EFFLUENT TREATMENT FACILITY-CHALLENGED TO MEET ENVIRONMENTAL RESTORATION

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ABSTRACT

The Hanford Site Effluent Treatment Facility (ETF) processes mixed waste water coming from Hanford Site processes. The processed waste streams are Building 242-A Evaporator distillate, process distillate discharge (PDD) and ammonia scrubber distillate (ASD) from the PUREX plant, and waste water from the Liquid Effluent Retention Facility (LERF). These low-activity radioactive water streams contain small amounts of ammonia, inorganic, organics, and particulates.

The ETF will reduce the level of contamination in the water to a level that is less than that required by Westinghouse Hanford Company (WHC), the US Department of Energy (DOE), and the State of Washington. To accomplish this, the ETF process uses eight proven technologies. Prior to preparing its proposal for the project, JGC Corporation (JGC) pre-qualified each process for its application in the ETF. In addition to water that can be released to the environment, the only other product from the ETF is a small quantity of packaged dry powder waste. Continuing on-schedule ETF project performance is a result of coordinated efforts by the ETF project team and the creative application of proven process technologies.

INTRODUCTION

The Effluent Treatment Facility (ETF) is located in the center of the Hanford Site. It is designed to receive liquid effluent from several of onsite sources. The ETF will process these liquid effluent to separate and package the hazardous and radioactive materials. Clean effluent will be discharged in compliance with applicable laws and regulations. The ETF design incorporates technologies selected as the best demonstrated available technology (BAT) for their particular application and the wastes that will be treated. Figures 1 and 2 illustrate the flow through the process and the relationship of the technologies in the system. The technologies selected for the ETF include:

- Filtration
- Ultraviolet (UV) oxidation of organic materials
- Staged pH adjustment
- CO_2 removal (degasification)
- Reverse osmosis
- Ion exchange
- Forced circulation evaporation
- Thin-film drying

These processes will be controlled by an advanced integrated monitoring and process control system. This distributed control system is linked by fiber optics. An automated, remotely controlled system packages the dried solid waste that is produced.

In November, 1991 a fixed-price, turn-key contract was awarded to JGC Corporation (JGC) for the design, procurement of equipment for, and the construction of the ETF. JGC's U.S. office is located in Herndon, Virginia. After JGC completed the basic design of the ETF facility and processes, JGC worked with a wholly-owned U.S. subsidiary company, ADTECHS Corporation (ADTECHS) to complete the design, direct procurement activities, provide overall project management, and provide construction subcontracting, supervision, and start-up support. In April, 1993 the ETF subcontract will be assigned from JGC to ADTECHS.

PROJECT AND DESIGN CHALLENGES

The ETF specification was developed by Westinghouse Hanford Co. (WHC) and Kaiser Engineers Hanford (KEH) after their in-depth review of available technologies. The specified technologies allow all applicable treatment requirements to be met without excessive cost or uncertainty, and in a manner that minimizes the amount of secondary wastes generated. Despite these efforts by WHC and KEH, the design of the facility required a high level of familiarity with and confidence in the technologies in order to develop a design to meet all ETF discharge requirements. In addition to imposing discharge requirements, the agreement between the U.S. Department of Energy, the Washington State Department of Ecology, and the U.S. Environmental Protection Agency, imposed a severe schedule on the project.

For over twenty years JGC has provided process designs and systems for radioactive waste processing and nuclear fuel reprocessing in Japan. JGC has provided solid, liquid and gaseous waste processing system designs for many other types of process facilities. Based on this experience, JGC performed extensive tests in its research laboratories before submitting its bid for the ETF. In this way JGC was able to develop a process design that would meet all of the ETF specification requirements. Extensive feasibility tests were performed on simulated waste to demonstrate the effectiveness of three of the most advanced technologies. There were tests of UV oxidation, reverse osmosis (RO), and thin-film drying.

ORGANIC MATERIALS DESTRUCTION

The design bases for the ETF influent included significant concentrations of organic compounds that required destruction or removal from the waste stream. Ultraviolet oxidation was considered the BAT appropriate for this constituent. After extensive testing and investigation, it was determined that the most effective implementation of UV oxidation for this application would be one using hydrogen peroxide as the principal oxidant in conjunction with high-intensity UV light. Use of this technology required a special process step to protect the RO system from the effects of residual hydrogen peroxide. In addition to the hydrogen peroxide, JGC also investigated several other approaches including ozone. While such systems work well in some applications, the temperature constraints on the ETF system and the particular organic species present would not permit an ozone-based UV system to operate reliably and cost effectively when compared to the selected system.

