11.2 Liquid Waste Management System

This section of the reference ABWR DCD including all subsections, figures, and tables is replaced completely. This is due to a departure in the design of the liquid radioactive waste system. The departure includes the use of mobile technology and deletes the forced-circulation concentrator system.

STD DEP 11.2-1

11.2.1 Design Basis

11.2.1.1 Design Objective

The Liquid Waste Management System (LWMS) is designed to control, collect, process, handle, store, and dispose of liquid radioactive waste generated as the result of normal operation and anticipated operational occurrences, including refueling operation and back to back refueling.

The LWMS is housed in the radwaste building and consists of the following four subsystems:

- Low conductivity (equipment) drain subsystem
- High conductivity (floor) drain subsystem
- Detergent drain subsystem
- Chemical drain subsystem

The LWMS Process Flow Diagram is provided in Figure 11.2-1. Radwaste System Piping and Instrumentation Diagrams are provided in Figures 11.2-2. The radwaste building general arrangement drawings are provided in Figures 1.2-23a through 1.2-23e. The LWMS equipment codes and component capacities are provided in Tables 11.2-1 and 11.2-4, respectively. Capability of the LWMS to process expected waste is provided in Table 11.2-2. The process decontamination factors are provided in Table 11.2-5. Normal and maximum daily inputs for the LWMS subsystems are provided in Table 11.2-6.

The equipment and high conductivity drainage collection system, a major input source to the LWMS, is described in Subsection 9.3.8.

Process and effluent radiological monitoring and sampling systems are described in Section 11.5.

The LWMS complies with Regulatory Guide (RG) 1.143 guidance regarding liquid radwaste treatment systems.

No subsystems of the LWMS and the radwaste building that house the LWMS are shared between STP 3 & 4.

11.2.1.2 Design Criteria

The criteria considered in the design of this system include (1) minimization of solid waste shipped for burial, (2) reduction in personnel exposure, (3) minimization of offsite releases, and (4) maximizing the quality of water returned to the primary system. 'Minimization' is based on good engineering practice, and/or cost benefit analysis to keep waste generation and dose as low as reasonably achievable.

The design criteria for the LWMS are:

- The LWMS is designed so that no potentially radioactive liquids can be discharged to the environment unless they have been sampled and verified to be within the limits for discharge. Off-site radiation exposures on an annual average basis are within the limits of 10 CFR 20 and 10 CFR 50 Appendix I.

- The LWMS is designed to meet the requirements of General Design Criteria (GDC) 60 and 61 and the guidance of RG 1.143. RG 1.143 provides design guidance in regard to natural phenomena hazards, internal and external man-induced hazards, and quality group classification and quality assurance provisions for radioactive waste management systems; structures and components. Further, it describes provisions for mitigating Design Basis Accidents (DBA) and controlling releases of liquids containing radioactive materials, e.g., spills or tank overflows, from all plant systems outside reactor containment (see Table 11.2-1 Equipment Codes for Radwaste Equipment from RG 1.143).

- The LWMS is designed to keep the exposure to plant personnel "As Low As Reasonably Achievable" (ALARA) during normal operation and plant maintenance, in accordance with RG 8.8.

- All atmospheric liquid radwaste tanks are provided with an overflow connection at least the size of the largest inlet connection. The overflow is connected below the tank vent and above the high-level alarm instrument location. Each collection tank room is designed to contain the maximum liquid inventory in the event that the tank ruptures as described in Subsection 11.2.2.5. The radwaste building walls are sealed and coated. Tank cubicle liners are utilized to prevent accidental releases to the environment.

- The system is designed to control releases of radioactive materials within the numerical design objectives of Appendix I to 10 CFR 50.

- The system is designed to provide sufficient capacity, redundancy, and flexibility to meet the concentration limits of 10 CFR 20 during periods of equipment downtime and during operation at design basis fuel leakage (see Table 11.2-2 for capability of the four subsystems to process maximum inputs).

Compliance with numerical guidelines in Appendix I to 10 CFR 50 for offsite radiation doses as a result of liquid effluents during normal plant operations, including anticipated operational occurrences, is provided in Subsection 12.2.2.2. To demonstrate compliance with Section II, paragraph D of Appendix I, a cost-benefit analysis was performed in accordance with the guidance of Regulatory Guide 1.110. The analysis postulated the addition of three (3) augments to the LWMS of reasonably demonstrated technologies. These augments were:

- the addition of one low capacity evaporator to the liquid discharge stream, or
- the addition of the lowest capacity demineralizer to the liquid discharge stream, or
- the addition of one 10,000 gallon holdup tank to the liquid discharge stream(least cost option).

Regulatory Guide 1.110 cost data used to evaluate the three augments to the LWMS are summarized in the Table 11.2-7.

The total annual costs associated with implementing the three augments to the LWMS and the corresponding benefit-cost ratio are determined using the methodology prescribed in Regulatory Guide 1.110, the cost data provided in Table 11.2-7, and the collective 50 mile total body dose (due to liquid releases) that is presented in Table 5.4-9 of the STP 3 & 4 Environmental Report. The collective 50 mile total body dose is conservatively considered to be the total dose saved as a result of implementing each augment to the LWMS. The total annual cost of each augment to the LWMS and the associated benefit cost ratio are summarized in Table 11.2-8. These results demonstrate that the total annual cost associated with each augment to the LWMS, including the least cost option is substantially larger than the benefit derived from each augment. The cost-benefit numerical analysis, required by 10 CFR 50 Appendix I Section II Paragraph D, demonstrates that the addition of items to the LWMS of reasonably demonstrated technology will not provide a favorable cost benefit. Therefore, the STP 3 & 4 prescribed LWMS meets the numerical guides for dose design objectives.

