11.2 LIQUID WASTE MANAGEMENT SYSTEM

11.2.1 DESIGN BASES

Radioactive liquid wastes which are discharged from the plant are first processed by the Waste Management System (WMS) or the Boron Management System (BMS). The Chemical and Volume Control System (CVCS), Fuel Pool System (FPS), and Steam Generator Blowdown System (SGBS), all process potentially radioactive liquids in the confines of the plant in preparation for reuse. The contents of turbine building sumps and detergent wastes will be routinely discharged unprocessed due to their very small potential for radioactive contamination.

→(EC-47424 R308)

The principal design objective of the overall system is to protect plant personnel, the general public, and the environment by ensuring that all releases of radioactive materials, both in plant and to the environment, are as low as reasonably achievable (ALARA) and within the requirements of 10CFR20 and Appendix I to 10CFR50. The liquid radioactive waste system conforms to Regulatory Guide 1.143 as described in FSAR Section 1.8.1.143. The numerical design objectives for the BMS and WMS are:

←(EC-47424 R308)

a) The calculated annual total quantity of all radioactive materials in liquid effluents during normal operation including anticipated operational occurrences should not result in a dose or dose commitment from liquid effluents for any individual in an unrestricted area from all pathways of exposure of more than three millirem to the total body, or 10 millirem to any organ.

b) The concentrations of radioactive materials in liquid effluents released during operation with one percent failed fuel to an unrestricted area should not exceed ten times the effluent concentration limits in 10CFR20 Appendix B, Table 2, Column 2.

11.2.1.1 Chemical And Volume Control System (CVCS)

The basic CVCS operations, process flows, and evolutions are described in Subsection 9.3.4. Radiological data for shielding design is contained in Subsection 12.2.1. The decontamination factors for CVCS equipment are provided in Table 11.1-1.

11.2.1.2 Fuel Pool System (FPS)

Basic operations of the FPS are discussed in Subsection 9.1.3. Radiological data for shielding design are provided in Subsection 12.2.1. The decontamination factors for FPS equipment are provided in Table 11.2-8.

11.2.1.3 Steam Generator Blowdown System (SGBS)

Basic operations of the SGBS are discussed in Subsection 10.4.8. Radiological data for shielding design is contained in Subsection 12.2.1.

11.2.1.4 Turbine Building Sump

→(DRN 03-2065, R14)

The Turbine Building Floor drains will collect leakage at a rate of approximately five gpm at main steam activity (see Table 11.1-20 for steam generator liquid activity). Since the activity will be extremely low, it will be routinely discharged unprocessed after monitoring. However, if monitoring reveals significant levels of activity the sump water will be routed to the Waste Management System.

←(DRN 03-2065, R14)

11.2.1.5 Waste Management System (WMS) and Boron Management System (BMS)

→(DRN 00-1045, R11-A; 01-1248, R11-B)

The BMS and the liquid subsystem of the WMS are designed with sufficient capacity, redundancy, and flexibility to meet ten times the effluent concentration limits of 10CFR20 during periods of equipment downtime when operating at design bases fuel leakage of one percent. The BMS has redundancy in its tanks, pumps, filters, and ion exchangers. The WMS has redundancy in its tanks and pumps . Radioactive liquid waste is normally processed through the piping taps in the LWMS process stream to a demineralizer system. In the case of the WMS, if a filter cartridge must be changed or an ion exchanger bed be replaced, sufficient tankage is provided to hold the waste so that these operations can be performed with no loss of efficiency. The same is true for the BMS with the added advantage of redundant equipment.

←(DRN 00-1045, R11-A; 01-1248, R11-B)

The WMS and BMS are located in the seismic Category I Reactor Auxiliary Building.

Tanks outside of containment are provided with level indication and alarms for high level conditions. The level alarms will alert operators when tanks are nearly full and transfer flow from a filled tank to alternate tanks may proceed. For cubicles which contain tanks with significant radioactivity and thus require shielding, the floors in these cubicles will be pitched to floor drains located at low points to facilitate floor drainage.

Collection tanks and tanks which receive processed waste are generally provided in pairs. The pairing of tanks allows one tank to be in the fill mode while the other tank is in the sampling, recirculation, process, or standby mode. Since the schedule of influent waste (See Table 11.2-3 and 11.2-4) can be processed with approximately 10 percent operational time or less using the subsystems described in Subsection 11.2.2, an empty standby tank would normally be available for any filled tank. Thus, switching from one tank to another will normally prevent overflow of tanks.

→(DRN 99-2361, R11; 06-537, R15)

The monitor tanks (i.e., boric acid condensate tanks, waste condensate tanks, and laundry tanks) can be sampled prior to discharge or prior to transferring to the outside water storage tanks (i.e., the discharge structure). If analysis indicates further processing is required the water will be reprocessed prior to leaving the building. These measures reduce the potential of an uncontrolled release of radioactive material due to an overflowing of outside storage tanks. The outside storage tanks have level detection instrumentation which will annunciate under high level conditions.

←(DRN 99-2361, R11; 06-537, R15)

In addition to the outside storage tanks discussed previously, equipment drain tank, spent resin tank, waste storage tank and concentrate storage tank do not have backup tanks. The equipment drain tank does not have an overflow nozzle and hence does not have the potential for overflow to the floor. Overflow of the concentrate storage tank and spent resin tank will go onto the floor of tank's respective cubicles. Curbing will prevent the spread of liquid from the cubicles. Provisions to prevent entry of the concentrates and resin into the floor drain system are necessary to prevent potential solidification within the drainage system.

The portions of the CVCS, BMS, and WMS which contain significant radioactivity are located in the Reactor Auxiliary Building which is designed to seismic Category I standards. Therefore, uncontrolled release to the environs would not occur as a result of a seismic occurrence. The two release points of the BMS and WMS have radiation monitors which automatically close valves to prevent uncontrolled release of radioactivity. These monitors and their operation are described in Section 11.5.

→ (DRN 99-2361)

Equipment in the CVCS, BMS, WMS which requires shielding is placed in separate cubicles. The separate cubicles are provided with appropriate shielding. This allows operation to continue by using alternate process routes while performing maintenance on a particular piece of equipment.

← (DRN 99-2361)

To reduce gaseous radioactive releases to the building atmosphere the following design features have been incorporated into the plant design; (a) venting of high radiation level equipment is provided and collected in the vent gas collection header, (b) tanks are provided with water seals on overflow lines to prevent radioactive gases from escaping, and (c) diaphragm valves are used to provide protection against leakage.

The expected and design inventories of individual radioisotopes (curies) in WMS and BMS equipment and components containing radioactive liquids are provided in Section 12.2. The geometry and layout of equipment, as required for shielding design calculation, are shown on the General Arrangement Drawing in Section 1.2. Tanks receive influent liquid until processing begins or until tank liquid volume reaches a predetermined level. The tank is then isolated from the feed while its contents are processed. Appropriate control devices and alarms are utilized to alert operators of tank high or low level and to shut off the pump on low level. Overflow lines are provided with loop seals to contain potential radioactive gases.

The WMS and BMS provide means to control the discharge of liquid waste. The operator in the main control room discharges the waste from either the waste condensate, laundry, or boric acid condensate tanks through flow meters recorders and radiation monitors, which automatically alarms and terminates discharge flow on high activity. Other features and procedures used to prevent inadvertent releases to the environment from the systems include strict administrative procedures, operator training, and redundant discharge valves.

The systems are designed for ALARA operation as discussed in Chapter 12.

The BMS shall have the capacity to accommodate all liquid wastes generated during the following anticipated operational occurrences:

a) Base-loaded operation at warranted output up to approximately 97 percent of equilibrium cycle core life

→(DRN 00-1045)

b) Back-to-back cold shutdowns to five percent subcritical and startups to approximately 85 percent of equilibrium cycle core life.

←(DRN 00-1045)

The BMS also provides sufficient flexibility to allow the plant operator to select the desired balance between holdup for radioactive decay, evaporation, ion exchange, filtration, and dilution. This capability permits removal of radioactivity as soon as feasible in the process in order to concentrate activities into areas where adequate shielding can be provided, thus preventing the build-up of excessive activity in the remainder of the system.

All components within the BMS are designed in accordance with the applicable codes and design parameters at Table 11.2-1. Safety classes and seismic categories are as shown in Table 3.2-1.

