"MINIMUM RADWASTE SYSTEM TO SUPPORT COMMERCIAL OPERATION-WHAT EQUIPMENT CAN BE DEFERRED?"

by

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ABSTRACT

Because of cash flow problems being experienced by utilities as nuclear power stations approach completion, areas of the plant for which the completion of the construction effort could be deferred past commercial operation should be reviewed. The radwaste treatment systems are prime candidates for such a deferral because of the availability, either temporary or permanent, of alternative treatment methods for the waste streams expected to be produced. In order to identify the radwaste equipment, components and associated hardware in the radwaste building which could be deferred past commercial operation, a study was performed by Impell Corporation to evaluate the existing radwaste treatment system and determine the minimum system necessary to support commercial operation of a typical BWR.

The study identified the minimum-installed radwaste treatment system which, in combination with portable temporary equipment, would accommodate the waste types and quantities likely to be produced in the first few years of operation. In addition, the minimum-installed system had to be licensable and excessive radiation exposures should not be incurred during the construction of the deferred portions of the system after commercial operation.

From this study, it was concluded that a significant quantity of radwaste processing equipment and the associated piping, valves and instrumentation could be deferred. The estimated savings, in construction manhours (excluding field distributables) alone, was over 102,000 M-H.

INTRODUCTION

Because of the concern with potential cash flow problems as a nuclear power plant approaches completion, areas of the plant for which the completion of the construction effort can be deferred past the commercial operation date should be investigated. The radwaste treatment systems in the radwaste building are prime candidates for such a deferral because of the availability, either temporary or permanent, of alternative treatment methods to accommodate the waste streams expected to be produced. In order to identify specifically the radwaste equipment, components and associated hardware in the radwaste building which could be deferred past commercial operation, a study of the radwaste treatment systems at a typical BWR was performed.

OBJECTIVE

The objective of the study was to identify the minimum-installed radwaste treatment system which, in combination with portable temporary equipment, could accommodate the waste types and quantities likely to be produced in the first year of operation. In addition, the minimum-installed system had to be licensable and excessive radiation exposures should not be incurred during the construction of the deferred portions of the system after commercial operation.

The study included: (a) an assessment of the current construction status of the equipment and components within the radwaste subsystems, (b) an identification of processing equipment or subsystems which could be deferred, (c) a discussion of alternative treatment methods and the operational impacts of their use, (d) a detailed listing of equipment, components and associated hardware which could be deferred, (e) a rough order-of-magnitude estimate of the quantities of hardware to be deferred and the associated construction manhours and (f) recommendations for a radwaste system configuration which should be considered for permanent installation.

The primary aim of the study was to maximize the construction effort which could be deferred, the election to install some of the recommended deferred hardware because of the ease of installation or to reduce operational risks in the interim period prior to installation of the permanent system were not addressed.

ALTERNATIVE TREATMENT METHODS

The following provides a discussion of the alternative treatment methods recommended and the basis for the recommendations. In addition, the process equipment which could be deferred because of the alternative treatment methods is identified. The listing of the deferred hardware associated with the recommendations discussed below is provided later.

Waste Collector Subsystem

The treatment method designed for the plant equipment drains was filtration followed by cation, anion and mixed-bed ion exchangers. The ion exchange beds were designed for in-place regeneration of the resins. It was recommended that the equipment drains be treated by filtration followed by mixed-bed ion exchange operated in the throw-away mode. This recommended alternative treatment method is in use in a majority of BWRs currently operating in the U.S. and, consequently, the performance should be adequate.

The decontamination factors might be slightly lower than the designed system, but should be acceptable. This is particularly true in the first year of operation when fuel performance problems should be minimal. Also, the operating costs could be slightly higher for the throw-away mode, however, the increase should not be significant. The Appendix I analysis would have to be reviewed to determine if any re-analysis is required because of the modified treatment method. The use of a single mixed-bed ion exchanger allows the deferral of the installation of the cation and anion ion exchangers including the associated piping, valves and instrumentation.

Floor Drain Collector Subsystem

Plant floor drains were designed to be treated by either filtration followed by cation, anion and mixed-bed ion exchangers or by evaporation. The ion exchangers were designed for in-place regeneration of the resins. It was recommended that the plant floor drains be treated by filtration and mixed-bed ion exchange using the alternative treatment equipment recommended for the Waste Collector Subsystem. Many operating BWRs routinely treat their floor drains by filtration and ion exchange while other BWRs only treat the floor drains by ion exchange whenever adequate capacity exists in the Waste Collector Subsystem.

If the plant floors are washed down prior to plant operation to reduce silica levels in the waste influent streams, the silica loadings on the radwaste ion exchanger should be acceptable. Also, with the absence of chemical regeneration of the plant ion exchangers and if the site is a fresh water site, the conductivity levels in the floor drains should not be high. It will, however, be necessary to monitor and control the oil contamination levels in the floor drains to protect the radwaste ion exchanger.

If additional processing capacity is required, portable temporary filtration and ion exchange equipment could be provided in the truck shipping bay to treat plant equipment drains. This would off-load the in-plant equipment and free it up to be used to treat floor drain wastes which are likely to be difficult to treat in portable temporary equipment because of the higher suspended solids loadings in this waste stream.

