"RADWASTE DESIGN AND EXPERIENCE WORKSHOP"

Chairman: Larry Oyen

This workshop dealt with the radioactive waste produced and treated at the light water reactor nuclear stations.

The first speaker was John Stewart, formerly with Cosmodyne Corporation. Mr. Stewart discussed sources of gaseous radwaste for BWR's and PWR's and the systems to process this waste.

For a boiling water reactor, the off gases are discharged from the main condenser with a steam jet air ejector system. The volume of these gases is relatively large compared to the radioactive gases from a pressurized water reactor. In the PWR, the primary system is sealed, and the reactor coolant does not go to the turbine and hence the condenser. The primary gaseous waste of the PWR is the reactor coolant degasifier or gas from the chemical volume control system tank. The purpose of the off-gas treatment systems is to reduce the radioactive gases to "as low as practicable" level which meets the AEC guidelines which are dependent on the site boundary and meteorological conditions.

For the BWR, the off-gas activity is normally reduced to less than 100 u Ci/sec resulting in a minimum decontamination factor (DF) of 100 with reference to the 30 min. decay activity level. For the PWR, the activity is reduced to less than 200 μ Ci/sec.

To reduce the activity to the acceptable level, the isotopes are delayed for a period of time to allow their decay. The various methods to achieve this are (1) residence or storage delay, (2) dynamic adsorption delay on charcoal beds and (3) delay after separation with a cryogenic distillation or cyogenic adsorption process.

For the BWR's, the systems currently being licensed and built usually contain the following subsystems: The pretreatment subsystem contains a preheater, catalytic recombiner, and condenser, to remove hydrogen and oxygen. Next the subsystems include a dehumidification subsystem. The purpose is to reduce the moisture content of the off-gas stream so that water vapor does not compete for a place in the adsorption of Xenon and Krypton in the charcoal delay tanks. Several methods of drying were discussed, such as desiccant dryers, freezout dryers and combinations of the two. The drying often is accomplished in two steps. The final major subsystem is the decay subsystem. Most of the plants use charcoal, kept at 75°F to -20°F. The lower temperature results in a cost savings in the total building cost and the amount of charcoal required.

Cryogenic systems were discussed, but several other problems can occur with this more complex system.

The disposal of bottled krypton is still a problem.

The second speaker, Larry Oyen, Supervisor, Radwaste Design Section, Sargent & Lundy, discussed liquid radwaste equipment and systems.

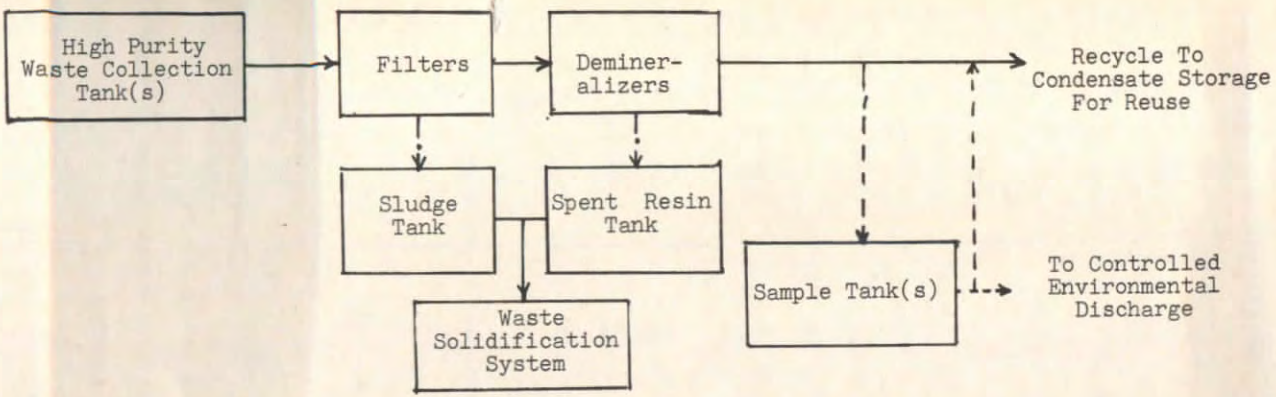
Liquid radioactive wastes are generally classified as to type, in terms of their physical and chemical characteristics.