Provisions are incorporated on all BMS tanks to contain and collect overflows in the event that any of these tanks are inadvertently over-filled. High level alarms have been provided on all these tanks to minimize the possibility of inadvertent overfilling. In addition, the overflow lines are either interconnected (headered) to other tanks within the BMS or are provided with liquid relief to the containment or radwaste sump. All BMS tanks can also be vented to appropriate gas surge and collection headers for protection against inadvertent gas releases.

All BMS storage and collection tanks were sized to receive maximum expected influent surges with the capability of holding the liquid waste prior to routine batch processing.

The WMS waste tank sizes were selected to receive maximum influent surges to 3600 gpd (see Table 11.2-4 for normally expected liquid waste) with the capability of holding this waste for two days before processing. The process flow rate is 20 gpm, which is sufficient to handle the assumed maximum influent surges. The capacity of the laundry tanks was determined to allow a 2.5 day holdup in a single tank with a maximum influent surge rate of 1400 gpd. The average waste input into the tank (450 gpd) gives an eight day holdup time in a single tank. A single, 38,000 gallon, waste storage tank is provided to supplement the capacity of the two waste tanks.

All components in the liquid portion of the WMS are non-seismic Category I and non-safety related. The design and fabrication codes, seismic category and classification of components meet or exceed the requirements of Regulatory Guides 1.26 (Rev. 1) and 1.29 (Rev. 1). Table 11.2-2 lists the system components and their design parameters.

All tanks in the WMS are closed atmospheric tanks that are vented to the gas collection header, except for the waste storage tank which is vented via duct to the RAB ventilation system.

11.2.2 SYSTEM DESCRIPTION

11.2.2.1 Boron Management System (BMS)

The BMS (see Figure 11.2-1) is designed to accept, collect, and process radioactive waste from various plant systems for recycle or disposal.

The major influent to the BMS is from the letdown line in the CVCS and is the result of feed and bleed operations during plant shutdowns, startups, and dilution due to fuel burnup over core life. A schedule of the waste generated for the various plant evolutions is presented in Tables 9.3-11 and 9.3-12. Other sources into the BMS consist of valve and equipment leakoffs, miscellaneous drains and relief valve discharges. The reactor drain tank collects these discharges within the containment, while the equipment drain tank and equipment drain sump accumulates those from outside the containment. Both the reactor drain tank and equipment drain tank are maintained with a nitrogen blanket to prevent the buildup of hydrogen in each tank.

All processing components in the BMS from the discharge of the collection tanks and CVCS, except the holdup tanks and the boric acid condensate tanks, can be bypassed individually or collectively. Chemistry and radiological concerns determine which processing components are lined up in the processing flowpath. Also water from any point in the processing flowpath can be recirculated back to any point in the processing flowpath.

→(DRN 00-696)

From the discharge of the collection tanks and CVCS, water is sent to the on line holdup tank. (Note that the Flash Tank is no longer used. Temporary equipment could be utilized if required due to significant increases in noble gas activity.) The holdup tanks provide sufficient storage capacity to accumulate discharges until a sufficient volume is available for further processing on a batch basis. The radioactivity of the liquid is significantly reduced during storage by natural decay of the short half-live radionuclides. During this period, any degasification and radioactive decay can be monitored by liquid sample analysis. The gas analyzer can be used to monitor the holdup tanks for hydrogen and oxygen content. The holdup tanks also have a continuous nitrogen blanket to eliminate the possibility of a buildup of hydrogen. The holdup tanks can be vented to the plant stack. The holdup tanks have high and low, level and pressure alarms, which annunicate in the control room.

←(DRN 00-696)

→(DRN 00-1045)

The contents of the holdup tanks are normally sent to the boric acid condensate tanks through some or all of the following process equipment: the preconcentrator filters, the preconcentrator ion exchangers and the boric acid condensate ion exchangers. Prior to recycle or controlled discharge of the treated liquid waste, the fluid is analyzed for acceptability of both chemistry and activity. Recycle capability is provided for water conservation. Controlled discharge is accomplished through an effluent radiation monitor which records the release activity level and automatically terminates discharge on high radiation.

←(DRN 00-1045)

→(DRN 00-1045, R11-A; 06-537, R15)
Design data for the major components is given in Table 11.2-1. Flow, temperature, and pressure are given in Table 11.2-9. Process flow modes one and two indicate the system parameters during the normal processing of the reactor drain tank and equipment drain tank contents respectively through the flash tank. Modes three, four and five indicate the system parameters during three possible conditions of processing the CVCS letdown flow which has been diverted from the volume control tank. In the event that the holdup tank contents require additional processing, recirculation mode seven can be employed to cycle the tank's contents through the preconcentrator filter and ion exchanger or back to the flash tank if necessary before mode six is initiated. Mode eight indicates the process data during discharge operations of the boric acid condensate tank contents to the circulating water discharge piping. In the event that the boric acid condensate tank contents require additional processing, mode nine is initiated to recirculate the tank's contents through the boric acid condensate ion exchanger or back to the holdup tanks if necessary.
←(DRN 00-1045, R11-A; 06-537, R15)

All process components have been used extensively in the nuclear industry to remove radioactive contaminants from liquids. The performance of process units used in the analysis is in agreement with general industry experience. Decontamination factors are presented in Table 11.2-6.

11.2.2.2 Waste Management System

The design of the WMS is presented in Figure 11.2-2. Principal flow paths through the system (heavy lines) and the release point (circulating water discharge) are clearly indicated on the figure. The figure indicates all system interconnections.

Process data is presented in Table 11.2-10. Input streams into the WMS are identified in Figure 11.2-2 and expected sources, volumes, and activities of waste influent are listed in Table 11.2-4. Decontamination factors are presented in Table 11.2-7 for WMS process equipment.

11.2.2.2.1 Miscellaneous Waste

→ (DRN 99-1050; 01-1248)

Miscellaneous non-detergent waste is collected in one of two waste tanks. Additional storage capacity is provided in the waste storage tank. As wastes are collected, they are processed on a batch basis through the portable demineralization system which consists of vessel(s) typically containing various filtration media and/or Ion exchange media. The demineralization system removes suspended solids, dissolved solids, and radioactivity. An ion exchanger is provided in the path from the Portable Demineralizer should further treatment be desired. The effluent is collected in one of two waste condensate tanks for sampling and analysis prior to release to the circulating water discharge. Discharge activity is monitored for radioactivity, as described in Section 11.5.

← (DRN 99-1050; 01-1248)

All potential bypass routes in the WMS are indicated in Figure 11.2-2. Because of the redundancy of equipment; it is not expected that equipment will need to be bypassed very frequently. If process equipment is bypassed for any reason, and sampling of the waste condensate tank shows that further processing is necessary, the contents of one tank can be recycled back through a filter, or ion exchanger as desired, including the portable demineralizer system and collected in the second tank.

The WMS has sufficient capacity to accept liquid waste during startup, shutdown, and refueling.

11.2.2.2.2 Laundry Waste

→ (DRN 99-2361)

Liquid detergent waste from the laundry, laundry sump, contaminated showers, and contaminated sinks are collected in two laundry tanks. The waste may be sampled to assure low activity and then be pumped through a filter directly to the circulating water discharge. The waste water may be processed through the LWMS portable demineralization skid and handled as miscellaneous waste. Discharge activity is monitored as described in Section 11.5.

← (DRN 99-2361)

11.2.2.3 <u>Steam Generator Blowdown System</u>

→(DRN 01-560)

The Steam Generator Blowdown System (SGBS) is described in Subsection 10.4.8. The waste removed by the blowdown filters and the waste produced by regeneration of the blowdown demineralizers is collected in the filter flush tank and the regenerative waste tank. The waste collected in the regenerative waste tank and the filter flush tank will normally be disposed of in the Waterford 1 and 2 Waste Processing facility or the Waterford 3 Low Volume Wastewater Basin. In case of radioactivity in the blowdown, blowdown demineralizer waste and the filter flushing water will be transferred to a Radwaste Processing System via a temporary connection.

