11.2 LIQUID WASTE MANAGEMENT SYSTEMS

Several systems within the plant serve to control, collect, process, handle, store, recycle, and dispose of liquid radioactive waste generated as a result of normal plant operation, including anticipated operational occurrences. This section discusses the design and operating features and performance of the liquid radwaste system and the performance of other liquid waste management systems which are discussed in other sections.

11.2.1 DESIGN BASES

11.2.1.1 Safety Design Basis

Except for two containment penetrations and the component cooling water side of the reactor coolant drain tank heat exchanger, the liquid radwaste system (LRWS) is not a safety-related system.

SAFETY DESIGN BASIS ONE - The containment isolation valves in the LRWS are selected, tested, and located in accordance with the requirements of 10 CFR 50, Appendix A, GDC-56, and 10 CFR 50, Appendix J, Type C testing.

11.2.1.2 Power Generation Design Bases

POWER GENERATION DESIGN BASIS ONE - The LRWS, in conjunction with other liquid waste management systems, is designed to meet the requirements of the discharge concentration limits of 10 CFR 20 and the ALARA dose objective of 10 CFR 50, Appendix I.

POWER GENERATION DESIGN BASIS TWO - The LRWS uses design and fabrication codes consistent with quality group D (augmented), as assigned by Regulatory Guide 1.143, for radioactive waste management systems.

POWER GENERATION DESIGN BASIS THREE - Liquid effluent discharge paths are monitored for radioactivity and isolated upon detection of unacceptable radioactivity.

11.2.2 SYSTEM DESCRIPTION

11.2.2.1 General Description

This section describes the design and operating features of the LRWS. The performance of the LRWS, in conjunction with other liquid waste management systems, is discussed in Section 11.2.3. Detailed descriptions of other liquid waste management systems are provided in the following sections:

a. Boron recycle 9.3.6

b. Steam generator blowdown 10.4.8

c. CVCS boron thermal regeneration and purification 9.3.4

d. Secondary liquid waste 10.4.10

The piping and instrumentation diagram for the LRWS is shown in Figure 11.2-1.

The LRWS collects and processes radioactive or potentially radioactive waste water. The LRWS consists of two subsystems designated as drain channel A and drain channel B. Drain channel A is for processing water which could be recycled and drain channel B is for processing water which would normally be discharged. Equipment drains and waste streams are segregated to prevent the intermixing of the liquid wastes. Tritiated waters (CRW), potentially radioactive nontritiated waste (DRW), and detergent waste (SRW) are discussed in Section 9.3.3. A drain system is also provided inside the containment to collect drainage and leakage and transfer it to an appropriate tank.

Operating experience has shown that operating dose rates and overall release of radioactivity to the environment are minimized by not recycling triatiated water to the Reactor Makeup Water Storage Tank (RMWST). This method of operation eliminates the potential for contamination of secondary systems while degassing the Reactor Makeup Water System (BL) water in the Demineralized Water Makeup Storage and Transfer System (AN).

The various waste streams are processed as follows:

BORON RECYCLE SYSTEM - The bulk of the radioactive liquid discharged from the reactor coolant system is processed by the Boron Recycle System as described in Section 9.3.6. This water is transferred from a Recycle Holdup Tank to the LRWS for processing by the Liquid Radwaste Processing Skid as indicated in Figure 11.1A-2.

TRITIATED WASTES - These consist of reactor coolant which has been exposed to the atmosphere and has become aerated. This waste consists of equipment drains, leakoffs, and overflows from tritiated systems (e.g., CVCS and reactor coolant samples which have not been chemically contaminated). This waste is typically collected in the floor and equipment drain system, transferred to the waste holdup tank and processed in the Liquid Radwaste Processing system prior to entering the waste evaporator condensate tank, waste monitor tanks or secondary liquid waste monitor tanks. The processed wastes are analyzed for chemical and radioactive content in the waste evaporator condensate tank, waste monitor tanks (WMTs) or secondary liquid waste monitor tanks prior to being discharged.

HIGH LEVEL CHEMICAL WASTE - High level chemical waste consists of plant samples which have been chemically contaminated and decontamination solutions used in the decontamination tanks located in the hot machine shop. These wastes are collected in the chemical drain tank. The contents are received and sampled by chemistry to ensure that no highly contaminated chemical solutions are allowed to enter the floor drain system. This is done by analyzing for conductivity and PH. (If an abnormal parameter exists the contents are drained in small quantities to the floor drain system to allow for dilution).