Table 11.2-7 REGULATORY GUIDE 1.110 COST DATA (1) (Costs are in 1000s of 1975 Dollars)			
Cost- Benefit Parameter	15 gpm Radwaste Evaporator	50 gpm Demineralizer (BWR 2nd Waste Demineralizer in Series)	10,000 Gallon Tank
Equipment and Material Direct Cost (2)	386	43	55
Direct Labor Cost (DLC)(2)	201	29	43
Labor Cost Correction Factor (LCCF)(3)	1	1	1
Annual Operating Cost (AOC)	20	15	1
Annual Maintenance Cost (AMC)	30	5	2

Notes:
(1) All costs are on a per unit basis.
(2) Equipment and Material Direct Costs and Direct Labor Costs are from Table A-1 of Regulatory Guide 1.110.
(3) The Labor Cost Correction Factors are from Table A-4 of Regulatory Guide 1.110. The lowest LCCF is chosen which maximizes the benefit.
(4) The Annual Operating Costs are from Table A-2 of Regulatory Guide 1.110.
(5) The Annual Maintenance Costs are from Table A-3 of Regulatory Guide 1.110.

Table 11.2-8 Liquid Radwaste Augment Benefit Cost Ratio Summary

Augments	Total Annual Costs (1975 Dollars)	Collective 50 Mile Total Body Dose Saved per Year (Person-Rem)	Benefit in 1975 Dollars (1000 dollars x Person Rem Saved)	Benefit Cost Ratio
15 gpm Radwaste Evaporator	117,940	0.003	3.00	2.54E-05
50 gpm Demineralizer (BWR 2nd Waste Demineralizer in Series)	28,330	0.003	3.00	1.06E-04
10,00 Gallon Tank	14,340	0.003	3.00	2.09E-04

Process and effluent radiological monitoring systems are described in Section 11.5.

The LWMS has no safety-related function. Failure of the system does not compromise any safety-related system or component nor does it prevent shutdown of the plant. No interface with the Class IE electrical system exists.

STP 3 & 4 is responsible, initially and subsequently, for the identification of mobile/portable LWMS connections that are considered non-radioactive, but later may become radioactive through interfaces with radioactive systems; i.e., a non-radioactive system becomes contaminated due to leakage, valving errors or other operating conditions in radioactive systems. STP 3 & 4 uses operating procedures to ensure the guidance and information in Inspection and Enforcement (IE) Bulletin 80-10 (May 6, 1980) is followed. The LWMS mobile systems are not connected to the potable or sanitary water system. All non-radioactive connections (e.g., makeup water for flushing, service air for sluicing process) to the radwaste system (including the mobile system) contain double isolation e.g., check valves and isolation valve to prevent cross contamination.

Subsection 11.2.1.2.4 addresses design requirements to minimize contamination of the facility and environment, facilitate decommissioning, and minimize the generation of radioactive waste, in compliance with 10 CFR 20.1406 including design requirements for connections that are considered non-radioactive, but later may become radioactive through interfaces with radioactive systems.

11.2.1.2.1 Quality Classification, Construction, and Testing Requirements

The quality group classification, and corresponding codes and standards that apply to the design of the LWMS are discussed in FSAR Section 3.2.

The non-safety related SSC Quality Control Program for the LWMS is described in the STP 3 & 4 Quality Assurance Program description in section 17.5S.

11.2.1.2.2 Seismic Design

The seismic category and corresponding codes and standards that apply to the design of the LWMS are discussed in FSAR Section 3.2.

11.2.1.2.3 Occupational Exposure

Design features to minimize occupational exposure include:

- Design of equipment for easier decontamination in order to reduce maintenance time
- Location of instruments requiring calibration in a central station outside of equipment cells
- Arrangement of shield wall penetrations to avoid direct exposure to normally occupied areas

- Piping design to minimize crud traps and plateout (there are no socket welds in contaminated piping systems)
- Provision for remote pipe and equipment flushing
- Utilization of remote viewing and handling equipment as appropriate
- A centralized sampling station to minimize exposure time
- Controlled tank vents

11.2.1.2.4 Minimization of Contamination and Radwaste Generation

The LWMS radwaste system, including mobile units as applicable, is designed to minimize contamination of the facility and environment, facilitate decommissioning, and minimize the generation of radioactive waste, in compliance with 10 CFR 20.1406. The following radwaste system design features meet 10 CFR 20.1406 requirements:

- Leakage is controlled and collected to reduce contamination of building floors and interconnecting systems (by use of curbing, floor sloping to local drains, floor-to-floor seals over expansion joints, wall-to-floor joint seals, sheathed hoses, drip pans or containment boxes, backflow preventers, siphon breakers, self-sealing quick disconnects, etc.).
- The Condensate Storage Tank, which is located outdoors (Figure 1.2-37 - Plot Plan), has liquid level monitoring with alarms in the control room. The tank overflows, drains and sample lines are routed to the LWMS. A dike is provided around the tank to prevent runoff in the event of a tank overflow. A drain within the dike is routed to the LWMS.
- The radwaste system design minimizes embedding contaminated piping in concrete, to the extent practicable.
- Provisions are included to clean contaminated materials (e.g., system components, equipment) and reuse resin beds when feasible.
- Mobile liquid radwaste treatment systems with interconnections to permanently installed radwaste system components include provisions that (i) avoid the contamination of nonradioactive systems, (ii) prevent uncontrolled and unmonitored releases of radioactive materials into the environment, and (iii) avoid connections with potable and sanitary water systems.
- Pressure testing of temporary and flexible lines, system piping embedded in concrete, and effluent discharge lines are performed in accordance with RG 1.143 guidance.
- Corrosion resistant properties of all system piping and valves associated with transfer lines to storage tanks and discharge piping in concrete are included. The LWMS also includes features designed for early detection of leaks and spills (e.g., leak detection sumps and wells).