REVERSE OSMOSIS

The process selected to remove inorganic dissolved solids from the ETF process stream is RO. Several challenges were overcome in order to cost effectively incorporate RO. The concentration of the dissolved solids in the RO unit would have a significant effect on the sizing of the downstream secondary waste systems, especially the initial forced circulation evaporator. Also, any dissolved solids not removed in the RO unit would have to be removed by the ion exchange polishing system. Since regeneration of the ion exchange system would produce additional secondary waste, the RO system was designed to remove the maximum amount of dissolved solids possible.

A goal of 95 percent recovery rate for the RO permeate and a 99 percent rejection rate of dissolved solids into the secondary waste stream was established. These design parameters were significantly more stringent than required by the specifications. While this adversely affected the sizing of the RO system, it significantly reduced the amount of secondary liquid and solid wastes produced. By specifying a 95 percent permeate recovery rate, the portion of the process flow sent to the evaporator was reduced by 70-80 percent less than the specification requirement. This design decision resulted in significant overall facility cost savings. To achieve optimum performance in the RO system, a recirculation system was incorporated in order to maintain flow through the system at a prescribed rate.

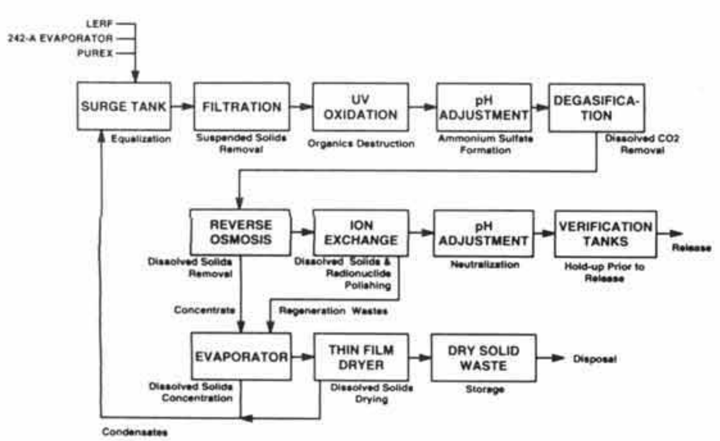

Fig. 1. ETF block flow diagram.

To assure that treatment targets can be met, the condensates from the secondary waste treatment processes are sent back through the primary treatment stream. If a sufficiently high recovery rate can not be maintained in the RO system, the primary treatment stream capacity would have to be increased to handle the increased recirculation flow. The selected RO design greatly reduces the overall cost of the facility although the RO system itself has considerably more capability than required by the project specification.

ION-EXCHANGE POLISHING

A mixed bed, multiple vessel ion exchange system was chosen to remove any remaining radionuclides and other selected dissolved solids in the process stream. The anion and cation resins used are regenerated with sulfuric acid and sodium hydroxide. Because of the high dissolved solids rejection rate of the RO system, the ion exchange resins process more liquid and require less regeneration. This reduces the size of the secondary treatment process systems.

SECONDARY WASTE TREATMENT

JGC selected two different types of evaporation systems to process the secondary waste stream. This selection of forced circulation evaporation and thin film evaporation and drying was based upon experience developed from its design of the radioactive waste processes for the first Japanese nuclear fuel reprocessing facility at Tokai. This Tokai experience gave the process design engineers a special understanding of appropriate secondary waste processing technologies. Forced circulation evaporation is used for the first stage of evaporation. The bottoms from this evaporator are next processed and dried to a powder in the thin film evaporator. The condensates from both evaporators are returned to the front of the primary process and pass through the process again. The thin film dryer is considered the most practical means of producing the mainly ammonium sulfate dried solids which are the final and only waste stream from the facility. This dry powder is placed in drums for storage and future processing and disposal.

PROJECT INTEGRATION

The ETF roles for WHC and KEH are defined in a memorandum of understanding (MOU) that was issued by the U.S. Department of Energy Richland Field Office (RL). This MOU establishes an integrated management team (IMT) approach for environmental restoration work at the Hanford Site. This MOU has streamlined the management of projects like the ETF by focusing all project management team members on common objectives. It creates the mechanisms and the environment for integrated activity.

WHC is the ETF operating contractor and has overall responsibility and authority to:

- Direct the project
- Be the prime interface with RL
- Establish baseline, scope, cost, and schedule
- Manage environmental permit activities
- Approve definitive design for compliance with baseline, safety, and environmental compliance
- Involve operations and maintenance in design reviews