This alternative treatment method will allow the deferral of the floor drain collector filter and the cation and anion ion exchangers including the piping, valves and instrumentation.

Regenerant Waste Subsystem

The regenerant waste subsystem was designed to treat the regenerant chemical wastes from the regeneration of the condensate demineralizers and radwaste ion exchangers. It was recommended that the condensate demineralizers (and the radwaste ion exchangers as discussed above) be operated in the throw-away mode. Many deep bed condensate demineralizer BWRs operate their systems in the throw-away mode because of failures or operating problems with the regenerant evaporators. The operating costs for the condensate demineralizer system might be slightly higher in the throw-away mode, but would not likely be significant with a fresh-water main condenser cooling system.

Operating the radwaste ion exchangers and condensate demineralizers in the throw-away mode allows the deferral of the installation of the piping, valves and instrumentation associated with the waste regenerant pumps. It also allows the deferral of the installation of the Waste and Regenerant Evaporation Systems including evaporators, tanks, pumps, piping, valves and instrumentation. The miscellaneous building floor drains would have to be rerouted from the Regenerant Waste Tank to the Backwash Tank for subsequent processing in the radwaste system. With the elimination of the chemical regeneration function in the radwaste building, the high conductivity sump could also be deferred.

Sludge Dewatering Subsystem

Sludges and resins from the plant filters and ion exchangers were designed to be collected in phase separators and a backwash tank for dewatering in a centrifuge or flatbed filter. It was recommended that the dewatering step for all resins and sludges be performed by the use of dewatering shipping containers in the truck shipping bay. This technique of dewatering sludges and resins in specially-designed shipping containers is in use in dozens of operating plants, both PWRs and BWRs, and should be acceptable. If solidification was required for some or all of the waste streams, then the solidification step could also be performed in the shipping container. As with the dewatering, there are many operating plants using in-container solidification for their wastes.

The use of in-container dewatering (and solidification, if required) allows the deferral of the installation of the flatbed filter, including the precoat and body feed systems and the filtrate tank and pump, and the centrifuge. In addition, the piping, valves and instrumentation associated with these systems could also be deferred.

Miscellaneous Subsystems

If the radwaste ion exchangers were operated in the throw-away mode, then the caustic and acid addition system could be deferred. This includes all inter-connecting piping and valves and all system instrumentation.

For the cleaning or laundering of anti-contamination clothing, it was recommended that an outside contractor be used for the first year of operation. This allows deferral of the installation of the dry cleaning equipment and the associated electric steam boilers. This approach may cause an increase in clothing inventories because of the longer turn-around times associated with the use of an outside contractor. Several operating plants have used and continue to use outside contractors for this service and find it acceptable.

Because of the unlikelihood of experiencing significant fuel failures in the first year of operation, the radwaste tank vent exhaust filters should not be required. It was recommended that the installation of these filters be deferred until after the first year of operation.

DETAILED LISTING OF DEFERRED HARDWARE

Based on the process equipment which was recommended to be deferred past commercial operation, the following provides a detailed identification of the specific hardware associated with the deferral.

To minimize radiation exposures which would be incurred at a future date when the piping and valves associated with deferred process equipment are installed, it was recommended that certain portions of the piping be installed. This was particularly true for piping routed in tank cells and piping tunnels. Termination points, were located to facilitate future completion of the piping systems without significant radiation exposures.

After reviewing system flow diagrams and piping drawings, rough quantity take-off were developed and are tabulated in Table I. In addition, the number of construction manhours associated with the installation of the deferred hardware were estimated and are presented in the same table. The construction manhour estimates were based on typical unit rates.

SUGGESTIONS FOR PERMANENT RADWASTE SYSTEM INSTALLATION

The following is a brief description of the permanent radwaste system configuration that was recommended. The recommendations for the permanent radwaste system configuration were based on technical judgement and were made without the benefit of detailed studies or analyses. However, the judgements were based on considerable experience in the waste management area and on past studies.

Waste Collector Subsystem

For the permanent system configuration, it was recommended that consideration be given to the permanent deletion of the cation and anion ion exchangers and the regeneration capability on the mixed-bed ion exchanger. Because of extremely low conductivity levels in the equipment drain wastes, the cost increase of operating the mixed-bed in a throw-away mode as opposed to a regenerable cation, anion, and mixed-bed system would not be significant. The decontamination factors for a single mixed-bed have proven adequate in dozens of operating BWRs, even though they would likely be lower than with a three-bed system. Lastly, the operating complexity and chances for error would be significantly reduced for the throw-away mode. The regeneration steps in the 3-bed system and the subsequent concentration step in the evaporators would require greater operator attention than the relatively simple dewatering step.

