DECOMMISSIONING A SPENT FUEL PROCESSING FACILITY
LOW LEVEL WASTE MANAGEMENT

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INTRODUCTION

A spent fuel reprocessing facility is designed to recover fissile and fertile material from the fuel. During the operation of the facility, high level liquid wastes are generated which are presently stored in tanks as dilute or concentrated chemical solutions and slurries. The surfaces of the processing equipment and the structures become contaminated during plant operation due to various causes. Normal fuel cutting operations release fines that become airborne and settle out and leakage from process equipment and pipe lines also contaminate surfaces which are contacted.

There are a number of options available to decommission such a facility. It can be dismantled and demolished, entombed or left in protective storage for later dismantlement and demolition. In all cases, the facility should be decontaminated to minimize inadvertent radiation exposure to custodians or the general public after plant operation is halted.

Decontamination of the facility, generates radioactive wastes that are classified as low level wastes (LLW). This paper examines means to manage the LLW.

DECONTAMINATION

The decontamination operations involve, 1) chemical solution and water flushes, sprays and lancing, 2) mechanical scrubbing and 3) surface abrasion to remove surface contamination. Other means such as electropolishing[1] can also be considered for this purpose. Whichever processes or operations are considered, contaminated radioactive material, liquid, gaseous, and solid will be generated and must be considered for treatment.

LLW SOURCES

LLW is generated during decontamination. However, similar wastes on an equivalent or smaller scale are generated during normal plant operation. It would therefore be prudent to consider installation of LLW management features in the initial plant design.

The solutions which are used to dissolve or suspend surface contamination are one source of LLW. The liquids may consist of a variety of acids and alkali including the following - nitric acid, hydrofluoric acid, tartaric acid, sodium hydroxide, potassium permanganate and salts of the various acids.

Solid wastes must also be considered in waste management. They will consist among others of rags and paper products used to wipe surfaces, plastics used to cover contaminated surfaces, plastic shoe covers and various abrasives that may be used on surfaces. Metal equipment or parts, which cannot be decontaminated adequately for reuse or for scrapping as inactive waste, is another source of LLW.

A final source of LLW, which is also present during normal plant operation, consists of the following: Resins used to treat contaminated water solutions and HEPA filters used to treat air effluent.

TREATMENT OF LLW

Liquids

Liquid wastes constitute the largest volume of the low level wastes (LLW) that are generated during decommissioning. Therefore, means should be provided to reduce the volume of liquid wastes in order to minimize the cost of disposal. The concentration of radioactivity and chemicals in the decontamination solutions, including the flush rinses is considered to be too high to permit direct disposal to the environment. The treatment suggested for the liquid waste depends on the nature of the waste stream. In all cases, the aim is to concentrate dissolved and suspended solids in the liquids at minimum operating cost in a head end process and to immobilize this waste to permit subsequent disposal in approved burial grounds.[2,3,4]

Two types of liquid wastes are considered herein.

1. High conductivity solutions
2. Low Conductivity Solutions

High Conductivity Solutions

Concentration by evaporation is recommended for the treatment of high conductivity solutions. This is considered to be the most economical operation to separate the solids from the liquid. The bulk of the solids, including radioactive species, remains with the bottoms. [2,3,4] The overhead can be treated further.

In cases where nitric acid solutions are used, additional reductions in waste volume can be achieved. The overhead can be fractionated so that acid can be recovered for reuse in decontamination solutions. This results in cost reduction because less nitric acid will have to be purchased and because the resulting waste volume can be reduced. However, an economic assessment must be made, on a case by case basis, to justify the cost for installation, operation and disposal of fractionation equipment.

The flow scheme shown in Fig. 1 shows the following chemical operations and processes:

1. Filtration of the initial solution - to remove suspended solids[5]

2. Evaporation of the filtrate - to concentrate dissolved salts

3. Fractionation of vapor - to recover acid for reuse

4. Ion exchange of condensate - to polish the effluent

Low Conductivity Solutions

Treatment by ion exchange is recommended for low conductivity solutions. Although evaporation is an equally acceptable operation, it is not economical because of the large volume of water that must be evaporated with the attendant cost of energy. Ion exchange and filtration, on the other hand, are perceived to