←(DRN 01-560)

11.2.3 RADIOACTIVE RELEASES

→(DRN 00-1045, R11-A)

During liquid processing by the BMS and WMS, radioactivity is removed so that the bulk of the liquid is restored to clean water, which is either recycled in the plant or discharged to the environment. The radioactivity removed from the liquids is concentrated in filters and ion exchange resin. These concentrated wastes are sent to the SWMS for packaging and eventual shipment to an approved offsite disposal location. If the water is to be recycled back to the RCS, it must meet the purity requirements for reactor coolant. If the liquid is to be discharged, the activity level must be consistent with the discharge criteria of 10CFR20 and Appendix I to 10CFR50. The BMS and WMS are capable of monitoring radioactive liquid discharge from the systems to ensure that activity concentrations do not exceed predetermined limits. If a limit is exceeded, discharge will be automatically terminate.

←(DRN 00-1045, R11-A)

→(DRN 03-2065, R14)

An estimate of the normal liquid effluent from the facility, including anticipated operational occurrences, is presented in Table 11.2-11. Table 11.2-12 presents the assumption used. The values were obtained using the guidance presented in NUREG 0017, Calculation of Releases of Radioactive Materials in Gaseous and Liquid Effluents from PWRs (April 1976). It should be noted that the evaluation demonstrates compliance with the September 4, 1975 Annex to Appendix I. Accordingly, a rigorous cost benefit analysis of compliance with Section II D of Appendix I is not provided.

←(DRN 03-2065, R14)

The liquid effluent concentrations after uniform dilution in the circulating discharge flow of 2130 cfs, are presented in Table 11.2-13 for normal operation, including anticipated operational occurrences. These concentrations are compared to ten times of the effluent concentration limits of 10CFR20, Table 2, Column 2, and are shown to be much less. The doses caused by the release of radioactivity in the liquid effluents are given in Table 11.2-14. The exposures are well within the limits of Appendix I to 10CFR50. The doses were calculated in accordance with Regulatory Guide 1.109 (March, 1976).

→(DRN 99-2361, R11)

The discharge points are shown on the general site plan of Figure 2.1-4.

→(DRN 03-2065, R14)

Tritium will build up in the process streams during the life of the plant. However, the buildup will be limited by evaporation from the surface of the spent fuel pool and radioactive decay. Assuming a tritium production rate of 1292 Ci/yr, as presented in Table 11.1-15, and an evaporation rate of 500 lbs/hr from the surface of the spent fuel pool, the concentration of tritium in the process streams is not expected to exceed 0.5 μci/gm. At this concentration air saturated with this water would have a concentration of 2.11×10^{-5} μci/cc.

←(DRN 03-2065, R14)

The following is the method by which this calculation was performed.

$$C\left(\frac{\mu \mathrm{Ci}}{\mathrm{cc}}\right) = \frac{(G)(W_s)(4.2)}{(\lambda + \beta)(V)(V_a)}$$

←(DRN 99-2361, R11)

where:

C = Airborne (μCi/cc) concentration of tritiated water

→(DRN 03-2065, R14)

G = Tritium generation rate in reactor coolant (1292 Ci/yr)

←(DRN 03-2065, R14)

W_s = Humidity ratio at 90°F (0.0312)

V_a = Specific Volume of air at 90°F (13.85 ft^3/lb)

λ = radioactive decay constant (0.05/yr)

β = evaporation coefficient = $\frac{(500\text{ lbs/hr})(8760\text{ hr/yr})}{(10^6\text{ gal})(8.34\text{ lb/gal})}$

= 0.53/yr

V = combined volume of coolant plus spent fuel pool plus refueling water storage pool (10^6 gal)

→(DRN 99-2361, R11; 00-1045, R11-A; 03-2065, R14)

This analysis indicates that the airborne levels of tritiated water vapor will slightly exceed the DAC of 2.0E-5 μCi/cc; however, the analysis assumes no dilution in the process streams due to purification losses (shim bleed) and water makeup (demineralized water). The ventilation provided for the Fuel Handling Building keeps the concentration of the airborne tritium much below the value calculated above.

←(DRN 99-2361, R11; 00-1045, R11-A; 03-2065, R14)

BMS EQUIPMENT DESCRIPTION

Reactor Drain Tank

Quantity	1
Type	Horizontal, cylindrical
Internal Volume (useful), gallons	1600
Design Pressure, psig	25 (internal)/15 (external)
Design Temperature, F	250
Normal Operating Pressure, psig	2.0
Normal Operating Temperature, F	120
Code	ASME VIII, Div 1 1968 Edition, Sammer 1970 Addenda
Material	SA-240, Type 304

Equipment Drain Tank

Quantity	1
Type	Horizontal, cylindrical
Internal Volume (useful), gallons	4,000
Design Pressure, psig	10
Design Temperature, F	200
Normal Operating Pressure, psig	3
Normal Operating Temperature, F	120
Code	ASME VIII, Div 1, 1968 Edition, Summer 1970 Edition
Material	SA-240, Type 304

→(DRN 00-696)
Flash Tank (Inactive per ER-W3-00-0225-00-00)
←(DRN 00-696)

Quantity	1
Type	Vertical, cylindrical
Internal Volume (useful), gallons	400

BMS EQUIPMENT DESCRIPTION

Flash Tank (Cont'd)

Design Pressure, psig	75 internal/15 external
Design Temperature, F	250
Normal Operating Pressure, psig	0.5
Normal Operating Temperature, F	120
Code	ASME III, Class 3, 1968 Edition, Summer 1970 Addenda
Material	SA-240, Type 304

Holdup Tanks

Quantity	4
Type	Vertical, cylindrical
→ (DRN 99-2361)	
Internal Volume (useful) gallons	47,960
← (DRN 99-2361)	
Design Pressure, psig	10 internal/2 external
Design Temperature, F	240
Normal Operating Pressure, psig	0.5 to 1.5
Normal Operating Temperature, F	120
Code	ASME III, Class 3 1968 Edition, Summer 1970 Addenda
Material	SA-240, Type 304

Boric Acid Condensate Tanks

Quantity	4
Type	Vertical, cylindrical
Internal Volume (useful), gallons	17,200
Design Pressure, psig	Atmospheric
Design Temperature, F	250

BMS EQUIPMENT DESCRIPTION

Boric Acid Condensate Tanks (Cont'd)

Normal Operating Pressure, psig	Atmospheric
Normal Operating Temperature, F	120
Code	ASME VIII, Div 1, 1968 Edition, Summer 1970 Addenda
Material	SA-240, Type 304

Reactor Drain Tank and Equipment Drain Tank Pumps

Quantity	1 (each)
Type	Centrifugal
Design Pressure, psig	150
Design Temperature, F	200
Normal Operating Temperature, F	120
Capacity, rate, gpm	50
Rated Head, ft.	145
→(DRN 00-1045)	
NPSH Available, ft.	
Reactor Drain Tank Pump	49.3
Equipment Drain Tank Pump	36.25
←(DRN 00-1045)	
Motor Horsepower	7.5
Wetted Materials	Austenitic stainless steel
Code	ASME III, Class 3, 1971 Edition, Summer 1972 Addenda

→(DRN 00-696)

Flash Tank Pumps (Inactive per ER-W3-00-0225-00-00)

←(DRN 00-696)

Quantity	2
Type	Centrifugal
Design Pressure, psig	150
Design Temperature, F	200
Normal Operating Temperature, F	120

TABLE 11.2-1 (Sheet 4 of 7)

BMS EQUIPMENT DESCRIPTION

Flash Tank Pumps (Cont'd)	
Capacity, rate, gpm	150
Rated Head, ft.	60
NPSH Available, ft.	24.1
Motor Horsepower	7.5
Wetted Materials	Austenitic stainless steel
Code	ASME III, Class 3, 1971 Edition, Summer 1972 Addenda
Holdup Drain and Recirculation Pumps	
Quantity	I drain, I recirc/drain I recirc
Type	Centrifugal
Design Pressure, psig	150
Design Temperature, F	200
Normal Operating Temperature, F	120
Capacity, rated, gpm	50
Rated Head, ft.	145
NPSH Available, feet	36.3 (drain), 13.5 (recirc)
Motor Horsepower	7.5
Wetted Materials	Austenitic stainless steel
Code	None
Boric Acid Condensate Pumps	
Quantity	2
Type	Centrifugal

BMS EQUIPMENT DESCRIPTION

Boric Acid Condensate Pumps (Cont'd)

Design Pressure, psig	150
Design Temperature, F	200
Normal Operating Temperature, F	120
Capacity, rated, gpm	50
Rated Head, ft.	145
NPSH Available, ft.	25
Motor Horsepower	7.5
→ (DRN 99-2361)	
Material	Austenitic stainless steel
← (DRN 99-2361)	
Code	None