11.2.1.2.4.1 Minimization of Contamination to Facilitate Decommissioning

Examples of the design features for operation that minimize contamination and facilitate decommissioning are as follows:

- Equipment design minimizes the buildup of radioactive material and facilitates flushing of crud traps.
- Equipment design contains provisions for draining, flushing, and decontamination of the equipment and associated piping.
- In order to minimize leakage and releases of radioactive gases, pressure retaining components of process systems utilize welded construction to the maximum practicable extent. Flanged joints or suitable rapid disconnect fittings are used where maintenance or operational requirements clearly indicate that such construction is preferable. Pitching of lines is applied where possible to minimize the potential for entrapment of radioactive material.
- Radwaste system connections including to the mobile system for the process of radioactive liquid waste (including slurries and sludges) utilize welded construction to the maximum practicable extent.
- All non-radioactive connections (e.g., makeup water for flushing, service air for sluicing process) to the radwaste system (including the mobile system) contain double isolation e.g., check valves and isolation valve to prevent cross contamination of the radioactive system. The radwaste mobile systems are not connected to the potable or sanitary water system.
- All radwaste system components, piping and valves are constructed of corrosion resistant material compatible with the process fluid.
- Penetrations through outer walls of the radwaste building are sealed to prevent miscellaneous leaks to the environment.
- Equipment vents, to the maximum extent possible, are piped directly to the radwaste building HVAC system to prevent airborne contamination of the radwaste building.
- Appropriately sloped floors and floor drains are provided in areas where potential for a spill exists to limit the extent of contamination.
- Provisions for epoxy-type or steel wall and floor coverings which provide smooth surfaces to minimize contamination and facilitate decontamination.
- Low conductivity and high conductivity sumps are stainless steel lined to reduce crud buildup and to facilitate decontamination.
- Radwaste tanks containing radioactive liquids are located in shielded compartments. The tank compartments are designed to contain leakage and the postulated failure of a tank or pipe rupture as described in Subsection 11.2.2.5.

- Curbs, drip pans or thresholds with floor drains routed to the radwaste system are provided for pumps and mobile treatment systems. Leakage is prevented from entering unmonitored and non-radioactive systems and ductwork in the area.

- System controls provide interlocks to prevent spillage from potential operator errors as well as equipment failure and provisions to collect leakage from LWMS. Therefore, no single operator error or equipment malfunction (single failure) results in an uncontrolled release of radioactive material to the environment.

- The LWMS provides one discharge line to the Main Coolant Reservoir (MCR) via the circulating water system. Administrative control and radiation monitoring equipment are placed on this line to measure the activity discharged, to assure no unintended release, and to assure that specified limits are not exceeded. A high radiation signal from this monitor will close the discharge valve.

11.2.1.2.4.2 Minimization of Radioactive Waste Generation

Examples of the design features to minimize the generation of radioactive waste include the following:

- The LWMS is divided into four subsystems (low conductivity waste (LCW) subsystem, high conductivity waste (HCW) subsystem, detergent waste subsystem, and chemical drain subsystem) which segregate the various types of liquid radwaste based on their composition and process requirements. The segregation is used to help provide the optimum water quality and radionuclide removal prior to recycle to the condensate storage tank or plant discharge. The segregation of the LWMS allows optimization of the LWMS treatment process and minimizes the generation of sludge and spent resin from the LWMS treatment. The sludge and spent resin generated from the radioactive material removed from the LWMS are transferred to the solid waste system for disposal.

- The LWMS is designed with margin so that liquid waste should not be discharged except as needed to maintain the plant water balance. The radwaste system is designed to maximize the recycling of water within the plant, which minimizes the releases of liquid to the environment. Maximizing recycling serves to minimize the potential for exposure of personnel in unrestricted areas from the liquid release pathway.

- Regeneration of the condensate demineralizers is not performed. Resin regeneration, produces a large volume of waste, every three to five days. The resin is replaced when necessary. Also, the filtration of condensate through high efficiency filters upstream of the condensate demineralizers reduces the amount of insoluble solids which come into contact with the resin.

11.2.2 System Description

The LWMS collects, monitors, processes, stores, and disposes of potentially radioactive liquid waste collected throughout the plant.

The low and high conductivity drainage systems are described in Section 9.3.

Potentially radioactive liquid wastes are collected in tanks located in the radwaste building. System components are designed and arranged in shielded enclosures to minimize exposure to plant personnel during operation, inspection, and maintenance. Tanks, processing equipment, pumps, valves, and instruments that may contain radioactivity are located in controlled access areas.

The LWMS normally operates on a batch basis. In the event of liquid waste input surge, such as from refueling operations, including back to back refueling, the LWMS is operated on a continuous basis to support plant operation. Provisions for sampling at important process points are included. Protection against accidental discharge is provided by detection and alarm of abnormal conditions and by administrative controls.

The LWMS is divided into four subsystems, so that the liquid wastes from various sources can be segregated and processed separately, based on the most economical and efficient process for each specific type of impurity and chemical content. Cross-connections between subsystems provide additional flexibility in processing the wastes by alternate methods and provide redundancy if one subsystem is not operating.

The LWMS is designed to treat process liquids with radionuclide concentrations associated with the design basis fuel leakage and produce water suitable for recycling to the condensate storage tank. Operational and outage related water balance considerations occasionally may require the discharge of processed radioactive effluent from the sample tanks to the environment, in which case concentrations of radionuclides in the effluent will meet the requirements of 10 CFR 20. Radiation exposure to persons in unrestricted areas resulting from liquid waste discharged during normal operation and anticipated operational occurrences will be less than the values specified in 10 CFR 50, Appendix I. Liquid discharge to the MCR via the circulating water system can be initiated from only one sample tank at a time through a locked-closed valve that is under administrative control. The discharge sequence is initiated manually. No single error or failure will result in discharge to the MCR via the circulating water system. The LWMS provides one discharge line to the MCR via the circulating water system for the release of liquid. Radiation monitoring equipment is placed on this line to measure the activity discharged and to assure that specified limits are not exceeded. A high radiation signal from this monitor automatically closes the discharge valve. The discharge line is fed by either the hot shower drain (HSD) sample tank (a very low level radioactivity source) or one of the LCW or HCW sample tanks.