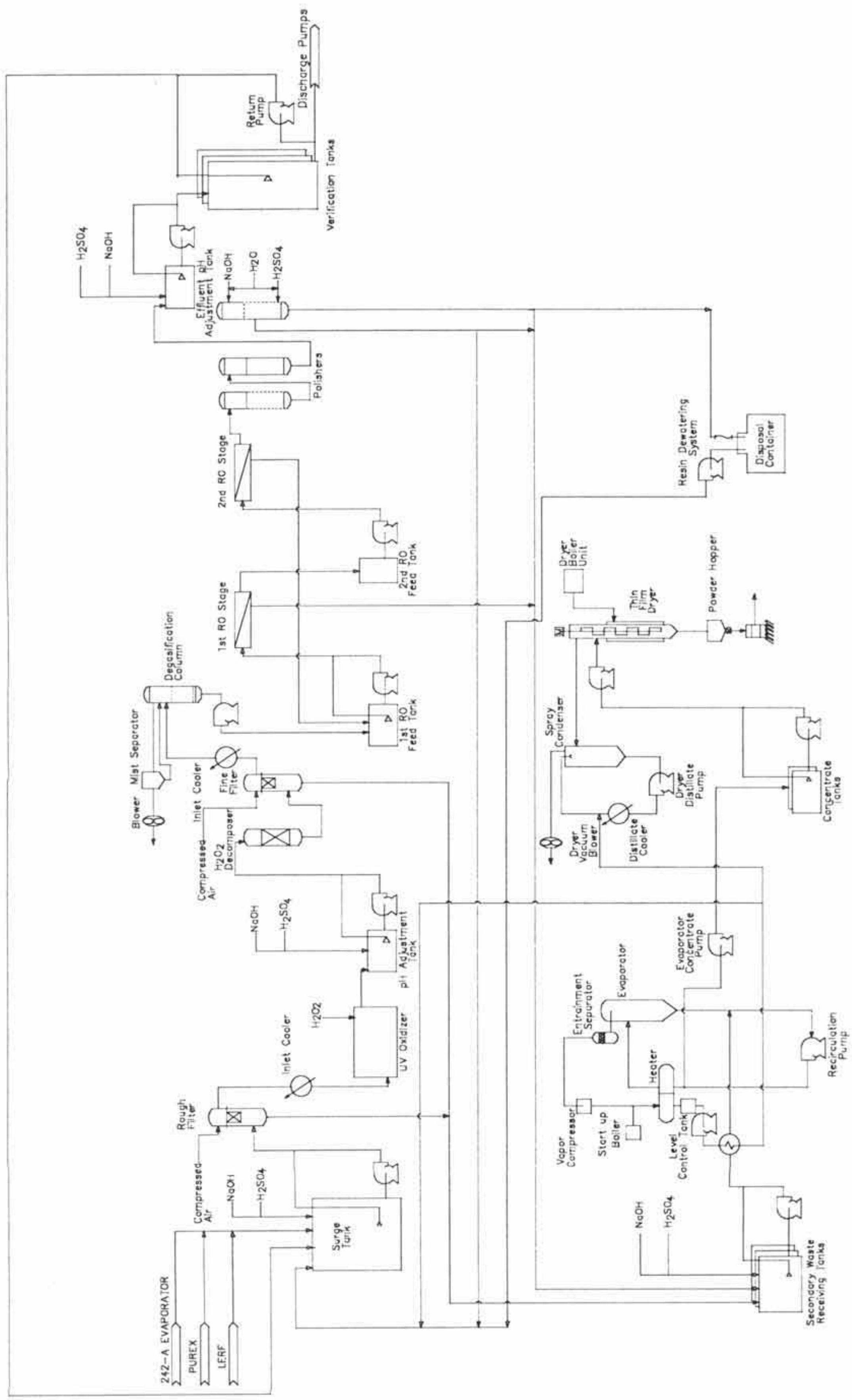

Fig. 2. ETF flow diagram.

- Establish and implement a quality assurance plan that defines the project quality requirements.

KEH is the ETF engineer and construction contractor and has responsibility and authority to:

- Manage project design, construction, and inspection activities
- Manage fixed-price contractors
- Develop estimated project costs and schedules
- Inspect construction in accordance with inspection plans to provide adequate bases for final acceptance of completed work.

JGC is the ETF detail designer, procurer, and constructor. As the ETF design has developed, responsibilities have been shifted from JGC to ADTECHS. As mentioned above, the contract was ultimately assigned to ADTECHS. To maintain project continuity, JGC shifted some key personnel from its home office technical staff to ADTECHS. In the Spring of 1993 site construction will start. This will be managed by an ADTECHS site staff.

CONCLUSIONS

A result of their experience handling similar wastes and their ongoing research and development is that JGC and ADTECHS were able to develop an efficient and cost effective design for the ETF. This design was completed on schedule. Construction will begin on time. The ETF will provide the Hanford Site state-of-the-art treatment of wastes generated in the DOE's environmental restoration activities.

As a result of the IMT approach implemented by RL, the contract schedule for the JGC ETF scope of work remains on schedule. All parties to this work, WHC, KEH, JGC and ADTECHS has worked together to achieve prescribes results on the established project schedule.