Floor Drain Collector Subsystem

For the permanent Floor Drain Collector subsystem, it was recommended that a second filter be installed (assuming that the first filter is deemed acceptable in the first year of operation) followed by a new carbon bed and mixed-bed ion exchanger. It was recommended that the ion exchanger be operated in the throw-away mode and not regenerated. The second filter was recommended for long-term reliability and back-up to the waste collector filter. The carbon bed should result in increased run lengths on the mixed-bed ion exchanger and thus reduce the operating costs for the throw-away mode. The second ion exchanger could be used to treat only floor drains or it could be valved to operate in series with the Waste Collector ion exchanger. This series arrangement would produce higher DFs, if required, and should also increase the run lengths on the beds thereby reducing the operating costs. The use of ion exchange in place of evaporation for floor drains offers considerable operational and reliability advantages over evaporation which was the fundamental reason for the selection of this treatment in the long-term.

Regenerant Waste Subsystem

It was recommended that a detailed study be performed to examine the operating costs and waste disposal volumes associated with the condensate demineralizers operated in the throw-away mode as compared to the regeneration mode. In addition, the increased operating complexity associated with the regeneration and subsequent evaporation of the chemical regenerant solutions should be evaluated against the simpler throw-away operation and against the expected higher operating costs for the throw-away mode. If this detailed study would conclude that regeneration and evaporation is the better approach for the condensate demineralizer system, then consideration should be given to installing only one evaporator. A single evaporator should be adequate to handle the wastes, particularly if the floor drains were treated by ion exchange. The back-up to a single evaporator would be a reversion to the throw-away mode for the condensate demineralizer resins.

Solids Dewatering Subsystem

It was recommended that the need for the flatbed filter and centrifuge in the as designed system be established after a final decision was made on whether or not to install a permanent solidification system and the type of system to install. The dewatering step prior to solidification may not be necessary or offer any advantages for such solidification systems as an asphalt system or an intensive dryer/solidification system. These systems have an integral dewatering step in the solidification processing and, therefore, unless there are capacity concerns with either of the two systems an external dewatering step is not likely to be necessary. Therefore, it was recommended that a decision to install the flatbed filter and centrifuge be delayed and considered in combination with a decision on a permanent solidification system.

Miscellaneous Subsystems

If the radwaste ion exchangers were operated in the throw-away mode, it was recommended that the acid and caustic systems be simplified to accommodate the waste neutralization function only and delete the regeneration functions.

For the long-term, it was recommended that dry cleaning machines be installed to clean the anti-contamination clothing. Plants with such equipment have expressed satisfaction with the performance of the equipment and have indicated that smaller inventories of clothing can be maintained. The additional manpower required to operate the machines is off-set by the elimination of the manpower required to survey, inventory and package the clothing for shipment to an outside contractor.

Also, with a re-examination of the Appendix I analysis, it may be possible to permanently delete the radwaste building ventilation exhaust filtration system.

Table I

Quantity Take-Offs For Deferred Equipment

Item	Quantity	Unit Rate (Manhours)	Manhours
Equipment			
Cation IX Bed	2	346	693
Anion IX Bed	2	346	693
Mixed IX Bed	1	346	346
Floor Drain Filter	1	2400	2400
Flatbed Filter	1		
Evaporator	2	1102	2205
Centrifuge	1	800	800
Tanks	3	-[a]	-
Strainer	1	-[a]	-
Subtotal			7131
Piping			
10"	10	7.99	80
6"	595	4.71	2803
4"	478	5.64	2695
3"	837	3.12	2611
2"	1054	2.70	2846
1-1/2"	1768	2.70	4774
1" & below	2457	2.70	6634
Subtotal			22443
Piping Welds			
10"	1	32.35	22
6"	18	13.39	241
4"	12	10.06	121
3"	9	9.79	88
Subtotal			472
Valves			
MOV-6"	2	13	26
AOV-4"	3	4.24	13
AOV-3"	17	12.21	208
AOV-2"	15	6.5	98
AOV-1-1/2"	23	6.5	150
AOV-1"	12	6.5	78
Manual-6"	2	13.0	26
Manual-4"	3	4.24	13
Manual-3"	10	12.21	122
Manual-2"	21	6.5	136
Manual-1-1/2"	54	6.5	351
Manual-1" & below	67	6.5	435
Subtotal			1656
Instruments			
Sensing Elements	82	11.97	982
Process Switches	25	11.97	299
Transmitters	32	11.97	383
Subtotal			1664
Hangers			
2-1/2" & above	[b]		29450
2" & below	[b]		10097
Subtotal			39547
Electrical			
Cabling	69000[c]	.08	5520
Terminations-Power	134	1.0	134
Terminations-I&C	1334	.333	444
Subtotal			6098
Insulation	4320[d]	.616	2660
Tubing	4000[e]	5.092	20368
TOTAL			102045[f]

Footnotes

(a) Installation included in filter account.

(b) Hanger installation manhours were estimated by taking the ratio of the deferred piping quantity to the total piping quantity times the percent hangers to be completed times the total manhours for hangers.

(c) Cabling length was estimated using a specified number of cables per instrument, motor and AOV and multiplying times an average run length of 200' for I&C cable and 100' for power cable.

(d) Insulation quantity was assumed to be 80% of total in radwaste building.

(e) Tubing quantity was estimated by multiplying the number of instrument sensors and AOVs by an average run length of 20'.

(f) Does not include: field distributables, conduit installation painting, testing, rework and structural work.