The chemical drain tank contents are processed by draining its contents to the Floor Drain Tanks for dilution then processed by the LWPS.

CONTROLLED ACCESS AREA FLOOR DRAINAGE - Controlled access area floor drain wastes are miscellaneous liquid wastes collected by the floor drain system within the radiologically controlled areas of the plant. The controlled access areas are radiation zones B through E and include the containment, auxiliary building, fuel building, radwaste building, hot machine shop, and the access control areas of the control building.

Floor drainage consists of miscellaneous leakage from systems within the above areas. Generally, the amount of highly radioactive reactor coolant leakage into the drain system is very small. The bulk of the water originates as leakage from nonradioactive or slightly radioactive systems, such as the service water and component cooling water systems. In addition to system leakage, the floor drain systems collect decontamination water used for area washdowns, spent fuel cask decontamination, and laboratory equipment decontamination and rinses. Highly contaminated chemical solutions are not allowed to enter the floor drain system in large volumes, and, therefore, are directed to the chemical drain tank for processing. During maintenance, equipment drains from nontritiated systems are directed to the floor drain system. Large volumes of component cooling water are not drained to the floor drain system to prevent contamination of the LRWS by corrosion inhibitors.

The floor drain tanks are processed through the liquid radwaste demineralizer skid. The FDT may contain chemical contaminants, mild decontamination solutions, organics, etc. Filtration and ion exchange are capable of providing the required purity for environmental discharge. Relatively small volumes of exchange media are consumed in comparison to the volumes of solidified concentrates generated by evaporator bottoms processing. Since the processed water is not recycled, it is not necessary to deaerate for discharge to the environment.

The liquid waste charcoal adsorber (LWCA) should be used only if the presence of organics is detected. If the waste in the FDT has a low level of dissolved solids, an activity of less than 10-5 mCi/cc, and the operator intends to discharge, the floor drain tank filter, liquid waste charcoal adsorber, waste evaporator condensate filter, and waste monitor tank demineralizer in series may be used to process the waste effectively. This method of processing can also be employed when abnormally large volumes of floor drain wastes are to be processed. When the effluent has not been processed, it should be directed to an aerated waste monitor tank.

A second floor drain tank is available to allow one tank to be isolated and sampled prior to feeding the processing system while the other tank is available to receive wastes. The second floor drain tank also provides greater system storage volumes which will minimize inventory problems by providing greater surge capacity during periods of abnormal waste generation or equipment outages.

When processing floor drain waste it is highly desirable to operate with a known influent quality to ensure optimum system performance. This is normally accomplished by isolating the floor drain tank to be processed and withdrawing a sample to determine its chemical properties. The operator selects the appropriate process equipment.

If the sample indicates relatively clean waste (less than 25 ppm TDS without organic or boric acid contamination), it can be effectively processed through the demineralizer train. Waste is processed with the Liquid Radwaste Processing Skid. With known influent chemistry, the optimum process can be selected.

LAUNDRY AND PERSONNEL DECONTAMINATION WASTE - Laundry waste is generated by the washing of radioactively contaminated protective clothing and gear to remove the radioactivity so the clothing, or protective gear, can be worn again. The personnel decontamination waste contains detergents (inorganics) and/or soaps (organics) which have been used by personnel who may have become contaminated

with loose radioactive material within the plant. The hot shower in the access control area is used only for personnel decontamination; consequently, its use should be infrequent.

The laundry and personnel decontamination wastes are collected in the chemical and detergent waste system's detergent drain tank and then transferred to the laundry and hot shower tank. Also, they may be transfered to the monitor tanks for discharge. Suspended solids are removed by strainers and filters located at the beginning of the processing train. Laundry water stored in the laundry water storage tank is provided to the washing machine hot water heater, and laundry washing machines. The Laundry and Hot Shower Tank (LHST) contents are normally not reprocessed due to the small amount of water that would be recycled. The system generates low volumes due to contaminated laundry being processed offsite through vendor services.

Reclaimed laundry water is not recycled to any other portion of the plant because of the increased probability of organic contaminants, even though it may meet the necessary chemical criteria. Provisions are made to allow the addition of microbiocides to the laundry water storage tank to inhibit the growth of microorganisms.

The laundry system can receive makeup water from the waste monitor tank "A" or the secondary liquid waste monitor tank, or the Reactor Makeup Water System (RMWS). Makeup water is needed to replace water lost to wet clothes removed from the system, evaporated in the dryers, and vented from the plant, or to replace water that has been released to the environment. Reclaimed water is not recycled to the personnel decontamination shower.

