THE HISTORY OF RADWASTE AT ZION STATION
ITS PROBLEMS AND SOLUTIONS

Kevin J. Bennett, Radwaste Engineer

INTRODUCTION

Zion Station is located adjacent to Lake Michigan about 40 miles north of Chicago. The twin Zion units are four loop PWR's each rated at 1080 MWE with units 1 and 2 beginning commercial operation in 1973 and 1974 respectively.

DESIGN SPECIFICATIONS OF RADWASTE SYSTEM

The radwaste system at Zion Station was designed in 1967 when radwaste operations of a nuclear power plant received little consideration. At Zion, the system was to be automated with occasional operator interface to pump down a tank when full or to solidify waste. The solidification equipment purchased was designed for the 40 year life of the station; however, due to the under estimation of the input to radwaste, this was not the case.

The solidification equipment consisted of a resin/boric acid concentrates fill station, drum capper, tumbler, and a washing station. After washing, drums would be stored on conveyors, see Fig. 1. Because the input to radwaste was greater than expected, all of this equipment exceeded its design life in six years.

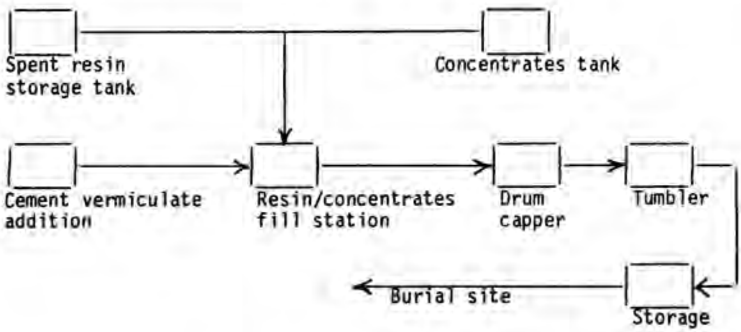

Fig. 1 - ORIGINAL RADWASTE DESIGN

The equipment purchased for cement and vermiculite addition to drums was placed into a small space. A fork lift was to be used to move loaded pallets for storage in the drumming area but, due to the small area provided, this was not possible.

The drum fill equipment provided additional problems. Resins were sluiced into a batch tank and then dumped into a drum. The fill line to this batch tank often clogged and it was not unusual to take an hour to fill one drum. An air lift was used to seal the drum to the resin fill hood. This lift often failed resulting in splashing and spillage of resins onto the drumming station floor.

Drumming of boric acid concentrates provided no better success. The fill line from the concentrates storage tank often froze. Eventually this line was eliminated and a hose was run from the tank to fill drums. The lift for the concentrates fill hood often failed and the sealing gasket required frequent replacement. The actual fill was done through a sight glass in the fill hood. Operator error led to over-filling drums and contamination problems. To prevent overfill, smaller amounts of concentrates were put into drums which led to poor packing efficiencies.

After the drums were filled they would be moved to a capping station. The capper would sometimes fail which would necessitate an operator going into the drumming room to manually tighten the ring bolt.

The next station was a drum tumbler for inspection of the drum for leaks and for mixing of the waste. The last station was a washer to remove any loose contamination on the drum.

After solification, drums were to be stored on gravity feed conveyors under the drumming station. Approximately one design year of radwaste was intended to be stored on the conveyors. In practice the storage conveyors could be filled in two months. The conveyors often jammed, and due to their layout, it was a very high man-Rem maintenance item.

The volume reduction equipment consisted of a 12 gpm evaporator and a DAW compactor. Very early in plant operation an additional 15 gpm evaporator was installed for radwaste service.

HISTORY OF OPERATING CONDITIONS AND RESULTANT COMPONENT FAILURES

The 12 gpm evaporator was originally intended to process all liquid waste at the station. Because of the volume of waste being created, the turbine building drains were segregated from the evaporator leaving about 16 gpm still being fed to a 12 gpm evaporator. A second evaporator, this one with a 15 gpm capacity, was then installed to makeup the difference.

Even with two evaporators, radwaste was still a problem due to extensive repairs and modifications which were made. The concentrates line from the 12 gpm evaporator often became clogged requiring shutdown of the evaporator for line cleaning.

The 15 gpm evaporator installed for radwaste was actually designed for boron recycle service. The purchase was made because of the availability of the unit even though problems were expected. Several modifications were performed on this evaporator. The package was installed on an elevated platform and the concentrates and distillate pumps were lowered to floor level since past experience with the evaporators in the boron recycle systems showed the type and location of the concentrates pumps led to cavitation and very short pump life. The concentrates pumps were also changed from a canned pump to another design.

The diaphragm valves supplied on the 15 gpm evaporator caused significant maintenance problems. The diaphragms would tear and block flow in various lines in the evaporator. Also the vent lines would become partially blocked resulting in extensive start up time after a concentrates shoot.

High levels of TSS in equipment and floor drain water led to short life of filters which were consequently bypassed for long periods. Failure of spray nozzles on the 12 gpm evaporator occurred along with tube fouling on both evaporators. Fouling led to increased concentration time before a batch of acid could be disposed of.

In 1978 both radwaste evaporators were taken out of service for chemical cleaning. The tube bundle of the 12 gpm evaporator was eddy current tested and found to have massive tube failures. Two new tube bundles were put on order, one is like replacement of 304SS for interim use until an Iconel 625 bundle arrives as a final replacement.

The 12 gpm evaporator is still undergoing modifications and has yet to be returned to service. The 15 gpm evaporator was run for a brief time in 1979 but, due to operational difficulties, never returned to full time service. Recently this evaporator was disposed of to make room for a new crystalizer.