The LWMS consists of the following four process subsystems described in the following subsections.

11.2.2.1 Low Conductivity Subsystem

The LCW collector tanks receive low conductivity inputs from various sources within the plant. These waste inputs have a high chemical purity and are processed on a batch basis. The low conductivity drain subsystem consists of four LCW collector tanks and pumps, a mobile based processing system (typically consisting of a collection of filtration systems (carbon and membrane filters), reverse osmosis system, deep-bed ion exchanger systems, and the associated piping, instrumentation and electrical systems as required), and two sample tanks and sample pumps.

The LCW collected in the LCW collector tanks is sampled and the treatment process is selected based on the chemical and radiological removal requirements. Provisions for bypassing processing units such as the charcoal filters, the reverse osmosis units and the polishing demineralizer are provided. The LCW (primarily equipment drains) processing based on the expected high purity water quality may not always need to include the charcoal filter and reverse osmosis units. These units provide redundant processing components for the HCW subsystem.

The LCW collector tanks influent header is cross-connected to the HCW collector tanks influent header such that either system can collect low conductivity waste and/or high conductivity waste. Cross-connections with the high conductivity waste subsystem allow processing of LCW through the mobile system for high conductivity waste treatment. Cross-collection and processing are not expected to be used during normal operations but infrequent operation during an outage when large quantity of radioactive liquid waste may be generated for processing in the LWMS.

A strainer or filter is provided downstream of the last ion exchanger in series to collect any resin fines that may be present due to the failure of the internal screen in the ion exchanger vessel.

The LCW sample tanks collect the process effluent, so that a sample may be taken for chemical and radioactivity analysis before discharging or recycling. The discharge path depends on the water quality, dilution stream availability and plant water inventory. Off-standard quality effluent can be recycled to LCW collector tanks. If the treatment effluent meets water quality standards and if the water inventory permits it to be recycled, the processed LCW effluent can be recycled to the condensate storage tank.

Filters are backwashed periodically to maintain their performance. Backwash waste from the membrane filters and rejects from reverse osmosis units are discharged to a liquid waste (LW) backwash receiving tank. Spent deep-bed ion exchanger resin is normally discharged to the spent resin storage tank as slurry. Spent charcoal from the LWMS filter is normally packaged directly in a liner or high integrity container (HIC) or transferred to the spent resin tank.

11.2.2.2 High Conductivity Subsystem

The HCW collector tanks receive HCW inputs from various high conductivity drain sumps in the Reactor Building (RB), Turbine Building (TB), and Radwaste Building.

The high conductivity drain collection tanks can also receive waste input from the chemical drain collection tank.

The high conductivity drain subsystem consists of three HCW collector tanks and pumps, a mobile based processing system, consisting of filtration systems (carbon and membrane filters), reverse osmosis system, deep-bed ion exchanger systems and the associated piping, instrumentation and electrical systems as required, and two sample tanks and sample pumps. The waste collected in the HCW collector tanks is processed on a batch basis.

Cross-connections with the LCW subsystem also allow for processing through that subsystem. The HCW collector tanks can be shared with the LCW subsystem to provide additional collection capacity.

A strainer or filter is provided downstream of the last ion exchanger in series to collect resin fines that may be present.

The HCW sample tanks collect the process effluent, so that a sample may be taken for chemical and radioactivity analysis before discharging or recycling. The discharge path depends on the water quality, dilution stream availability and plant water inventory. Off-standard quality effluent can be recycled to HCW collector tanks. If the treatment effluent meets water quality standards and if the water inventory permits it to be recycled, the processed HCW effluent can be recycled to the condensate storage tank.

Backwash waste from the membrane filters and rejects from reverse osmosis units are discharged to a LW backwash receiving tank. Spent deep-bed ion exchanger resin is discharged to one of the spent resin storage tanks in the radwaste building as slurry. Spent charcoal from the LWMS filter is normally packaged directly into a liner or transferred to the spent resin storage tank.

The capability exists to accept used condensate polishing resin in a spent resin storage tank. The used condensate polishing resin from the Condensate Purification System is transferred to the spent resin storage tank in the Radwaste Building prior to use in the deep-bed ion exchanger in the high conductivity waste subsystem.

11.2.2.3 Detergent Waste Subsystem

Wastewater containing detergent from the controlled laundry and personnel decontamination facilities and decontamination wastewater from throughout the plant is collected in the hot shower drain (HSD) receiver tank. The detergent drain subsystem consists of one HSD receiver tank and two pumps, two inline strainers and associated piping, instrumentation and electrical systems as required, and one sample tank and sample pumps. The detergent waste treatment includes suspended solid removal processing. The treated waste is collected in a sample tank. A sample is taken and if discharge standards are met, then the waste is discharged off-site. Off-standard quality water can either be recycled for further processing to the HSD receiver tank or to a HCW collector tank in the receiving mode.

11.2.2.4 Chemical Drain Subsystem

The chemical waste collected in the chemical drain collection tank consists of laboratory wastes and decontamination solutions. After accumulating in the chemical drain collection tank, chemical drains are recirculated. A sample is then taken and if discharge standards are met, then the waste may be discharged off-site via the HSD receiving tank. Off-standard quality water is recycled for further processing to a HCW collector tank in the receiving mode. A cross-connection with the detergent drain subsystem is also provided.