Provisions are made to permit the discharge of laundry water to the environment, by means of a waste monitor tank or secondary liquid waste monitor tanks.

All tanks which contain or may contain concentrations of radioactivity have provisions to prevent the uncontrolled release of the fluid. Table 11.2-2 indicates the provisions made for each tank.

The system is designed to handle the occurrence of equipment faults of moderate frequency such as:

a. Malfunction in the LWPS

   Malfunction in this system could include such things as pump or valve failures or evaporator failure. Because of pump standardization throughout the system, a spare pump can be used to replace most pumps in the system. There is sufficient surge capacity in the system to accommodate waste until the failures can be fixed and normal plant operation resumed.

b. Excessive leakage in reactor coolant system equipment

The system is designed to handle a 1-gpm reactor coolant leak in addition to the expected leakage of 50 lb/day (Ref. 1) during normal operation, which is discussed in Section 5.2.5. Operation of the system is almost the same for normal operation, except that the load on the system is increased. A 1-gpm leak into the reactor coolant drain tank is handled automatically. If the 1-gpm leak enters the waste holdup tank, operation is the same as normal, except for the increased load on the system. Abnormal liquid volumes of reactor coolant resulting from excessive reactor coolant or auxiliary building equipment leakage (in excess of 1 gpm) can also be accommodated by the floor drain tank and processed by the LWPS.

c. Excessive leakage in the auxiliary system equipment

Leakage of this type could include water from steam side leaks and fan cooler leaks inside the containment which are collected in the containment sump and sent to the floor drain tank. Other sources could be component cooling water leaks, service water leaks, and secondary side leaks. This water enters the floor drain tank and is processed and discharged as during normal operation.

11.2.2.2 Component Description

Codes and standards applicable to the LRWS are listed in Tables 3.2-1 and 11.2-1. The LRWS is designed and constructed in accordance with quality group D (augmented). The LRWS is housed within a seismically designed building. Regulatory Guide 1.143 is complied with to the extent specified in Table 3.2-5.

REACTOR COOLANT DRAIN TANK PUMPS - Due to the relative inaccessability of the containment and the loop drain requirements, two pumps are provided. One pump provides sufficient flow for normal tank operation with one pump for standby.

WASTE EVAPORATOR FEED PUMP - One standard pump is used. The waste evaporator feed pump supplies feed to the evaporator and the liquid radwaste demineralizer skid (LRDS). The pump is shut off when low level is reached in the waste holdup tank.

WASTE EVAPORATOR CONDENSATE TANK PUMP - The waste evaporator condensate tank pump is a transfer pump. One standard pump is used to transfer the contents of the waste condensate tank to the reactor makeup water storage tank or the boron recycle system holdup tanks.

CHEMICAL DRAIN TANK PUMP - One standard pump is used to recirculate the liquid back to the chemical drain tank for mixing prior to sampling.

LAUNDRY AND HOT SHOWER TANK PUMP - One standard pump is used to transfer the water to the waste monitor tank.

FLOOR DRAIN TANK PUMPS - Two standard pumps are available to transfer the contents of the floor drain tanks to the waste monitor tank. The pumps are cross-connected to the pump from either floor drain tank. The pumps can also be used to supply the LRDS.

WASTE MONITOR TANK PUMPS - One standard pump is to be used for each tank to discharge water from the plant site or for recycle if further processing is required. The pump may also be used for circulating the water in the waste monitor tank in order to obtain uniform tank contents and hence a representative sample before discharge. The pump can be throttled to achieve the desired discharge rate.

REACTOR COOLANT DRAIN TANK HEAT EXCHANGER - The reactor coolant drain tank heat exchanger is a U-tube type with one shell pass and four tube passes. Although the heat exchanger is normally used in conjunction with the reactor coolant drain tank, it can also cool the pressurizer relief tank from 200 to 120°F in less than 8 hours.

REACTOR COOLANT DRAIN TANK - One tank is provided to collect leakoff type drains inside the containment at a central collection point for further disposition through a single penetration via the reactor coolant drain tank pumps.

Only water which can be directed to the recycle holdup tanks enters the reactor coolant drain tank. The tank is provided with a hydrogen or nitrogen cover gas. The water must be compatible with reactor coolant.

Sources of water entering the reactor coolant drain tank include the reactor vessel flange leakoff, reactor coolant pump number two seal leakoffs, and the excess letdown heat exchanger flow. No continuous leakage is expected from the reactor vessel flange during operation.