Preconcentrator Ion Exchanger

Quantity	2
Type	Flushable
Design Pressure, psig	150
Design Temperature, F	250
Normal Operating Pressure, psig	60
Normal Operating Temperature, F	120
Resin Volume (total), $ft.^3$	36
Resin Volume (useful) required, $ft.^3$	34
Design Flow, gpm	100
Normal Flow, gpm	20
Code for Vessel	ASME VIII, Div 1, 1968 Edition, Summer 1970 Addenda
Material	Austenitic stainless steel
→ (DRN 99-1050)	
Resin	Bead Type
← (DRN 99-1050)	

TABLE 11.2-1 (Sheet 6 of 7) Revision 11-A (02/02)

BMS EQUIPMENT DESCRIPTION

Boric Acid Condensate Ion Exchangers

Quantity	2
Type	Flushable
Design Pressure, psig	150
Design Temperature, F	250
Normal Operating Pressure, psig	60
Normal Operating Temperature, F	140
Resin Volume (total)	36
Resin Volume (useful) required	34
→ (DRN 99-2361)	
Design Flow, gpm	50
Normal Flow, gpm	20
← (DRN 99-2361)	
Code for Vessel	ASME VIII, Div 1, 1968 Edition Summer 1970 Addenda
Material	Austenitic stainless
→ (DRN 99-1050)	
Resin	Bead Type
← (DRN 99-1050)	

→(DRN 00-1045)

←(DRN 00-1045)

TABLE 11.2-1 (Sheet 7 of 7) Revision 11-A (02/02)

BMS EQUIPMENT DESCRIPTION

→(DRN 00-1045)

←(DRN 00-1045)

Preconcentrator Filters

Quantity	2
→ (DRN 99-1050)	
Type Element	Cartridge
← (DRN 99-1050)	
→ (DRN 99-2361)	
Normal Operating Pressure, psig	60-90
← (DRN 99-2361)	
Design Pressure, psig	150
Design Temperature, F	240
→ (DRN 99-2361)	
Normal Operating Temperature, F	90-120
← (DRN 99-2361)	
Design Flow, gpm	100
Normal Flow, gpm	20
Code for Vessel	ASME VIII, 1968 Edition, Winter 1970 Addenda
Material	Austenitic stainless steel

Table 11.2-2 (Sheet 1 of 3) Revision 14 (12/05)

WMS EQUIPMENT DESCRIPITION

Tanks	Waste	Waste Condensate	Laundry	Waste Storage
Quantity	2	2	2	1
Type (cylindrical)	Horizontal	Horizontal	Horizontal	Vertical
→(DRN 99-2361, R11)				
Internal volume (useful), gallons	4000	15000	4000	38,000
←(DRN 99-2361, R11)				
Design Pressure	ATM	ATM	ATM	ATM
Normal Operating Pressure	ATM	ATM	ATM	ATM
Design Temperature, F	200	250	200	120
Normal Operating Temperature, F	120	120	120	120
Code	None(1)	None(1)	None(1)	ASME VIII, 1983 Edition- Winter Addenda
Material	SA-240 Type 304	SA-240 Type 304	SA-240 Type 304	SA-240 Type 304

→(DRN 99-2361, R11)

Filters	Waste	Laundry
←(DRN 99-2361, R11)		
Quantity	1	1
→(DRN 99-1050, R11)		
Type element	Cartridge	Cartridge
←(DRN 99-1050, R11)		
Design Pressure, psig	150	150
Normal Operating Pressure, psig	60	60
Design Temperature, F	200	200
Normal Operating Temperature, F	120	120
Design Flow, gpm	50	50
Normal Operating Flow, gpm	20	50
→(DRN 03-2065, R14)		
Code for vessel	ASME VIII, 1968	ASME VIII, 1968
←(DRN 03-2065, R14)		
Material	Edition - Winter 1970 Addenda Type 316 Stainless Steel	Edition - Winter 1970 Addenda Type 316 Stainless Steel

	Oil Removal Filter
→(DRN 01-458, R11-A)	
Quantity	1
Type	Pleated Paper Cartridge
←(DRN 01-458, R11-A)	
Design Pressure, psig	150
Normal Operating Pressure, psig	60
Design Temperature, F	200
Normal Operating Temperature, F	120
Design Flow, gpm	50
Normal Operating Flow, gpm	20

WMS EQUIPMENT DESCRIPITION

Oil Removal Filter (Cont'd)

Code for vessel	ASME VIII, 1968 Edition Winter 1970 Addenda

→(DRN 99-2361, R11)
←(DRN 99-2361, R11)

Material	Austenitic Stainless Steel

Waste Condensate Ion Exchanger

Quantity	1
Type	Flushable deep resin bed
Design Pressure, psig	150
Normal Operating Pressure, psig	60
Design Temperature, F	250
Normal Operating Temperature	120
Design Flow, gpm	50
→(DRN 99-2361, R11)	
Normal Operating Flow, gpm	20
←(DRN 99-2361, R11)	
Resin Volume (total), $ft.^{-3}$	36
Resin Volume (useful), $ft.^{-3}$	32
Code for vessel	ASME VIII, 1968 Edition, Summer 1970 Addenda
Material	Austenitic Stainless Steel
→(DRN 99-1050, R11)	
Resin	Bead Type
←(DRN 99-1050, R11)	

→(DRN 01-1248, R11-B)
Waste Demineralizer System
←(DRN 01-1248, R11-B)

Quantity	1
Design DF	10^4
→(DRN 02-263, R11-B; 06-558, R15)	
Design Pressure, psig	150
Design Temperature, F	150
Design Flow, gpm	50
←(DRN 02-263, R11-B)	
Normal Operating Flow, gpm	20
←(DRN 06-558, R15)	
Electric Load	480V 3OA/3ϕ 120V 30A 120V 15A
Material	Austenitic Stainless Steel
→(DRN 02-263, R11-B)	
Code	ASME VIII "U" Stamp and ANSI B31.1

←(DRN 02-263, R11-B)

Table 11.2-2 (Sheet 3 of 3) Revision 11-A (02/02)

WMS EQUIPMENT DESCRIPTION

→ (DRN 98-1595)

Pumps	Waste	Waste Condensate	Laundry	Waste Storage
← (DRN 98-1595)				
Quantity	2	2	2	
Type	Centrifugal	Centrifugal	Centrifugal	Centrifugal
Design Pressure, psig	150	150	150	150
→(DRN 00-1882)				
Design Temperature, F	200	250	200	200
←(DRN 00-1882)				
Normal Operating Temperature, F	120	120	120	120
Capacity, rated, gpm	50	50	50	60
→ (DRN 98-1595, 00-543, 00-1028; 00-1882; 01-551)				
Rated head, ft.	147.9	147.9	147.9	125
← (DRN 98-1595, 00-543, 00-1028; 00-1882; 01-551)				
NPSH, Available, ft.	15.5	23.4	24	5
Motor Horsepower	7 1/2	7 1/2	7 1/2	7 1/2
Wetted Materials	Stainless Steel	Stainless Steel	Stainless Steel	Stainless Steel

→ (DRN 98-1595, 00-543, 00-1028; 01-551)

← (DRN 98-1595, 00-543, 00-1028; 01-551)

→(DRN 00-1882; 01-551)

←(DRN 00-1882; 01-551)

→ (DRN 99-2361)

(1) The tank is designed and fabricated to ASME VIII Division I but is not stamped.

← (DRN 99-2361)

TABLE 11.2-3

SOURCES, VOLUMES, AND ACTIVITIES FOR BMS LIQUID INFLUENTS

Operations from CVCS	Expected gallons/year	Fraction of (a) RCS Activity
Shim Feed and Bleed for Fuel Burnup	252,300	(b)
Refueling Shutdown and Startup	106,508	(b)
Hot Shutdown at 55% and 65% of Core Life	131,000	(b)
Cold Shutdown at 30%, 60%, and 90% of Core Life	292,672	(b)
TOTAL	782,480	
	Expected gallons/day	Fraction of RCS Activity
Reactor Drain Tank	200	1.0
Equipment Drain Tank	50	0.1

(a) The expected RCS specific activities are given in Table 11.1-3.