For the boiling water reactors (BWR) the four main categories of liquid waste are: high purity, low purity, chemical and detergent wastes.

The high purity waste system as shown in Figure 1 has input from equipment drains from all of the buildings plus low conductivity backwash water from the various demineralizers. The good quality water is processed so that it can be returned to the condensate storage tank for reuse in the system. The water is normally filtered, demineralized, sampled and sent back to the storage tank.

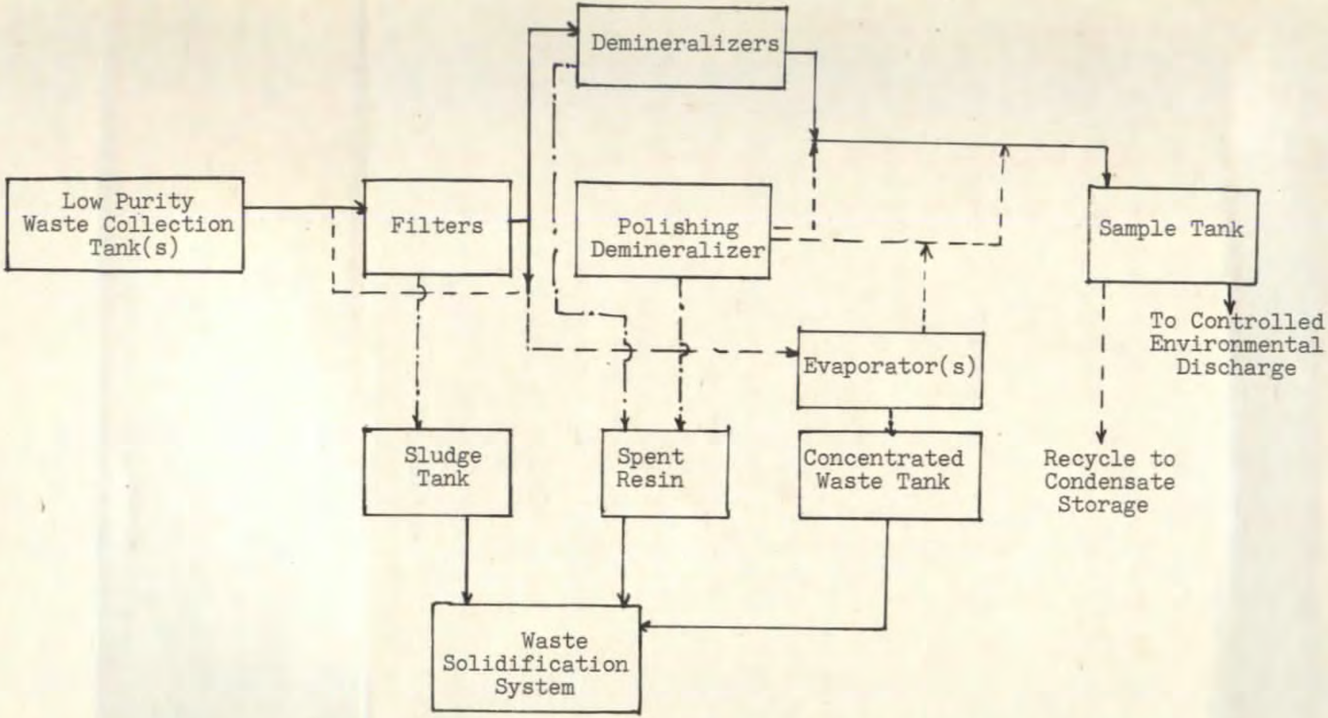
The filter used in a BWR is normally a pressure precoat type which uses solka floc or diatomaceous earth for a precoated filter media. The crud removed from the water and the filter media is discharged to a sludge tank. The demineralizer resins when expended will either be regenerated or discarded to the spent resin tank. These two tanks then are an input to the waste solidification system.