The tank maintains a constant level to minimize the amount of gas sent to the gaseous waste processing system and also to minimize the amount of hydrogen or nitrogen required. The level is maintained by using a proportional control valve in the discharge line. This valve operates, on a signal from a level controller, to maintain a constant level by discharging normally to the recycle system. The remainder of the flow is recirculated to the tank.

WASTE HOLDUP TANK - One atmospheric pressure tank is provided outside the containment to collect equipment drainage, pump seal leakoffs, recycle holdup tank overflows, and other water from tritiated, aerated sources.

WASTE EVAPORATOR CONDENSATE TANK - One tank with a diaphragm to exclude air is provided to collect condensate from the waste evaporator or demineralized water from the LRDS.

CHEMICAL DRAIN TANK - One tank is provided to collect chemically contaminated tritiated water from the laboratories.

LAUNDRY AND HOT SHOWER TANK - One atmospheric pressure tank is used to collect laundry and hot shower drainage.

FLOOR DRAIN TANKS - Two atmospheric pressure tanks are used to collect floor drainage from the reactor plant operations.

WASTE MONITOR TANKS - The two atmospheric waste monitor tanks are provided for monitoring liquid discharges from the plant site. Each tank is sized to hold a volume large enough such that sampling requirements are minimized, thus minimizing laboratory effluent.

WASTE EVAPORATOR REAGENT TANK - One tank is used for adding chemicals to the plant for such things as cleaning of the waste evaporator tubes.

WASTE EVAPORATOR CONDENSATE DEMINERALIZER - One mixed bed demineralizer with nonregenerative hydrogen-hydroxide resin is provided to remove ionic contaminants from the waste condensate.

WASTE MONITOR TANK DEMINERALIZER - One mixed bed demineralizer with nonregenerative hydrogen-hydroxide resin is provided to remove trace contaminants from the water in the floor drain tank.

FILTERS - The filters provided are of a disposable-type cartridge.

The methods employed to change filters and screens are dependent on activity levels. Filters are valved out of service, drained to the appropriate tank, and vented locally. If the radiation level of the filter is low enough, it is changed manually. Filter handling is discussed in Section 11.4.

STRAINERS - Strainers are provided in the discharge of the laundry and hot shower pump and the floor drain tank pumps to remove large particulate matter and thus prevent clogging of the downstream lines and filters.

WASTE EVAPORATOR - The waste evaporator is abandoned in place.

LIQUID RADWASTE PROCESSING SKID - The liquid radwaste processing skid is a series of mobile components employing various processes specifically designed to provide maximum decontamination factors. These processes may include filtration, reverse osmosis, and/or demineralization.

11.2.2.3 System Operation

The LRWS operation is manually initiated, except for some functions of the reactor coolant drain subsystem. The system includes adequate control equipment to protect the system components and instrumentation and alarm functions to provide operator information to ensure proper system operation. All pumps in the system have low level shutoffs, and all filters, strainers, and demineralizers have differential pressure indication to indicate fouling.

Operation of the LRWS is essentially the same during all phases of normal reactor plant operation; the only differences are in the load on the system. The following sections discuss the operation of the system in performing its various functions. In this discussion, the term "normal operation" should be taken to mean all phases of operation, except operation under emergency or accident conditions. The LRWS is not regarded as a safety-related system.

REACTOR COOLANT DRAIN TANK SUBSYSTEM OPERATION - Normal operation of the reactor coolant drain subsystem is automatic and requires no operator action. The system can be put in the manual mode, if desired. The leakage rate of reactor coolant pump No. 2 seal leakoffs, reactor vessel flange leakoffs, and discharges from the excess letdown heat exchanger into the reactor coolant drain tank (RCDT) can be estimated by putting the system

in the manual mode, stopping operation of the reactor coolant drain tank pump, and watching the rate of level change. The reactor coolant drain tank pump normally discharges to the boron recycle system. These drains can also be processed in the waste holdup tank. The level in the RCDT is maintained by running one RCDT pump continuously and using a proportional control valve (LCV-1003) in the discharge line. This valve operates on a signal from the RCDT level controller to limit the flow out of the subsystem. The remainder of the flow is recirculated to the RCDT. The RCDT heat exchanger is sized to maintain the RCDT contents at or below 170°F, assuming an in-leakage of 10 gpm at 600°F.