11.2.2.5 Detailed System Component Description

The LWMS consists of permanently installed tanks, pumps, pipes, valves, and instruments, and mobile systems for waste processing. Mobile systems provide an operational flexibility and maintainability to support plant operation. The major components of the LWMS are described in the following subsections.

11.2.2.5.1 Pumps

The LWMS process pumps are constructed of materials in accordance with RG 1.143.

11.2.2.5.2 Tanks

Tanks are sized to accommodate the expected volumes of waste generated in the upstream systems that feed waste into the LWMS for processing. The tanks are constructed of stainless steel to provide a low corrosion rate during normal operation. They are provided with mixing eductors and/or air spargers. The capability exists to sample LWMS collection and sample tanks. All permanently installed LWMS tanks are vented into the plant vent. The LWMS tanks are designed in accordance with the equipment codes listed in Table 11.2-1.

Atmospheric liquid radwaste tanks are provided with an overflow connection at least the size of the largest inlet connection. The overflow is connected below the tank vent and above the high-level alarm instrument location. Each collection tank room is designed to contain the maximum liquid inventory in the event that the tank ruptures. Each collection tank compartment is designed to contain the maximum liquid inventory in the event that the tank ruptures. Each collection tank compartment is stainless steel-lined up to a height equivalent to the tank capacity in the room as described in Subsection 15.7.3.1.

11.2.2.5.3 LWMS Mobile Systems for LCW and HCW processing

The radwaste treatment systems include modular mobile system skids that are designed to be readily replaced during the life of the plant. The mobile system is a skid-mounted design configured for ease of installation and process reconfiguration. In-plant supply and return connections from permanently installed equipment to the mobile system are provided to ensure operational flexibility.

LWMS mobile systems consist of equipment modules, complete with subcomponents, piping and instrumentation and controls necessary to operate the subsystem. Components are in module(s) designed for ease of installation and replacement due to component failure and/or technology upgrade. The modules include the shielding required between the radiation sources of the modules and access and service areas in the Radwaste Building. The modules are permanently installed in the Radwaste Building.

The LWMS mobile systems are located in the Liquid Waste Treatment System bay area of the radwaste building to allow truck access and mobile system skid loading and unloading. Modular shield walls are provided to allow shield walls to be constructed, as necessary, to minimize exposure to personnel during operation and routine maintenance.

The LCW and HCW mobile systems are two separate mobile systems. The LCW and HCW mobile systems are utilized to process the waste collected in the LCW Collector Tanks and HCW Collector Tanks. Each mobile system can utilize a combination of a charcoal filtration unit for removing organics and a membrane filtration unit for removing suspended solids, a reverse osmosis system (RO) for removing ionic impurities, and deep-bed ion exchangers for filter demineralizers for polishing.

The low conductivity drain is processed through the membrane filtration system to remove suspended solids and then processed through the ion exchangers to remove soluble impurities. Fine mesh strainers with flushing connections are provided in the ion exchange vessel discharge and in the downstream piping to prevent resin fines from being carried over to the sampling tanks.

The HCW collector tank content can be processed through a charcoal filter to remove any organics and oils and large particulates that may be present. It is then processed through a membrane type filter for the removal of suspended solids. The filtrate is processed through RO units using membranes that are made of a semi-permeable material for the removal of any remaining solids and ionic impurities. When pressure is applied to the feed side of the membrane, the solution passes through the membrane (permeates) and the solids and other impermeable wastes are rejected. The rejected solids and ionic impurities are collected in the LW backwash receiving tank and the final permeate is polished by deep-bed ion exchangers or filter demineralizers to produce treated water with condensate water quality standards. Fine mesh strainers with flushing connections are provided in the ion exchange vessel discharge and in the downstream piping to prevent resin fines from being carried over to the sampling tanks.

Backwash operation for charcoal filters and membrane filters is performed when the differential pressure across the filter exceeds a preset limit. Membrane filters backwash waste is discharged to the LW backwash receiving tank. Spent organic removal media is packaged directly into a liner or to the spent resin storage tank when the differential pressure exceeds a preset limit or waste quality of the effluent from the unit exceeds a preset value. Exhausted ion exchange resins may be sluiced to the spent resin storage tank when some chosen effluent purity parameter (such as conductivity) exceeds a preset limit or upon high differential pressure. Spent charcoal from the LWMS filter is normally packaged directly in a liner or HIC or transferred to the spent risen tank.

11.2.3 Estimated Releases

During liquid processing by the LWMS, radioactive contaminants are removed and the bulk of the liquid is purified and either returned to the condensate storage tank or discharged to the environment. The radioactivity removed from the liquid waste is concentrated on the filter media, ion exchange resins and in the reject water from the RO units. The decontamination factors (DFs) that are listed in Table 11.2-5 are in accordance with NUREG-0016 and are conservative values. The filter media, reverse osmosis rejects and ion exchange resins are sent to the Solid Waste Management System (SWMS) for further processing. If the liquid meets the purity requirements it is returned to the plant for condensate makeup. If the liquid is discharged, the activity concentration is consistent with the discharge criteria of 10 CFR 20 and dose commitment in 10 CFR 50, Appendix I.

The parameters and assumptions used to calculate releases of radioactive materials in liquid effluents and their bases are provided in Section 12.2.2.5. The LWMS design ensures that calculated individual doses from the release of radioactive liquid effluents during normal operation and anticipated operational occurrence is less than 0.03 mSv (3 mrem) to the whole body and 0.1 mSv (10 mrem) to any organ.

Expected releases of radioactive materials by radionuclides in liquid effluents resulting from normal operation, including anticipated operational occurrences, and from design basis fuel leakage are provided in Section 12.2.2.5.

An assessment of potential radiological liquid releases following a postulated failure of a LWMS tank and its components in accordance with SRP 15.7.3 is provided in Subsection 15.7.3.