The low purity waste system (Figure 2) has input from floor drains from the various buildings plus water resulting from the dewatering of slurries. It is normally high in dissolved solids and high in suspended solids. The water is normally first filtered then sent either to a demineralizer or after filtration to an evaporator.



HIGH PURITY WASTE SYSTEM

FIGURE 1

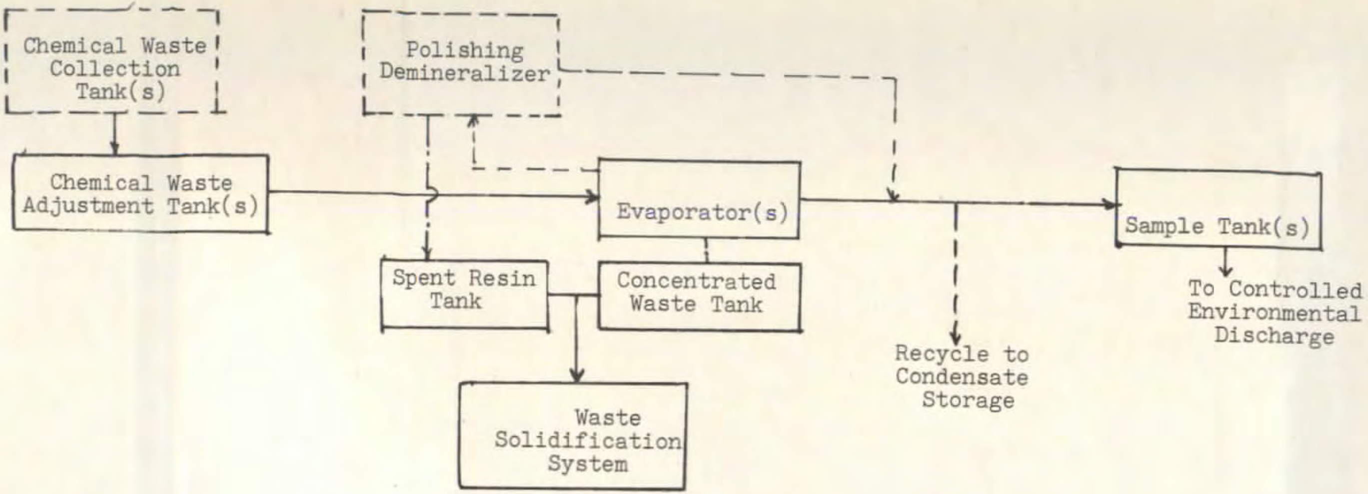


LOW PURITY WASTE SYSTEM FIGURE 2

After evaporation it could be sent to a sample tank or sent through a polishing demineralizer for greater water purification and decontamination of the water. The spent resins, filter sludge and/or evaporator concentrates are all inputs to the waste solidification system.