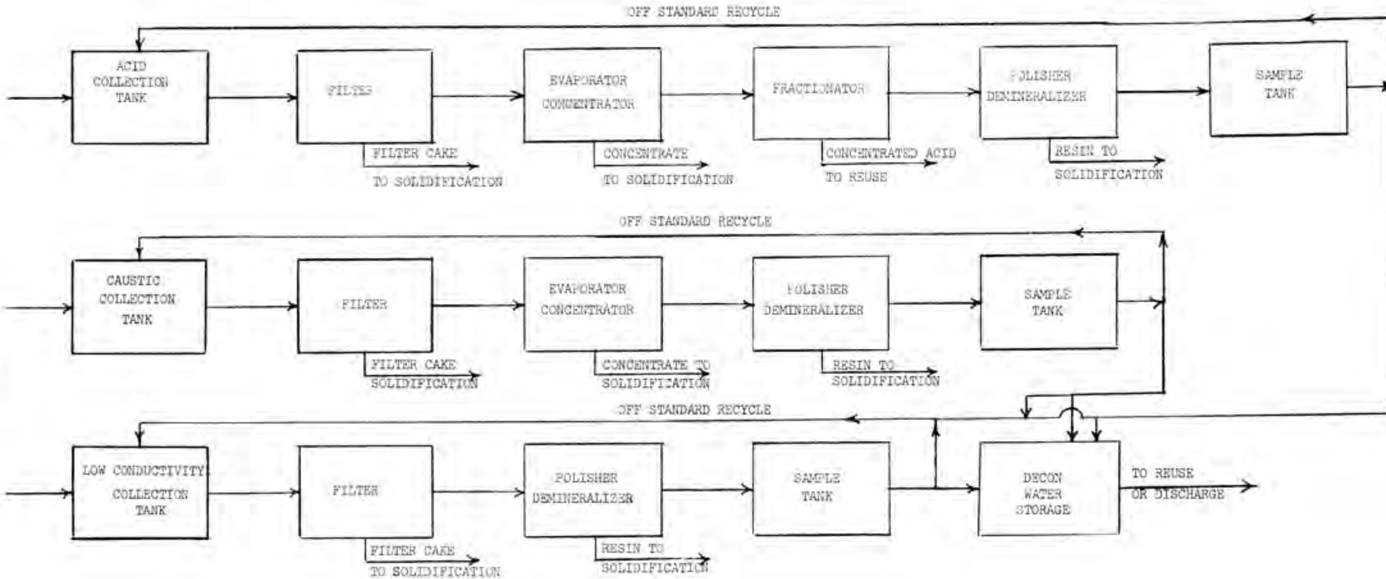

Fig. 1. Low Level Liquid Waste Treatment.

be more economic. It is generally economical not to regenerate the ion exchange material and to consider it as part of the concentrate in which the radioactivity has been absorbed.

Solids

The treatment of solids again considers the nature of solids. Solids may be considered as flammable, non-flammable, compactible and non-compactible.

For flammable solids, incineration is one option that can be considered to reduce the volume of waste. However, a cost assessment must be made, on a case by case basis, to evaluate the relative costs. Costs that must be assessed include the cost of the incineration equipment, auxiliary equipment to treat off gases, its installation, operation and disposal together with the cost of shipment and burial of the incinerated material versus the cost of packaging the raw material and its shipment and burial without volume reduction by incineration.

Compactible material which is not incinerated should be compacted in order to reduce the volume of the waste that has to be shipped and buried.[6]

Non-compactible material such as metallic equipment can also be reduced in volume by melting. However, here again an economic assessment must be made to evaluate, on a case by case basis, the cost savings achieved by volume reduction versus costs of furnace equipment, its installation, operation and final disposal.

Gases

Treatment of gaseous effluent depends on the nature of the system being decommissioned. All gaseous effluents from treatment of contaminated waste should be treated by HEPA filters to remove entrained solids. It is considered unlikely that treatment of gaseous fission products need be considered during decommissioning of a fuel reprocessing plant. These elements will have decayed sufficiently to be innocuous at time of decommissioning or will have been vaporized and separated from the facility contents during earlier treatment processes in fuel reprocessing.

LOW LEVEL WASTE SOLIDIFICATION

All LLW generated during decommissioning should be solidified and immobilized in a form that will minimize the possibility that radioactivity, associated with the waste, can be leached from the buried waste and returned to the biosphere.[2,3,4]

A number of binders can be considered as suitable for immobilizing LLW. These include cement, asphalt and Dow Vinylester among others.[7,8] In selecting a binder, an economic assessment must be made. In all cases the leachability and stability of the final product must be considered paramount. The cost of immobilization as well as the net burial cost of finally disposing of the waste must be evaluated. The larger the volume of waste that must be treated the more expense can be tolerated for the equipment cost, because it can be spread over a larger volume.

DECOMMISSIONING OPTIONS

Several options for decommissioning a facility can be considered. One is immediate entombment. This option appears to be the least costly on a short term basis. The cost of decontamination will be kept to a minimum, because equipment can be entombed in situ and a minimum of LLW will be generated during the decontamination activities. However, the site becomes unavailable for use for time periods exceeding several centuries. In addition, the cost and feasibility of maintaining surveillance over the area for long periods must be considered.

Decommissioning by partial decontamination of the facility followed by protective storage later dismantlement is a second option. This option may generate less LLW because of the extent to which decontamination is carried out. However, consideration must be given to the costs for maintaining surveillance over the facility until it is dismantled. Moreover the use of the site will be precluded except for use as a controlled nuclear facility.

Decommissioning of a fuel reprocessing facility must also take into consideration the presence of transuranic (TRU) wastes. It is inevitable that traces of TRU will be present as surface contamination on equipment and cell wall surfaces. The TRU will therefore be removed to some extent by the decontamination activities and will find its way into LLW. It is considered probable that the treatment by large volumes of chemical will dilute the

TRU concentrations to levels below ten (10) nanocuries/ gram. This means that the LLW can be disposed of in commercial LLW facilities and need not be sent to federal repositories, where disposal costs will be much greater. However, waste management must provide the capability to assess the TRU content of all waste leaving the facility so that it can be disposed of in a suitable manner.

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