A tabulation of the releases by radionuclides can be found in Table 12.2-22, Section 12.2.2.5. The tabulation is for the total system and for each subsystem and includes indication of the effluent concentrations. The calculated concentrations in the effluents are within the concentration limits of 10 CFR 20; the doses resulting from the effluents are within the numerical design objectives of Appendix I to 10 CFR 50 and the dose limits of 10 CFR 20 as set forth in Section 12.2.2.4.

11.2.3.1 Release Points

The release points for liquid discharge to the environment are the discharge of the effluent from the LCW sample tanks or HCW sample tanks or the hot shower drain sample tank as indicated on the process diagram (Figure 11.2-1) and the P&ID (Figure 11.2-2, Sheet 12).

11.2.3.2 Dilution Factors

Refer to Table 12.2-23 for dilution factors used in evaluating the release of liquid effluents.

11.2.4 Tank Resistance to Vacuum Collapse

LWMS is designed to operate at atmospheric and greater than atmospheric pressures. Tanks are vented to the atmosphere via the heating, ventilation and air conditioning (HVAC) System. No condensing vapors are housed that could create a vacuum. Therefore, no adverse vacuum conditions are expected.

11.2.5 COL License Information

11.2.5.1 Plant-Specific Liquid Radwaste Information

The following site-specific supplement addresses COL License Information Item 11.1.

(1) STP 3 & 4 complies with Appendix I to 10 CFR 50 and the guidelines given in ANSI Std. N13.1, “Guide to Sampling Airborne Radioactive Materials in Nuclear Facilities” (Reference 11.2-3), Regulatory Guide (RG) 1.21, “Measuring and Reporting Radioactivity in Solid Wastes and Releases of Radioactive Materials in Liquid and Gaseous Effluents from Light-Water-Cooled Nuclear Power Plants,” and RG 4.15, Revision 1, “Quality Assurance for Radiological Monitoring Programs (Normal Operation)—Effluent Streams and the Environment,” as described in Section 12.2.2.4 with the QA aspects described in Subsection 11.5.7S.

(2) A radiation monitor in the discharge line automatically terminates liquid waste discharges from the sample tanks in the LCW, HCW or detergent waste subsystem if radiation measurements exceed a predetermined level set to meet 10 CFR 20, Sections 1001 - 2402, Appendix B, Table 2, Column 2 for the applicable subsystem is provided as described in Section 11.5.

(3) The Offsite Dose Calculation Manual (ODCM) provides specific administrative controls and liquid effluent source terms to limit the liquid wastes to 3700 MBq/yr (excluding tritium). This will be implemented per the schedule in Table 13.4S-1.

(4) The Process and Effluent Monitoring and Sampling Program has specific procedures to comply with 10 CFR 50 (Appendix I) Sections II and III.

(5) The ODCM has administrative controls to limit the instantaneous discharge concentrations of the radionuclides in liquid effluents to an unrestricted area to within 10 times the limits in 10 CFR 20, Appendix B, Table 2, Column 2.

(6) The non-safety related SSC Quality Control Program for the LWMS is described in the STP 3 & 4 Quality Assurance Program description in section 17.5S.

11.2.6 Testing and Inspection Requirements

The LWMS is tested during the preoperational test program as discussed in Section 14.2.12.1.75. In addition to hydrostatic testing of the LWMS, the pumps and mobile systems are performance tested to demonstrate conformance with design flows and process capabilities. An integrity test is performed on the system upon completion.

Provisions are made for periodic inspection of major components to ensure capability and integrity of the systems. Display devices are provided to indicate parameters (such as tank levels and process radiation levels) required in routine testing and inspection.

11.2.7 Instrumentation Requirements

The LWMS is operated and monitored from the Radwaste Building Control Room (RWBCR). Major system parameters, i.e., tank levels, process flow rates, filter and ion exchanger differential pressure, ion exchanger effluent conductivity, etc., are indicated and alarmed to provide operational information and performance assessment. A continuous radiation detector, as described in Section 11.5, is provided to monitor the discharge of radioactivity to the environment. Priority system alarms (such as tank levels and process radiation levels) are repeated in the main control room.

Requirements for sampling are set forth in Subsection 9.3.2.

11.2.8 References

11.2-1 EPRI Technical Report 1013503, Program on Technology Innovation: Technical Support for GE Economic Simplified Boiling Water Reactor (ESBWR)-Radwaste System Design, Final Report, November 2006.

11.2-2 ANSI 55.6 –July 16, 1993, American National Standard for Liquid Radioactive Waste Processing System for Light Water Reactor Plants.

11.2-3 ANSI Std. N13.1, Guide to Sampling Airborne Radioactive Materials in Nuclear Facilities.

Table 11.2-1 Equipment Codes for Radwaste Equipment (from Table 1, RG 1.143, Rev. 2)

Component	Design and Construction	Materials[1]	Welding	Inspection and Testing
Pressure Vessels and Tanks (>15 psig)	ASME Code-Section VIII, Div. 1 or Div. 2	ASME Code Section II	ASME Code Section IX	ASME Code Section VIII, Div. 1 or Div.2
Atmospheric Tanks	API 650	ASME Code Section II	ASME Code Section IX	API 650
0-15 psig Tanks	API 620	ASME Code Section II	ASME Code Section IX	API 620
Heat Exchangers	TEMA STD, 8th Edition ; ASME Code BPVC Section VIII, Div. 1 or Div. 2	ASTM B359-98 or ASME Code Section II	ASME Code Section IX	ASME Code Section VIII, Div. 1 or Div. 2
Piping and Valves	ANSI/ASME B31.3[4,5]	ASME Code Section II[6]	ASME Code Section IX	ANSI/ASME B31.3
Pumps	API 610; API 674; API 675; ASME Section VIII, Div.1 or Div.2	ASTM A571-84 (1997) or ASME Code Section II	ASME Code Section IX	ASME Code[2] Section III, Class 3
Flexible Hoses and Hose Connections for MRWP[3]	ANSI/ANS-40.37	ANSI/ANS-40.37	ANSI/ANS-40.37	ANSI/ANS-40.37