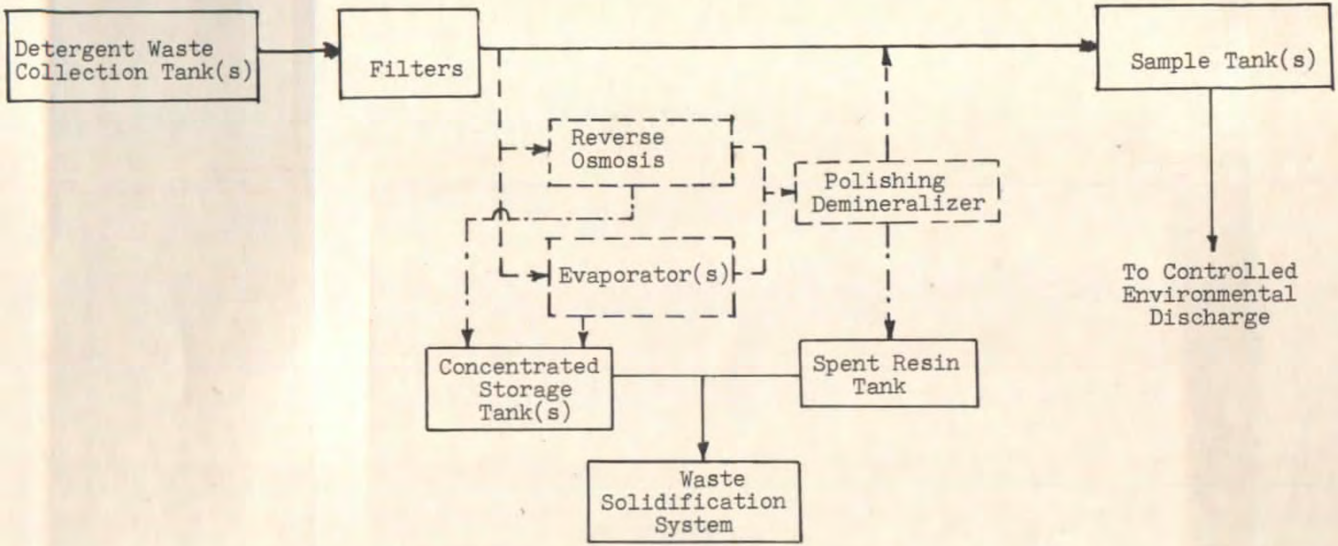
The chemical waste,major sources are regenerative wastes from condensate demineralizer, should be processed by chemical adjustment and evaporation (Figure 3). The adjustment tanks are used to add any chemicals to reach a desired pH level prior to feeding the evaporator. This tank may be used for collection or a separate collection tank ahead of the adjustment tank may be used. Ion exchange should be used to polish the evaporator distillate. After the effluent analysis, processed liquid may be discharged to the environment or routed to the condensate storage tank for reuse. The decision to reuse the treated wastes depends upon the water quality and the storage tank capacity available.

Detergent waste system as shown in Figure 4 has major inputs from laundry and detergent type wastes from decontamination. As a minimum, detergent waste should be processed by filtration and may be released after effluent analysis. Other methods for treatment would be through a reverse osmosis unit possibly followed by a polishing demineralizer. By the use of this equipment it is possible that the water may be reused depending on the chemical and radiological content. Evaporators are another alternate method for processing detergent waste, but with a normal



CHEMICAL WASTE SYSTEM

FIGURE 3



DETERGENT WASTE PROGRAM

FIGURE 4

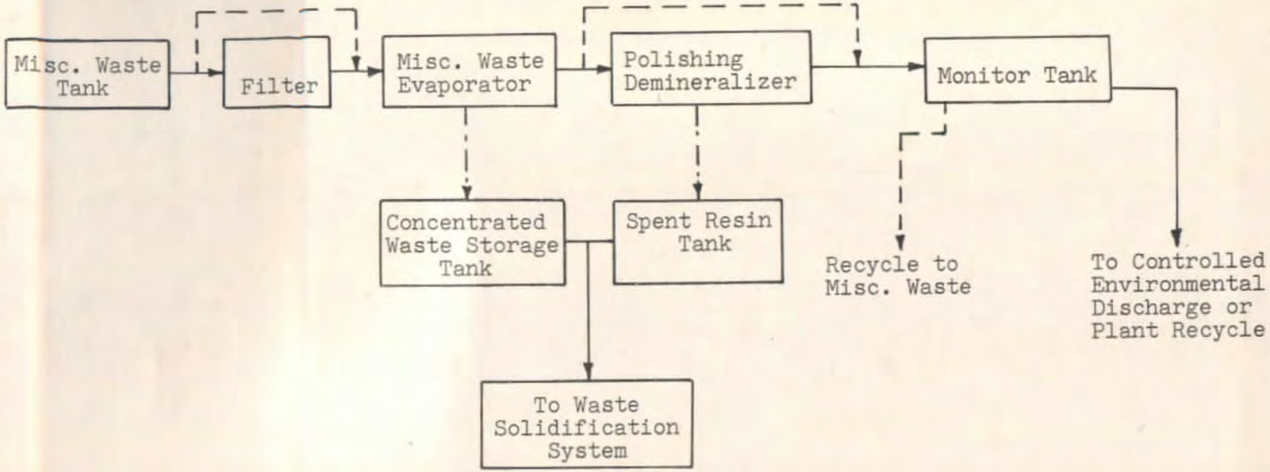
evaporator, the foaming detergent would greatly decrease the efficiency and decontamination factor of the evaporator.