(b) The waste entering the BMS from the CVCS is RCS water (Table 11.1-3) that has passed through the purification filter and ion exchanger. The total CVCS DF is 2 for Cs and Rb and 10 for all other nuclides, except tritium and noble gases, which are unity.

TABLE 11.2-4 Revision 14 (12/05)

SOURCES, VOLUMES, AND ACTIVITIES OF WMS LIQUID INFLUENTS

Waste Tanks [a]	Volumes (gallon/day) Expected	Maximum	Fraction of[a] RCS Activities
Containment Building Sump	40	40	1.0
Auxiliary Building Floor Drains	200	200	0.1
Laboratory Drains and Waste Water	400	400	0.002
Sampling Drains	35	35	1.0
Miscellaneous	700	700	0.01
Blowdown	50	17,300(b)	(c)
Total	1425	18,675	
Laundry Tanks	450	1400	(d)

(a) The expected RCS activities are given in Table 11.1-3.

(b) Based on one demineralizer regeneration and one filter backflush being radioactive.

(c) The specific activities of the waste from the "Blowdown Treatment System" is provided in Table 11.1-3.

→(DRN 03-2065, R14)

(d) Untreated releases of detergent waste are provided in Table 11.2-11.

←(DRN 03-2065, R14)

TABLE 11.2-5 Revision 14 (12/05)

→(DRN 03-2065, R14)

TABLE 11.2-5 HAS BEEN INTENTIONALLY DELETED.

←(DRN 03-2065, R14)

TABLE 11.2-6 Revision 11-B (06/02)

BMS EQUIPMENT DECONTAMINATION FACTORS

→(DRN 00-1045; 00-696)

Nuclide	Flash Tank (b)	Pre-Concentrator Filter	Boric Acid Codensate Ion Exchanger	Pre-Concentrator Ion Exchanger
I	1	1	1	10
→ (DRN 99-2361)				
← (DRN 00-696)				
Cs	1	1	1	100.
Rb	1	1	1	100.
← (DRN 99-2361)				
Mo	1	1	1	1
y	1	1	1	1
other Ca^{+}	1	1	1	10
other A^{-}	1	1	1	10
Crud	1	10	1	1
Tritium	1	1	1	1
Noble gases	2	1	1	1

←(DRN 00-1045)

→ (DRN 00-696)

(b) The Flash Tank has been made inactive per ER-W3-00-0225-00-00.

←(DRN 00-696)

TABLE 11.2-7 Revision 11-B (06/02)

WMS EQUIPMENT DECONTAMINATION FACTORS

→(DRN 01-1248)

Nuclide	Waste Demineralizer System	Waste Condensate Ion Exchanger	Filters [a]
I	10^4	10	1
Cs	10^4	10	1
Rb	10^4	10	1
Mo	10^4	10	1
Y	10^4	10	1
other Ca^+	10^4	10	1
other A^-	10^4	10	1
Crud	100	1	10
Tritium	1	1	1

←(DRN 01-1248)

(a) Includes Laundry, Waste, and Oil Filter

TABLE 11.2-8

FPS EQUIPMENT DECONTAMINATION FACTORS

Nuclide	Filter	Ion Exchanger
I	1	10
Cs	1	10
Rb	1	10
Mo	1	10
Y	1	10
other Ca^+	1	10
Other A^-	1	10
Crud	10	1
Tritium	1	1
Noble Gases	1	1

BORON MANAGEMENT SYSTEM PROCESS DATA [1], [2], [3]

→(DRN 00-696)

Mode I — Processing Reactor Drain Tank Contents to the Holdup Tank

Location:	1	2	3	4	5[4]	6[4]	7[4]	8	
Flow gpm	200 gpd	50	50	0	50	60	50	50	
Pressure, psig	0.5	12	75	7	6	3	40	2	
Temp. F	120	120	120	120	120	120	120	120	

Mode 2 — Processing Equipment Drain Tank Contents to the Holdup Tank

Location:	1a	1b	2	3	4	5[4]	6[4]	7[4]	8
Flow gpm	50 gpd	25	50	50	0	50	60	50	50
Pressure, psig	3	3	12	74	7	6	3	40	2
Temp. F	120	120	120	120	120	120	120	120	120

Mode 3 — Processing Normal Purification Flow to the Holdup Tank

Location:					4	5[4]	6[4]	7[4]	8
Flow gpm					40	40	50	40	40
Pressure, psig					5	4	3	41	2
Temp. F					120	120	120	120	120

Mode 4 — Processing Intermediate CVCS Purification Flow to the Holdup Tank

Location:					4	5[4]	6[4]	7[4]	8
Flow gpm					84	84	94	84	84
Pressure, psig					21	19	3	36	3
Temp. F					120	120	120	120	120

Mode 5 — Processing Maximum CVCS Purification Flow to the Holdup Tank

Location:					4	5[4]	6[4]	7[4]	8
Flow gpm					128	128	138	128	128
Pressure, psig					52	47	3	31	4
Temp. F					123	123	123	123	123

←(DRN 00-696)

Mode 6 — Processing Holdup Tank Contents Via the Boric Acid Concentrator

Location:	12	13	14	14a	15	16	17	17a	18
→(DRN 00-1045)									
Flow gpm	0	0	0	0	0	0	0	0	0
Pressure, psig	0	0	0	0	0	0	0	0	0
Temp. F	0	0	0	0	0	0	0	0	0

←(DRN 00-1045)

TABLE 11.2-9 (Sheet 2 of 2) Revision 15 (03/07)

BORON MANAGEMENT SYSTEM PROCESS DATA (1), (2), (3)

→(DRN 00-696, R11-B)

Mode 7 — Recirculating Holdup Tank Contents Through the Preconcentrator Filter and Preconcentrator Ion Exchanger or Back to the Flash Tank[(4)]

	via the Filter & Ion Exchanger					to the Flash Tank[(4)]			
Location:	9	10	11	11a	11b	5[(4)]	6[(4)]	7[(4)]	8
Flow gpm	60	60	50	50	50	50	60	50	50
Pressure,psig	24	86	31	24	5	6	3	40	2
Temp. F	120	120	120	120	120	120	120	120	120

←(DRN 00-696, R11-B)

→(DRN 06-537, R15)

Mode 8 — Discharging Boric Acid Condensate Tank Contents to the Circulating Water Discharge Canal

←(DRN 06-537, R15)

Location:	19	20	21
Flow gpm	60	50	50
Pressure, psig	13	62	32
Temp. F	120	120	120

Mode 9 — Recirculating Boric Acid Condensate Tank Contents through the Boric Acid Condensate Ion Exchanger or Back to the Holdup Tank

			via Ion Exchanger	to Holdup Tank		
Location:	19	20	20a	17a	18	8
Flow gpm	60	50	50	50	50	50
Pressure,psig	13	62	.40	34	0	2
Temp.,F	120	120	120	120	120	120

(1) Process data refers to nodal points of Figure 11.2-1.

(2) The pressure drop across the BMS filters, ion exchangers and strainers varies with loading. The pressure drops as shown are given with minimal crud deposition.

(3) Since line pressure drops are dependent on piping layouts and equipment elevations and assumed pipe lengths were used for calculation purposes, the pressure values are approximate.

→(DRN 00-696, R11-B)

(4) This is historical data. The Flash Tank path is inactive per ER-W3-00-0225-00-00. Effluent now flows directly to the Holdup Tanks.

←(DRN 00-696, R11-B)

TABLE 11.2-10

WASTE MANAGEMENT SYSTEM PROCESS FLOW POINT DATA

PROCESSING CONTENTS OF A WASTE TANK

Mode I Location(1)	1	2	3	4	5	6	7	8	9	10	11	12
Flow, gpm	50	20	30	20	20	1	19	19	60	50	10	50
Pressure, psig	62	62	62	52	42	20	30	20	62	62	62	52
Temperature, F	120	120	120	120	120	180	120	120	120	120	120	120

PROCESSING CONTENTS OF A LAUNDRY TANK

Mode 2 Location(1)	13	14	15	16	12
Flow, gpm	60	10	50	50	50
Pressure, psig	62	62	62	52	52
Temperature, F	120	120	120	120	120

→

(1) Refers to nodal points of Figure 11.2-2.