PRESENT OPERATIONAL AND MAINTENANCE PROBLEMS DUE TO SILICA

Operating with both radwaste evaporators out of service led to recycling water with low level silica back to the primary plant. The major chemical contaminant was silica. Over the years silica levels built up to 6.0 ppm in the reactor coolant system. No technical specifications were violated by the high silica, however, these levels are not recommended by the nuclear steam system supplier.

Treatment by systems available at the station cannot selectively remove silica from borated streams. With recycle of nearly the entire waste stream, water with silica was processed through the boron recovery system. The boric acid evaporator feed demineralizers were exhausted earlier than expected and poor sampling allowed continued use of these beds. Also, the spent resin storage tank was filled and became inoperable due to the solidification equipment problems, consequently resin change-out has been done on cask availability rather than effluent quality.

The evaporators in the boron recycle system concentrate all salts which go into them therefore, over the years, the silica level in the boric acid storage tanks reached nearly 80 ppm. The contents of the three boric acid concentrates tanks were recently disposed of, at significant expense, to prevent recycling the silica to the plant's primary system. Water in the spent fuel pit and refueling water storage tanks was also replaced as a means to improve total plant chemistry.

REMEDIAL MEASURES TAKEN

Presently radwaste is processed by a portable demineralizer. In the past this demin was replaced on radiation levels. Approximately 300,000 gallons of waste would be processed before replacement was necessary. Because of chemical problems associated with recycled water the change out is now determined by effluent quality. However, 250,000 gallons, or about three weeks operation, can still be processed before the demin reaches its end point.

To ensure high quality boric acid in the storage tanks no acid has been recycled to them since October 1980. Through a sampling program established to ensure chemical quality of all borated streams to be recycled, only waters of acceptable quality will be processed through the boron recycle system in the future. Borated waters will only be processed through one demineralizer train at a time; when one train is spent, the other will be put into service. Also, the spent resin storage tank is being modified and drained to ensure resin changes are made when effluent quality dictates.

An ongoing leak reduction program at the station has reduced the radwaste input to 6 gpm. Weekly plant walk downs are performed to find sources of waste input. Daily readings are taken on all waste tank levels and pump run times to determine where problems may arise. A leakage report is written after each refueling outage outlining where problems occurred. These reports and data serve as a basis for identifying reoccuring problems.

Work is in progress to return the 12 gpm evaporator to service in 1982. The current reduced radwaste inputs should be able to be entirely treated by the evaporator and it is expected that subsequently plant chemistry improvements will be realized. The portable demineralizer will only be used as a back up for the evaporator during maintenance outages.

FUTURE MODIFICATIONS FOR LONG TERM SOLUTION

The 12 gpm evaporator is being repaired to eliminate the use of the portable demineralizer. Longer term, volume reduction will be achieved with a radwaste crystalizer. This unit will be installed in the present drum storage and 15 gpm evaporator cubicles. June of 1983 is the expected start up date for the crystallizer.

The original solidification equipment has been disposed of and the station now does all solidification in bulk liners, see Fig. 2. In order to provide a back up to this, the station is investigating the option of a drum solidification system. To allow for more flexibility in shipping, the station is also looking into the merits of a five year waste storage facility, see Fig. 3.

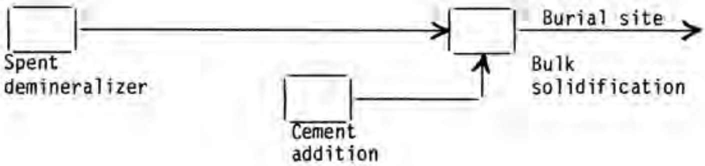

Fig. 2 - PRESENT RADWASTE SYSTEM

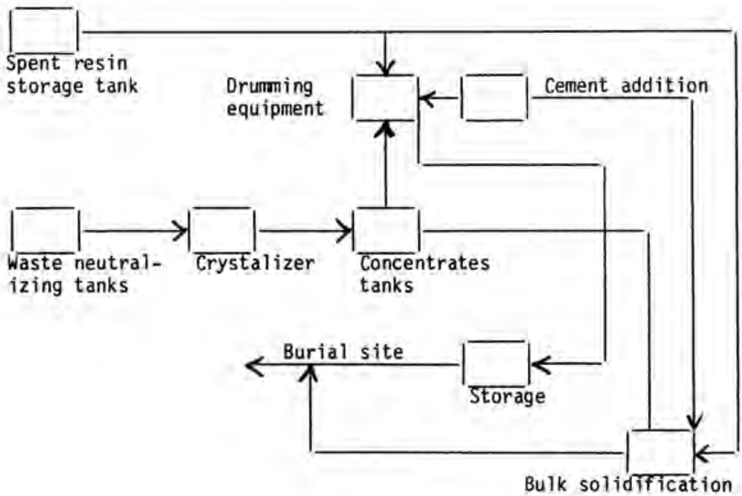

Fig. 3 - FUTURE RADWASTE CAPABILITY

Extensive testing is being conducted with reverse osmosis (RO) as a radwaste volume reduction process. Initial results indicate RO is effective at removing silica from borated water. Recommendations as to the benefits of RO processing should be made soon.

CONCLUSION

Serious problems have occurred at Zion due to inadequate equipment. Remedial measures are being taken to correct the problems. The modifications in progress are being installed with confidence due to the improvements in this type of equipment in the last ten years. Other technologies are being investigated to improve even further the volume reduction factor and improve equipment reliablity.