For the pressurized water reactors (PWR) the four main categories of liquid waste are: miscellaneous waste, steam generator blowdown or secondary waste, chemical and detergent waste. The last two systems have similar inputs and treatment systems as for the BWR.

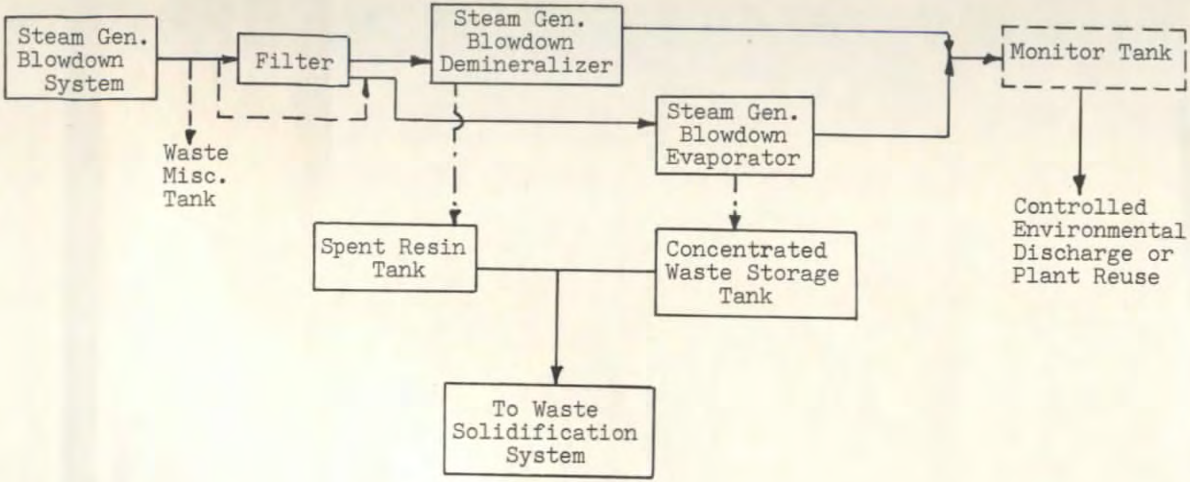
The miscellaneous waste system has input from floor drains, waste sample station, radioactive waste aerated systems and equipment drains, and other radioactive wastes which may be contaminated and are non-primary quality water. Outdoor controlled area wastes normally do not require processing; however, provision should be made to allow collection as miscellaneous waste.

This system to process miscellaneous waste (shown in Figure 5) should be designed to include provisions for evaporation and ion exchange. Evaporation may be preceded by filtration to minimize the deposition of particulate matter on evaporator components, such as sensory elements and heat exchanger surfaces. Evaporation is selected as a primary processing method due to the normally high decontamination factors which can be achieved for ionic and particulate matter. The distillate from the evaporator goes directly to the demineralizer. It should be analyzed in a monitored tank prior to release to the environment or recycled.

The steam generator blowdown or secondary system treatment system shown in Figure 6, should include filtration and ion exchange or equivalent processes such as an evaporator. In a pressurized



MISCELLANEOUS WASTE SYSTEM FIGURE 5



STEAM GENERATOR BLOWDOWN SYSTEM FIGURE 6 water reactor, it is not anticipated that turbine building drains will require processing; however, a radiation monitor should be provided and provisions for diversion to treatment facilities should be included. The miscellaneous waste treatment system may also be utilized to treat turbine building drains and steam generator blowdown. If the secondary system includes a condensate demineralizer, the spent regenerants may require processing within the radioactive waste treatment system and provisions should be included for this processing.