←

SOURCE TERMS
(NO GAS STRIPPING)
LIQUID EFFLUENTS

→(DRN 03-2065, R14)

ANNUAL RELEASES TO DISCHARGE CANAL

NUCLIDE	HALF-LIFE (DAYS)	COOLANT CONCENTRATIONS PRIMARY (μCi/ml)	SECONDARY (μCi/ml)	BORON RS (CURIES)	MISC. WASTES (CURIES)	SECONDARY (CURIES)	TURB BLDG (CURIES)	TOTAL LWS (CURIES)	ADJUSTED TOTAL (Ci/yr)	DETERGENT WASTES (Ci/yr)	TOTAL (Ci/yr)
CORROSION AND ACTIVIATION PRODUCTS											
Na-24	6.25E-01	7.78E-02	5.83E-06	0.00000*	0.00004	0.00000	0.00022	0.00026	0.00328	0.00000	0.00330
P-32	1.43E+01	0.00E+00	0.00E+00	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00018	0.00018
Cr-51	2.78E+01	6.19E-03	7.27E-07	0.00000	0.00001	0.00000	0.00004	0.00005	0.00063	0.00470	0.00530
Mn-54	3.03E+02	3.22E-03	3.68E-07	0.00000	0.00001	0.00000	0.00002	0.00003	0.00034	0.00380	0.00410
Fe-55	9.50E+02	2.42E-03	2.78E-07	0.00000	0.00001	0.00000	0.00001	0.00002	0.00025	0.00720	0.00750
Fe-59	4.50E+01	6.01E-04	6.74E-08	0.00000	0.00000	0.00000	0.00000	0.00000	0.00006	0.00220	0.00230
Co-58	7.13E+01	9.23E-03	1.07E-06	0.00000	0.00002	0.00000	0.00005	0.00007	0.00096	0.00790	0.00890
Co-60	1.92E+03	1.07E-03	1.25E-07	0.00000	0.00000	0.00000	0.00001	0.00001	0.00011	0.01400	0.01400
Ni-63	3.36E+04	0.00E+00	0.00E+00	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00170	0.00170
Zn-65	2.45E+02	1.03E-03	1.19E-07	0.00000	0.00000	0.00000	0.00001	0.00001	0.00011	0.00000	0.00011
W-187	9.96E-01	4.34E-03	3.74E-07	0.00000	0.00000	0.00000	0.00002	0.00002	0.00024	0.00000	0.00024
Np-239	2.35E+00	4.09E-03	4.14E-07	0.00000	0.00000	0.00000	0.00002	0.00002	0.00030	0.00000	0.00030
FISSION	**PRODUCTS**										
Sr-89	5.20E+01	2.81E-04	3.21E-08	0.00000	0.00000	0.00000	0.00000	0.00000	0.00003	0.00009	0.00012
Sr-90	1.03E+04	2.42E+05	2.78E-09	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00001	0.00002
Sr-91	4.03E-01	1.52E-03	9.76E-08	0.00000	0.00000	0.00000	0.00000	0.00000	0.00005	0.00000	0.00005
Y-91m	3.47E-02	6.22E-04	6.88E-09	0.00000	0.00000	0.00000	0.00000	0.00000	0.00003	0.00000	0.00003
Y-91	5.88E+01	1.04E-05	1.18E-09	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00008	0.00008
Y-93	4.25E-01	6.67E-03	4.24E-07	0.00000	0.00000	0.00000	0.00001	0.00002	0.00021	0.00000	0.00021
Zr-95	6.50E+01	7.83E-04	9.02E-08	0.00000	0.00000	0.00000	0.00000	0.00001	0.00008	0.00110	0.00120
Nb-95	3.50E+01	5.60E-04	6.17E-08	0.00000	0.00000	0.00000	0.00000	0.00000	0.00006	0.00190	0.00200
Mo-99	2.79E+00	1.20E-02	1.26E-06	0.00000	0.00001	0.00000	0.00006	0.00007	0.00693	0.00006	0.00099
Tc-99m	2.50E-01	7.09E-03	3.39E-07	0.00000	0.00001	0.00000	0.00003	0.00005	0.00661	0.00000	0.00061
Ru-103	3.96E+01	1.50E-02	1.74E-06	0.00000	0.00003	0.00000	0.00009	0.00012	0.00153	0.00029	0.00180
Rh-103M	3.96E-02	0.00E+00	0.00E+00	0.00000	0.00003	0.00000	0.00009	0.00012	0.00151	0.00000	0.00150
Ru-106	3.67E+02	1.81E-01	2.10E-05	0.00001	0.00044	0.00000	0.00104	0.00149	0.01906	0.00890	0.02800
Rh-106	3.47E-04	0.00E+00	0.00E+00	0.00001	0.00044	0.00000	0.00104	0.00149	0.01906	0.00000	0.01900
Ag-110m	2.53E+02	2.62E-03	3.00E-07	0.00000	0.00001	0.00000	0.00001	0.00002	0.00027	0.00120	0.00150
Ag-110	2.82E-04	0.00E+00	0.00E+00	0.00000	0.00000	0.00000	0.00000	0.00000	0.00004	0.00000	0.00004
Sb-124	6.00E+01	0.00E+00	0.00E+00	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00043	0.00043
Te-129m	3.40E+01	3.80E-04	4.37E-08	0.00000	0.00000	0.00000	0.00000	0.00000	0.00004	0.00000	0.00004
Te-129	4.79E-02	3.28E-02	4.90E-07	0.00000	0.00000	0.00000	0.00000	0.00000	0.00004	0.00000	0.00004
Te-131m	1.25E+00	2.66E-03	2.42E-07	0.00000	0.00000	0.00000	0.00001	0.00001	0.00016	0.00000	0.00016
Te-131	1.74E-02	1.03E-02	5.92E-08	0.00000	0.00000	0.00000	0.00000	0.00000	0.00003	0.00000	0.00003
I-131	8.05E+00	8.90E-02	9.83E-06	0.00000	0.00142	0.00000	0.00096	0.00238	0.03054	0.00160	0.03200

←(DRN 03-2065, R14)

SOURCE TERMS
(NO GAS STRIPPING)
LIQUID EFFLUENTS

➔(DRN 03-2065, R14)

ANNUAL RELEASES TO DISCHARGE CANAL

NUCLIDE	HALF-LIFE (DAYS)	COOLANT CONCENTRATIONS PRIMARY (μCi/ml)	SECONDARY (μCi/ml)	BORON RS (CURIES)	MISC. WASTES (CURIES)	SECONDARY (CURIES)	TURB BLDG (CURIES)	TOTAL LWS (CURIES)	ADJUSTED TOTAL (Ci/yr)	DETERGENT WASTES (Ci/yr)	TOTAL (Ci/yr)
Te-132	3.25E+00	3.22E-03	3.37E-07	0.00000	0.00000	0.00000	0.00002	0.00002	0.00025	0.00000	0.00025
I-132	9.58E-02	2.96E-01	7.71E-06	0.00000	0.00014	0.00000	0.00014	0.00028	0.00362	0.00000	0.00360
I-133	8.75E-01	2.41E-01	2.02E-05	0.00000	0.00150	0.00000	0.00165	0.00315	0.04041	0.00000	0.04000
I-134	3.67E-02	4.61E-01	5.19E-06	0.00000	0.00002	0.00000	0.00000	0.00003	0.00035	0.00000	0.00035
Cs-134	7.49E+02	1.32E-02	2.74E-06	0.00004	0.00016	0.00000	0.00014	0.00034	0.00436	0.01100	0.01500
I-135	2.79E-01	3.98E-01	2.10E-05	0.00000	0.00078	0.00000	0.00113	0.00190	0.02436	0.00000	0.02400
Cs-136	1.30E+01	1.58E-03	3.16E-07	0.00000	0.00001	0.00000	0.00002	0.00003	0.00041	0.00037	0.00078
Cs-137	1.10E+04	1.75E-02	3.66E-06	0.00006	0.00022	0.00000	0.00018	0.00045	0.00582	0.01600	0.02200
Ba-137m	1.77E-03	0.00E+00	0.00E+00	0.00005	0.00020	0.00000	0.00017	0.00043	0.00544	0.00000	0.00540
Ba-140	1.28E+01	2.57E-02	2.86E-06	0.00000	0.00005	0.00000	0.00014	0.00019	0.00240	0.00091	0.00330
La-140	1.67E+00	4.54E-02	4.38E-06	0.00000	0.00007	0.00000	0.00021	0.00028	0.00357	0.00000	0.00360
Ce-141	3.24E+01	3.00E-04	3.42E-08	0.00000	0.00000	0.00000	0.00000	0.00000	0.00003	0.00023	0.00026
Ce-143	1.38E+00	5.00E-03	4.56E-07	0.00000	0.00000	0.00000	0.00002	0.00002	0.00031	0.00000	0.00031
Pr-143	1.37E+01	0.00E+00	0.00E+00	0.00000	0.00000	0.00000	0.00000	0.00000	0.00001	0.00000	0.00001
Ce-144	2.84E+02	7.85E-03	9.06E-07	0.00000	0.00002	0.00000	0.00005	0.00006	0.00082	0.00390	0.00470
Pr-144	1.20E-02	0.00E+00	0.00E+00	0.00000	0.00002	0.00000	0.00005	0.00006	0.00082	0.00000	0.00082
ALL OTHERS		2.73E-01	1.22E-06	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
TOTAL (EXCEPT TRITIUM)		2.26E+00	1.16E-04	0.00017	0.00571	0.00000	0.00767	0.01355	0.17355	0.08975	0.26000

TRITIUM RELEASE 370 CURIES PER YEAR

- Releases which are less than 10^{-5} Ci/yr are designated as 0.00000.