1. Manufacturer's material certificates of compliance with material specifications may be provided in lieu of certified material test reports as discussed in Regulatory Position 1.1.2 of Regulatory Guide 1.143.
2. ASME Code stamp, material traceability, and the quality assurance criteria of ASME BPVC, Section III, Div.1, Article NCA are not required. Hence, these components are not classified as ASME Code Section III, Class 3.
3. Flexible hoses are used in conjunction with Mobile Radwaste Processing Systems (MRWP).
4. Class RW-IIa and RW-IIb Piping Systems are to be designed as category “M” systems.
5. Classes RW-IIa, RW-IIb and RW-IIc are discussed in Regulatory Position 5 of Regulatory Guide 1.143.
6. ASME BPVC Section II required for Pressure Retaining Components.

Table 11.2-2 Capability of the LWMS to Process Expected Wastes

System	Design Accident Volume Primary Loop Leakage (m^3) (1 day only)(a)(e)	Refueling / Plant Startup Max Influent (m^3) (1 day only) (a)(e)	Normal Influent per day(a) (m^3)	Process Rate(b) (m^3/hr)	Max Process Capacity (m^3/yr)(c)(d) (1 day only)	Normal Process Capacity (4hrs/day, 5days/wk) (m^3/yr) (c)(d)	Maximum Fraction of Capacity Utilized	Normal Fraction of Capacity Utilized	Storage Holdup Tank Designation	Capacity (m^3)(f)	Tank Holdup for Max Influent (days)(g)	Tank Holdup for Normal Influent (days)(g)	Redundant Process System
LCW	215	615	55	34	652.8	2.83E+04	0.94	0.71	LCW Collector Tanks (4)	560	0.91	10.18	HCW
									LCW Sample Tanks (2)	280	0.46	5.09	
HCW	65	65	15	34	652.8	2.83E+04	0.10	0.19	HCW Collector Tanks (3)	420	6.46	28.00	LCW
									HCW Sample Tanks (2)	280	4.31	18.67	
HSD	N/A	12	4	34	652.8	2.83E+04	0.02	0.05	HSD Receiver Tank	30	2.50	7.50	HCW
									HSD Sample Tank	30	2.50	7.50	
CHEM DRAIN	N/A	2	2	4	192.0	8.32E+03	0.01	0.09	Chem. Drain Collection Tank	4	2.00	2.00	HCW, HSD

Notes:

(a) ABWR DCD Table 11.2-2.

(b) Process Rate - see Process Flow Diagram, Figure 11.2-1 Radwaste system PFD Sheets 1 of 2 and 2 of 2 .

(c) HCW and LCW mobile units include filters, reverse osmosis ion exchangers with assumed process availability of 0.8. HSD is processed through a strainer with assumed process availability of 0.8.

(d) The process capacity = process rate (gpm) x availability factor x process time.

(e) Refueling/Plant Startup is used as bounding values

(f) Tank designations and storage holdup capacities are taken from Table 11.2-4

(g) Tank Holdup (days) = tank capacity / influent per day.

Table 11.2-3 Not Used

This table has been deleted. The design basis source terms appropriate for the radwaste building are presented in Section 12.2. For example LCW collector tank source terms are presented in Table 12.2-13a.

Table 11.2-4 Capacities of Tanks, Pumps, and Other Components

Component	Quantity	Standards	Type	Nominal Capacity per tank (m3)	Design Pressure (kg/cm2)	Design Temp (ºC)	Normal Operating Pressure (kg/cm2)	Normal Operating Temp (ºC)	Material
Tanks									
HCW Collector Tank	3	API-650/ API-620	Cylindrical, Vertical	140	atm	80	atm	66	SS
HCW Sample Tank	2	API-650/ API-620	Cylindrical, Vertical	140	atm	80	atm	66	SS
LCW Collector Tank	4	API-650/ API-620	Cylindrical, Vertical	140	atm	80	atm	66	SS
LCW Sample Tank	2	API-650/ API-620	Cylindrical, Vertical	140	atm	80	atm	66	SS
HSD Receiver Tank	1	API-650/ API-620	Cylindrical, Vertical	30	atm	80	atm	66	SS
HSD Sample Tank	1	API-650/ API-620	Cylindrical, Vertical	30	atm	80	atm	66	SS
Chemical Drain Collector Tank	1	API-650/ API-620	Cylindrical, Vertical	4	atm	80	atm	66	SS

Table 11.2-4 Capacities of Tanks, Pumps, and Other Components (Continued)

Component	Quantity	Standards	Type	Nominal Capacity per pump (m^3/hr)	Design Pressure (kg/cm2)	Design Temp (ºC)	Normal Operating Pressure (kg/cm2)	Normal Operating Temp (ºC)	Material
Pumps									
HCW Collector Pump	3	API-610; API-674; API-675; ASME Code Section VIII, Div. 1 or Div. 2	Centrifugal/ Mechanical Seal	68	15	80	10	66	SS
HCW Sample Pump	2	API-610; API-674; API-675; ASME Code Section VIII, Div. 1 or Div. 2	Centrifugal/ Mechanical Seal	150	15	80	10	66	SS
LCW Collector Pump	4	API-610; API-674; API-675; ASME Code Section VIII, Div. 1 or Div. 2	Centrifugal/ Mechanical Seal	68	15	80	10	66	SS
LCW Sample Pump	2	API-610; API-674; API-675; ASME Code Section VIII, Div. 1 or Div. 2	Centrifugal/ Mechanical Seal	150	15	80	10	66	SS
HSD Receiver Pump	2	API-610; API-674; API-675; ASME Code Section VIII, Div. 1 or Div. 2	Centrifugal/ Mechanical Seal	68	15	80	10	66	SS
HSD Sample Pump	2	API-610; API-674; API-675; ASME Code Section VIII, Div. 1 or Div. 2	Centrifugal/ Mechanical Seal	80	15	80	10	66	SS
Chemical Drain Collector Pump	2	API-610; API-674; API-675; ASME Code Section VIII, Div. 1 or Div. 2	Centrifugal/ Mechanical Seal	10	15	80	10	66	SS