In summary, the liquid radwaste system is used to purify liquid streams so that they can be reused or if low activity discharged. It is the byproduct of this purification process that is dewatered and solidified with the solid radwaste systems.

To complete discussion of nuclear station waste management, three speakers spoke on waste solidification systems. The first was Mr. Paul Williams, General Manager, Stock Equipment Company.

Mr. Williams discussed the equipment features of the Stock Equipment Company solid radwaste system built for the Salem Station. Components of the system have been under test for up to two years.

The cement handling system or drum preparation system is located in a very low radiation area, where dry cement is added to several 55 gallon drums. A mixing weight is placed in each of the drums to insure uniform mixing when the drum is tumbled. A remote operated crane moves the drums to the drum process unit. The Stock bridge crane was designed as a means of complete remote and accurate handling of radioactive containers. Its major features include: two separate electrical circuits. High and low-speed motors are supplied for all major functions. There are four television cameras on the crane. One sighting on a ceiling grid system for location of the bridge and trolley. A second is located on the drum grab to check location of the drum as it is lowered. The other two cameras are for general area surveillance.

Operation of the drum processing unit is both remote and automatic. The drum moves to various positions in the drum process unit where it is uncapped, filled, recapped, and mixed by an end-over-end tumbling action, all under automatic control.

When mixing is completed, the drum is removed from the drum process unit and its weight and radiation level are recorded. The drum is then moved remotely to a decay area or loaded onto a truck.

Resins and other filter sludges would be dewatered in a decant tank and then pumped with a positive displacement pump designed by Stock for accurately metering the waste into the drums.

Dr. James Leonard, President, Protective Packaging, Inc. (PPI), discussed recent trends in low-level waste solidification. Dr. Leonard stated that waste volumes continue to increase as more operating conditions and maintenance problems are encountered. Recent changes in PWR water chemistry control is also expected to increase wastes for PWR's.

PPI has sold 20 waste solidification systems, two of them are in operation, with two more in start up testing. Their system uses modified urea-formaldehyde resin called "Tiger-Lock" plus acid catalyst as the solidification agent.

The trend in solidification system functional requirements include more specific requirements on characteristics of solidified product. Included are leach resistance, mechanical strength, radiation exposure and fire resistance. PPI recently immersed a drum solidified with Tiger Lock in burning fuel oil.

PPI is including more automation in their design. A single-tank system is included for dewatering powdered resin slurries. More remote handling is needed to meet requirements of Regulatory Guide 8.8 to keep inplant doses as low as practical. This system also includes automatic flushing.

The final waste solidification system described, was by Mr. Harold Heacock, Manager, Commercial Operations, United Nuclear Industries. Mr. Heacock described an economic analysis they had performed comparing the cement, urea formaldehyde and a modified system which adds sodium silicate to cement. The use of the latter, it is claimed, will increase the shipping efficiency, i.e., get more waste shipped per unit volume. The use of sodium silicate will also improve the physical characteristics over most other solidification agents for a greater spectrum of wastes.

A discussion of the current solidification systems was made, along with a description of the proposed modified cement system.

The treatment, handling and disposal of the nuclear power plant process wastes has become a substantially larger factor in the plants than had been originally anticipated.

Each of the solidification processes described has particular advantages in a given plant system and represents an evolving technology and improvements of the processes and equipment designs.

In the reactor systems where large quantities of waste are anticipated to be generated, the cost of solidifying and disposing of the solidified wastes will become a significant plant operating cost. Careful consideration needs to be given to the packaging efficiency and reliability in the selection of solidification system. Volume reduction of the high quantity of condensate demineralizer regenerants is being considered by several plants.

Solidifying these high concentrated concentrates may become necessary to help reduce the number of cubic feet shipped from a Utility.

Several waste solidification system suppliers are performing leach resistance tests. The use of additives may improve this quality. There is an industry need for the establishment of a standard test procedure for leach testing of waste materials. This is needed, if there is to be regulatory requirements for particular leach resistance characteristics. Workshop consensus agreed with the need for several <u>waste solidification product standards</u> and <u>standard test procedures</u>.