←(DRN 03-2065, R14)

TABLE 11.2-12 (Sheet 1 of 3) Revision 307 (07/13)

PRINICIPAL PARAMETERS AND CONDITIONS USED IN RADIOLOGICAL EFFLUENT EVALUATIONS

→(DRN 03-2065, R14)

1.	Design Thermal Power Level	3716 MWt

←(DRN 03-2065, R14)

2.	Plant Load Factor	0.8
3.	Percent Failed Fuel	0.12
4.	Primary System	
	Mass of Coolant	455,950 lbs.
	Average Letdown Rate	40 gpm
	Average Letdown Rate through HBO_3 Demineralizers	8 gpm
	Shim Bleed Rate	0.54 gpm
	Steam Generator Leak Rate to Secondary Side →(DRN 03-2065, R14)	75 lbs./day
	←(DRN 03-2065, R14) Leakage Rate to Auxiliary Bldg.	160 lbs./day
	Source Term to Containment Bldg.	
	Noble Gases	1% of noble gas coolant inventory
	Iodine	0.001% of iodine coolant inventory
	Letdown Stripping	(no stripping)
5.	Secondary System	

→(DRN 03-2065, R14; EC-8458, R307)

	Steam Flow Rate	1.66×10^7 lbs./hr
	Mass of Steam in each Steam Generator	1.24×10^4 lbs.
	Mass of Water in each Steam Generator	1.81×10^5 lbs.

←(DRN 03-2065, R14; EC-8458, R307)

	Number of Steam Generators	2
	Mass of Secondary Coolant (includes Condenser hotwell)	2.8×10^6 lbs.
	Rate of Steam Leakage to Turbine Bldg.	1700 lbs./hr

→(DRN 03-2065, R14)

	Steam Generator Blowdown Rate	165 gpm
6.	Containment Volume	2.68×10^6 ft.^{3}

←(DRN 03-2065, R14)

7.	Frequency of Containment Purge	24 purges/yr. with 16 hrs. of recirculation through filters prior to each purge
8.	Gaseous Waste Management System	
	Number of Tanks	3
	Decay Tank Volume	600 ft.^{3} (each)
	Fill Time	60 days
	Holdup Time	60 days

Table 11.2-12 (Sheet 2 of 3) Revision 7 (10/94)

PRINICIPAL PARAMETERS AND CONDITIONS USED IN RADIOLOGICAL EFFLUENT EVALUATIONS

9. Iodine Partition Factors

Auxiliary Building Leakage	0.0075
Steam Leakage to Turbine Bldg.	1.0
Steam Generator (carryover)	0.01
Main Condenser	0.15

10. Steam Generator Blowdown Flash Tank — Routed to Condenser

11. Decontamination Factors(2)

Demineralizer	Anion	CsRb	Other Nuclides
Mixed Bed:			
Primary Coolant Letdown ($Li_3 BO_3$)	10	2	10
Radwaste ($H^+ OH^-$)	10^2 (10)(1)	2(10)	10^2 (10)
Evaporator Condensate Polishing	10	10	10
Cation Bed (any system)	1(1)	10(10)	10(10)
Anion Bed (any system)	10^2 (10)	1(1)	1(1)
Powdex (any system)	10(10)	2(10)	10(10)

➜

Evaporators(3)	All Nuclides Except Iodine	Iodine
Miscellaneous Radwaste	10^4	10^3
Boric Acid Recovery	10^3	10^2
Detergent Wastes	10^2	10^2

←

(1) For demineralizers in series, the DF for the second demineralizer is given in parenthesis.

(2) These DFs differ from DFs presented in Tables 11.2-6, 11.2-7 and 11.2-8 in that they take less credit for the effectiveness for filters and evaporators in order to place a conservative upper limit on liquid effluent from the plant.

➜

(3) The Waste Concentrator was abandoned per DC-3188.

Table 11.2-12 (Sheet 3 of 3)

PRINICIPAL PARAMETERS AND CONDITIONS USED IN RADIOLOGICAL EFFLUENT EVALUATIONS

12. Liquid Waste Streams

Stream	Flow Rate Gal/Days	Fraction of PCA	Fraction Discharged	Collection Time (Days)	Decay Time (Days)
Shim Bleed	7.78(+02)	1.000	0.120	26.000	1.300
Equipment Drains	5.00(+01)	0.100	0.120	90.000	1.300
Clean Wastes	6.22(+02)	1.000	0.120	32.400	1.300
Dirty Wastes	1.38(+03)	0.075	1.000	2.300	0.100
Blowdown	8.69(+04)		0.000	2.300	0.100
Untreated Blowdown	0.		1.000	0.0	0.0

Stream	Decontamination Factors		
	Iodine	Cesium	Others
Shim Bleed	1.00(+05)	2.00(+04)	1.00(+05)
Equipment Drains	1.00(+04)	2.00(+04)	1.00(+05)
Clean Wastes	1.00(+04)	2.00(+04)	1.00(+05)
Dirty Wastes	1.00(+04)	2.00(+04)	1.00(+05)
Blowdown	1.00(+01)	2.00(+00)	1.00(+01)
Untreated Blowdown	1.00(00)	1.00(00)	1.00(00)

13. Filtration of Airborne Effluents

	Decontamination Factors	
	Iodines	Particulates
Auxiliary Bldg. Vent	10	100
Reactor Bldg. Vent	10	100
Turbine Bldg.	Unfiltered	(open Turbine Building)
Air Ejector	10	100
Decay Tanks	Unfiltered	

14. X/Q's and D/Q's based on a ground release model only (i.e., no mixed mode release).

15. A filtration efficiency of 90% for the RAB filter during all normal operation, including Containment Building purge.

16. Iodine charcoal filter efficiency of 50% for the ARRS inside the Containment.

( ) Denotes power of 10

TABLE 11.2-13 (Sheet 1 of 2) Revision 14 (12/05)

FRACTION OF EFFLUENT CONCENTRATION (EC) AVERAGED OVER ONE YEAR

→(DRN 03-2065, R14)

