immediate possibilities for the reduction of waste storage costs. These

are 1) reduction of the volume, per unit of uranium processed, of wastes to be stored, 2) the design of cheaper storage facilities which are still adequate to contain the wastes safely. These lines of attack are discussed below in the order listed.

1 - REDUCTION OF VOLUME

About half of the waste now produced by our separations process is very high in radioactivity and originates in the first two steps of the process, namely, the scavenging precipitation and the first solvent extraction. These wastes contain at least 99.8% of the total radioactivity. Under present operating conditions, this high activity waste contains a large amount of nitric acid and substantial reduction in waste volume can be achieved by recovering this acid rather than neutralizing it and sending to waste as is now done. It should be noted at this point that a similar quantity of nitric acid from the second solvent extraction is already being recovered and reused in the process. We have been unwilling to attempt the recovery of nitric acid from the first extraction, however, because of the uncertainty as to whether this acid as recovered would be low enough in radioactivity to be handled as recycle. Otherwise there is no difference in principle between recovering acid used in the first extraction, and recovering acid used in the second extraction.

Recent experiments at the Savannah River Laboratory have shown that nitric acid sufficiently low in activity can be recovered from aqueous wastes of the first extraction. Existing plant equipment now used to concentrate the sodium nitrate solution resulting from neutralization of this acid can be used to recover nitric acid as such, assuming that the laboratory findings are confirmed by plant operations. It appears, therefore, that the first step towards reduction of waste volume should be an immediate plant trial of acid recovery from the first extraction waste. (It may be noted that the Hanford Purex plant scheduled to start operating this fall, is designed to recover such acid). This procedure would reduce total waste volume to about 60% of that now obtained, and the high activity residue would then comprise only a small fraction of the total wastes.

The low activity wastes, as previously noted, are estimated to contain less than 0.2% of the total activity, and consideration can be given to treating these wastes by techniques appropriate to relatively "cold" materials. These low activity wastes which include sodium aluminate from the coating removal step as well as the residue left after recovery

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cf nitric acid from the second extraction, are now stored with a solid content of about 35%. This is the highest concentration that can be handled at ambient temperatures without precipitation of solids.

It would be desirable to concentrate wastes beyond 35%, and experiments along this line have been made at Brookhaven during the past year. It may be noted that Hanford is concentrating various wastes beyond the ambient temperature saturation point.

Two methods of concentration appear worthy of immediate investigation on plant scale. These are a) boiling down in the storage tanks and b) installing an evaporator at the tank farm. Both of these methods are being used at Hanford, and are being applied to our wastes on semi-works scale at Brookhaven. (Hanford has had trouble in boiling down tanks containing high activity wastes. We propose to avoid this difficulty by limiting such boil down to low activity wastes).

Assuming that the low activity fraction is boiled down to a concentration of about 70% solids (which still remain in solution in the hot liquor) a three-fold reduction in volume would be obtained.

Summarizing the situation on volume reduction, it appears that a reduction to about one-quarter of the present volume could be obtained by a combination of acid recovery from the first cycle effluent and further concentration of the low activity solutions. In regard to high activity solutions, the volume remaining after removal of nitric acid is small and boil down of this residue can be deferred indefinitely without serious cost penalty.

2 - DESIGN OF CHEAPER STORAGE FACILITIES

Preliminary investigation has been made by the Engineering Department as to the possibility of constructing a deep underground storage facility at Savannah River. The proposal is to dig a mine shaft to a depth of about 1200 ft. where solid granite underlies the Savannah River Plant. It is conceived that mine tunnels stemming from such a shaft could serve directly as permanent waste storage. The cost of such storage has been tentatively estimated by mining engineer consultants at 20¢ to 35¢ per gallon. In order to attain a low cost per unit volume, it would be necessary to dig a mine

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containing something like 25,000,000 gallons of storage capacity. On any smaller scale the cost per unit volume rises sharply. Under present operating conditions, 25,000,000 gallons would be about seven years storage for F and H Area wastes. The time required to get such a mine ready for use including geological exploration, engineering design, digging the mine, and providing pipe lines and other auxiliaries is estimated to be about four years. It should be noted that the cost of 20¢ to 35¢ per gallon estimated for this mine does not include auxiliaries to be provided by the Savannah River Plant to bring the wastes to the mine shaft and get them into the tunnels.

The first step towards developing mine storage would be a more extensive engineering study, and it appears that the cost of such a study is justified in order to firm up our ideas on this method of disposal.

Another possibility for obtaining storage costing less per unit volume than our present design would be to revise our design concept as to the type of tank required for permanent storage of low activity wastes. This might be done upon the basis that new storage volume would be used only for low activity wastes. The existing tanks could then handle high activity waste for an interim period, or for the foreseeable future if nitric acid is removed from such wastes.

Our present tanks consist of a concrete vault with a shallow steel pan on the bottom. Inside this vault and on top of the pan is a steel storage tank. The roof of the vault consists of 4 ft. of concrete and to support this roof plus an earth fill above it, the tanks contain pillars of concrete covered with steel. Some of these tanks contain cooling coils to remove the heat of radioactive decay from high activity wastes. When providing tankage for low activity waste, the cooling coils can be omitted. Considering the tank proper, that is, leaving out cooling coils, pipe lines, diversion box and other auxiliaries, our present tanks cost 75¢ to \$1 per gallon, depending on size.

The Hanford tanks are simpler than ours and consist of a concrete vault with a steel liner which covers the bottom and sides but not the roof. Hanford tanks at present prices have been reported to cost about 15¢ per gallon for the tank proper, contract price exclusive of Hanford's own engineering costs.

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We have obtained information on the cost of concrete tanks which are built in large numbers with and without steel liners for city water reservoirs, armed forces gasoline storage, etc. These tanks are reported to be available at something like 15¢ a gallon contract price, with steel liner. These figures appear to confirm the Hanford cost reports. (As incidental information, prestressed concrete appears cheaper for tank construction than ordinary reinforced concrete). It should be noted that the cost for a mine above quoted is based on having the job done by an outside contractor. When comparing mine storage to tank storage, therefore, it appears appropriate to base the comparison on contract prices for both jobs. Additional costs involving our own design, preparing the site, and adding auxiliaries would be common to both cases.

If we are willing to accept this design of tank as adequate for low activity wastes, there appears to be a possibility of reducing costs of any new tanks by a substantial amount.

A longer term possibility is the storage of low activity wastes as solids in such tanks. When concentrated to about 70% these wastes become solid at ambient temperature when the salts take up water of crystallization. Obviously such solids would be less likely to get away than liquids. An even more permanent form of solid waste might be obtained by adding cement (or other stabilizing material) to the hot solution as discharged to the tanks.

VRT:L

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