Table 11.2-4 Capacities of Tanks, Pumps, and Other Components (Continued)

Component	Quantity	Standards	Type	Nominal Capacity per unit (m^3/hr)	Design Pressure (kg/cm2)	Design Temp (ºC)	Normal Operating Pressure (kg/cm2)	Normal Operating Temp (ºC)	Material
LWMS Mobile System for LCW Processing									
LCW Filter	1	API-620, ASME Code BPVC Div. 1 or Div 2[b]	Charcoal Filter	34	15	80	10	66	SS[c]
LCW Filter	1	API-620, ASME Code BPVC Div. 1 or Div 2[b]	Membrane Filter	34	15	80	10	66	SS[c]
LCW Reverse Osmosis Unit	1	API-620, ASME Code BPVC Div. 1 or Div 2[b]	2 Pass Reverse Osmosis Unit	34	variable	80	variable	66	SS[c]
LCW Demineralizer	2	API-620, ASME Code BPVC Div. 1 or Div 2[b]	Mixed Bed Type	34	15	80	10	66	SS[c]
LWMS Mobile System for HCW Processing									
HCW Filter	1	API-620, ASME Code BPVC Div. 1 or Div 2[b]	Charcoal Filter	34	15	80	10	66	SS[c]
HCW Filter	1	API-620, ASME Code BPVC Div. 1 or Div 2[b]	Membrane Filter	34	15	80	10	66	SS[a]
HCW Reverse Osmosis Unit	1	API-620, ASME Code BPVC Div. 1 or Div 2[b]	2 Pass Reverse Osmosis Unit	34	variable	80	variable	66	SS[c]
HCW Demineralizer	2	API-620, ASME Code BPVC Div. 1 or Div 2[b]	Mixed Bed Type	34	15	80	10	66	SS[c]
Strainers									
HSD Strainer	2	ANSI/ASME B31.1 (same as piping)	Inline Strainers	34	15	80	10	66	SS

Notes:
(a) Nominal capacity refers to the batch capacity
(b) For vessel design
(c) Vessel material
(d) When processing through the LWMS Mobile Units and HSD strainers, the remainder of the flow is recycled to the subsystem collector tank.

Table 11.2-5 Decontamination Factors*

Subsystems*	Filter	Reverse Osmosis	Ion-Exchanger	Total DF
Equipment (low conductivity)				
Drain Subsystem:				
Halogens	**1**	**10***	**100 (10)****	**10,000**
Cs, Rb	**1**	**10***	**10 (10)****	**1,000**
Other nuclides	**1**	**10***	**100 (10)****	**10,000**
Floor (high conductivity)				
Drain Subsystem:				
Halogens	**1**	**10***	**100(10)****	**10,000**
Cs, Rb	**1**	**10***	**2 (10)****	**200**
Other nuclides	**1**	**10***	**100 (10)****	**10,000**
A DF of 1 is used for tritium.				
Chemical Drain Subsystem:				
Chemical drain is processed in high conductivity drain subsystem.				
Detergent Drain Subsystem:				
A DF of 1 is used for the detergent drain strainer for all radionuclides.				

* Radwaste processing equipment is designed to meet or exceed these decontamination factors.

** From ANSI 55.6 –1993, July 16, 1993, American National Standard for Liquid Radioactive Waste Processing System for Light Water Reactor Plants, (Reference 11.2-4), Table 8, Decontamination Factors. For two ion exchangers in series, the DF for the second unit is given in parentheses.

Table 11.2-6 Probable Inputs to Liquid Radwaste from Operational Occurrences

Waste Generation Source	Batch Volume (m^3)	Normal Frequency	Maximum Frequency	Normal Volume (m^3/d)	Design Accident Volume Primary Loop Leakage (m^3)	Volume in m^3 on Maximum Day	
						Plant Startup	Refueling Water Cleanup
Low Conductivity Wastes							
DW Equipment Drain	-	-	-	10	110	10	10
R/B Equipment Drain	-	-	-	15	15	15	15
T/B Equipment Drain	-	-	-	15	15	15	15
RW/B Equipment Drain	-	-	-	5	5	5	5
Upper Pool Drain	-	-	-	-	-	-	500
CUW Backwash Receiving Tank	35	1/20	1	-	35	35	35
CF Backwash Receiving Tank	35	3/34	3	-	35	35	35
Others	-	-	-	10	-	20	-
Total	-	-	-	55	215	135	615
High-Conductivity Wastes							
Floor Drain							
R/B Floor Drain	-	-	-	5	55	5	5
T/B Floor Drain	-	-	-	5	5	5	5
RW/B Floor Drain	-	-	-	3	3	3	3
Equipment Displacement	-	-	-	-	-	-	50
Subtotal	-	-	-	13	63	13	63
Chemical Drain Wastes							
Hot Laboratory Chemical Drain	-	-	-	2	2	2	2
Total	-	-	-	15	65	15	65
Detergent Wastes							
Hot Shower Drain	-	-	-	3	-	8	-
Laundry Drain	-	-	-	1	-	4	-
Total	-	-	-	4	-	12	-

The following figures are revised due to STD DEP 11.2-1 and are located in Section 21:

Figure 11.2-1 Radwaste System (Sheet 1 and 2 of 2)

Figure 11.2-2 Radwaste system (Sheets 1 through 36 of 36)