Nuclide	Concentration in Discharge Canal (Ci)* (μCi/cc)	Effluent Concentration 10ECi** (uCi/cc)	Ci/10ECi***
Cr-51	2.79E-12	5.00E-03	5.57E-10
Mn-54	2.16E-12	3.00E-04	7.19E-09
Fe-55	3.94E-12	1.00E-03	3.94E-09
Fe-59	1.21E-12	1.00E-04	1.21E-08
Co-58	4.68E-12	2.00E-04	2.34E-08
Co-60	7.36E-12	3.00E-05	2.45E-07
Rb-86	0.00E+00	7.00E-05	0.00E+00
Sr-89	6.31E-14	8.00E-05	7.89E-10
Y-91	4.21E-14	8.00E-05	5.26E-10
Np-239	1.58E-13	2.00E-04	7.89E-10
Mo-99	5.20E-13	2.00E-04	2.60E-09
Tc-99m	3.21E-13	1.00E-02	3.21E-11
H-3	1.95E-07	1.00E-02	1.95E-05
I-131	1.68E-11	1.00E-05	1.68E-06
I-132	1.89E-12	1.00E-03	1.89E-09
I-133	2.10E-11	7.00E-05	3.00E-07
I-134	1.84E-13	4.00E-03	4.60E-11
I-135	1.26E-11	3.00E-04	4.21E-08
Cs-134	7.89E-12	8.00E-05	9.86E-08
Cs-136	4.10E-13	1.00E-07	4.10E-06
Cs-137	1.16E-11	7.00E-03	1.65E-09
Te-127m	0.00E+00	9.00E-05	0.00E+00
Te-127	0.00E+00	1.00E-03	0.00E+00
Te-129m	2.10E-14	7.00E-05	3.00E-10
Te-129	2.10E-14	4.00E-03	5.26E-12
Te-131m	8.41E-14	8.00E-05	1.05E-09
Te-132	1.31E-13	9.00E-05	1.46E-09
Na-24	1.73E-12	5.00E-05	3.47E-08
P-32	9.46E-14	9.00E-05	1.05E-09
Ni-63	8.94E-13	1.00E-03	8.94E-10
Zn-65	5.78E-14	5.00E-05	1.16E-09
W-187	1.26E-13		
Sr-90	1.05E-14	5.00E-06	2.10E-09
Sr-91	2.63E-14	2.00E-04	1.31E-10
Y-91m	1.58E-14	2.00E-02	7.89E-13
Y-93	1.10E-13	2.00E-04	5.52E-10
Zr-95	6.31E-13	2.00E-04	3.15E-09
Nb-95	1.05E-12	3.00E-04	3.50E-09
Ru-103	9.46E-13	3.00E-04	3.15E-09
Rh-103m	7.89E-13	6.00E-02	1.31E-11
Ru-106	1.47E-11	3.00E-05	4.91E-07
Rh-106	9.99E-12		
Ag-110m	7.89E-13	6.00E-05	1.31E-08

←(DRN 03-2065, R14)

TABLE 11.2-13 (Sheet 2 of 2) Revision 14 (12/05)

FRACTION OF EFFLUENT CONCENTRATION (EC) AVERAGED OVER ONE YEAR

→(DRN 03-2065, R14)

Nuclide	Concentration in Discharge Canal (Ci)* (μCi/cc)	Effluent Concentration 10ECi** (uCi/cc)	Ci/10ECi***
Ag-110	2.10E-14		
Sb-124	2.26E-13	7.00E-05	3.23E-09
Te-131	1.58E-14	8.00E-04	1.97E-11
Ba-137m	2.84E-12		
Ba-140	1.73E-12	8.00E-04	2.17E-09
La-140	1.89E-12	9.00E-05	2.10E-08
Ce-141	1.37E-13	3.00E-04	4.56E-10
Ce-143	1.63E-13	2.00E-04	8.15E-10
Pr-143	5.26E-15	2.00E-04	2.63E-11
Ce-144	2.47E-12	3.00E-05	8.24E-08
Pr-144	4.31E-13	1.00E-03	4.31E-10

* Uniform Dispersion in Entire Circulating Water Discharge of 2130 cfs.

** Ten times Effluent Concentration in 10CFR20, Appendix B, Table 2, Column 2.

*** Fraction of Effluent Concentration allowed by 10CFR20.

←(DRN 03-2065, R14)

TABLE 11.2-14 (Sheet 1 of 2) Revision 14 (12/05)

AQUATIC EXPOSURE PATHWAYS
(mrem/yr)

Pathway	Bone	Liver	Thyroid	Kidney	Lung	GI-LLI	Skin	Whole Body
→(DRN 03-2065, R14)								
Adults:								
Irrigation-								
Fruits & Vegetables & Grain	5.2E-04	1.6E-02	1.5E-02	1.5E-02	1.5E-02	1.5E-02	1.6E-02	1.6E-02
Leafy Vegetables	6.4E-05	2.0E-03	2.0E-03	2.1E-03	2.0E-03	1.8E-03	2.0E-03	2.0E-03
Milk	6.3E-04	1.0E-02	2.0E-02	9.3E-03	9.1E-03	9.0E-03	9.7E-03	9.7E-03
Meat & Poultry	8.9E-05	3.3E-03	1.4E-02	3.3E-03	3.2E-03	3.2E-03	3.3E-03	3.3E-03
Fish-	8.2E-02	1.4E-01	3.3E-02	4.7E-02	1.6E-02	3.8E-03	1.0E-01	1.0E-01
Drinking-	1.6E-03	2.4E-02	1.0E-01	2.3E-02	2.2E-02	2.2E-02	2.4E-02	2.4E-02
Shoreline Activities	5.5E-05	5.5E-05	5.5E-05	5.5E-05	5.5E-05	5.5E-05	6.4E-05	5.5E-05
TOTALS-	8.4E-02	2.0E-01	1.8E-01	1.0E-01	6.7E-02	5.4E-02	1.6E-01	1.6E-01
Teen:								
Irrigation-								
Fruits & Vegetables & Grain	8.3E-04	1.6E-02	1.5E-02	1.8E-02	1.5E-02	1.5E-02	1.5E-02	1.5E-02
Leafy Vegetables	5.6E-05	1.0E-03	1.0E-03	1.3E-03	9.9E-04	9.8E-04	1.0E-03	1.0E-03
Milk	1.1E-03	1.1E-02	2.4E-02	1.3E-02	9.3E-03	9.2E-03	9.9E-03	9.9E-03
Meat & Poultry	6.8E-05	1.6E-03	8.5E-03	2.0E-03	1.5E-03	1.5E-02	1.6E-03	1.6E-03
Fish-	8.3E-02	1.4E-01	3.0E-02	3.6E-02	1.8E-02	2.6E-03	5.8E-02	5.8E-02
Drinking-	1.5E-03	1.5E-02	7.8E-02	1.6E-02	1.3E-02	1.3E-02	1.3E-02	1.3E-02
Shoreline Activities-	3.1E-04	3.1E-04	3.1E-04	3.1E-04	3.1E-04	3.1E-04	3.6E-04	3.1E-04
TOTALS-	8.6E-02	1.8E-01	1.5E-01	8.6E-02	5.8E-02	4.3E-02	9.8E-02	9.8E-02
Child:								
Irrigation-								
Fruits & Vegetables & Grains	2.0E-03	2.5E-02	2.3E-02	1.5E-02	2.3E-02	2.3E-02	2.3E-02	2.3E-02
Leafy Vegetables	1.0E-04	1.3E-03	1.2E-03	7.8E-04	1.2E-03	1.2E-03	1.2E-03	1.2E-03
Milk	2.5E-03	1.7E-02	4.5E-02	9.9E-03	1.5E-02	1.5E-02	1.5E-02	1.5E-02
Meat & Poultry	1.3E-04	2.0E-03	1.3E-02	1.3E-03	1.8E-02	1.8E-02	1.8E-02	1.8E-02
Fish-	1.0E-01	1.3E-01	3.1E-02	1.6E-02	1.4E-02	1.2E-03	2.2E-02	2.2E-02
Drinking-	4.3E-03	2.9E-02	1.8E-01	1.6E-02	2.4E-02	2.3E-02	2.4E-02	2.4E-02
Shoreline Activities-	6.4E-05	6.4E-05	6.4E-05	6.4E-05	6.4E-05	6.4E-05	7.5E-05	6.4E-05
TOTALS-	1.1E-01	2.0E-01	3.0E-01	5.9E-02	7.8E-02	6.4E-02	8.6E-02	8.6E-02

←(DRN 03-2065, R14)

TABLE 11.2-14 (Sheet 2 of 2) Revision 14 (12/05)

AQUATIC EXPOSURE PATHWAYS
(mrem/yr)

Pathway	Bone	Liver	Thyroid	Kidney	Lung	GI-LLI	Skin	Whole Body
→(DRN 03-2065, R14)								
Infant:								
Irrigation- fruits & Vegetables & Grain, Leafy Vegetables, Milk*, Meat & Poultry	2.5E-03	1.7E-02	4.5E-02	9.9E-03	1.5E-02	1.5E-02	1.5E-02	1.5E-02
Fish, Drinking, Shoreline Activities	8.9E-03	4.7E-02	4.3E-01	1.6E-02	3.7E-02	3.6E-02	3.7E-02	3.7E-02
TOTALS-	1.1E-02	6.4E-02	4.7E-01	2.5E-02	5.2E-02	5.1E-02	5.2E-02	5.2E-02

* Assumed to be the same as Child.

←(DRN 03-2065, R14)