A venting system is provided to prevent wide pressure variations in the RCDT. Hydrogen or nitrogen cover gas is supplied from the service gas system and is automatically maintained between 2 and 6 psig by pressure-regulating valves. PCV-7155 maintains a minimum tank pressure by admitting hydrogen or nitrogen, while PCV-7152 maintains maximum tank pressure by venting the RCDT to the gaseous radwaste system. The hydrogen is supplied from no more than two 194 SCF bottles, to limit the amount of hydrogen gas which might be accidentally released to the containment atmosphere. The RCDT vents to the gaseous radwaste system to limit any releases of radioactive gases.

The reactor coolant drain subsystem may also be used in the pressurizer relief tank (PRT) cooling mode of operation. In this mode, the level control valve in the discharge line to the recycle evaporator feed demineralizers (LCV-1003), the isolation valve at the discharge of the reactor coolant drain tank (HV-7127) and the isolation valve in the reactor coolant drain tank recirculation line (HV-7144) are all closed. The PRT contents are circulated through the reactor coolant drain tank heat exchanger, via valve BB-HV-8031 and the reactor coolant drain tank pumps, prior to returning to the PRT via valve BB-HV-7141. In this mode of operation, the RCDT heat exchanger is capable of cooling the PRT contents from 200°F to 120°F in less than 8 hours. As an alternative to returning the cooled fluid to the PRT, the fluid may be directly transferred to the recycle holdup tanks in the boron recycle system. In any and all cases of PRT cooling, the PRT is vented to less than 50 psig to prevent overpressurization of the RCDT subsystem.

The reactor coolant drain subsystem may be used to drain the reactor coolant loops by first venting the reactor coolant system, then connecting the spool piece in the RCDT pump suction piping. The design objective of this mode of operation is to drain the RCS to the midpoint of the reactor vessel nozzles in less than 8 hours with both RCDT pumps running. In this mode, valve HV-7144 is

closed and, in order to maximize flow capability, the RCDT discharge level control valve (LCV-1003) may be bypassed during RCS draining operations. If automatic RCDT level control is desired, then the flow path through LCV-1003 may be used.

The reactor coolant drain subsystem may be used to drain down portions of the refueling pool which cannot be drained by the residual heat removal pumps. In this mode of operation, the RCDT heat exchanger may be bypassed and the RCDT level control valve (LCV-1003) may be bypassed to maximize flow through the fuel pool cooling and cleanup system to the refueling water storage tank. An alternate drain line is provided from the refueling pool to the containment sump to route decontamination chemicals away from the RCDT subsystem and minimize the possibility of contaminating any systems downstream of the RCDT pumps.

DRAIN CHANNEL "A" SUBSYSTEM OPERATION - Waste is accumulated in the waste holdup tank until a sufficient quantity exists to warrant processing. The Waste Holdup Tank contents are normally processed for discharge by the Liquid Radwaste Processing Skid. Processed effluent is not returned to the RMWS. Demineralized LRWS effluent is discharged.

WASTE EVAPORATOR OPERATION - The waste evaporator is abandoned in place.

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DRAIN CHANNEL "B" SUBSYSTEM OPERATION - Normally, one floor drain tank is aligned to receive the discharge from the floor and equipment drain system, while the other tank is being used to supply waste to the processing system. This procedure allows the waste to be sampled and pH adjusted prior to processing to ensure optimum system performance.

If the waste in the floor drain tank has a low total dissolved solids content (<25 ppm), an activity of less than 10^{-5} mCi/cc, and does not contain significant organics, it may be processed using the liquid waste charcoal adsorber and waste monitor tank demineralizer in series, and directed to waste monitor tanks.

Any planned releases from the system must be weighted with all other unit radioactive liquid releases to ensure that the local releases do not exceed the ODCM limits at the boundary of the restricted area.

LAUNDRY SUBSYSTEM OPERATION - Laundry waste from the washing machines and waste from the personnel decontamination shower is directed by gravity drain to the detergent drain tank located in the basement of the control building. This waste is pumped to the LHST where it is sampled, prior to being processed. If discharge of the LHST contents is desired and the tank contents are found to be of acceptable quality for discharge, the fluid may be transferred to the Secondary Liquid Waste Monitor Tanks or Waste Monitor Tank "B" by way of the Laundry and Hot Shower Tank Basket Strainer and Filter.

The processed laundry water is stored in the laundry water storage tank. The laundry water is then pumped, on demand to the washing machines through the washing machine hot water heater to the laundry equipment in operation. Note that the hot water heater is provided with a bypass to allow a feed of relatively cold water to the laundry equipment. Laundry operation additives such as detergents and soaps are used sparingly to ensure laundry waste water is compatible with process paths. The use of vendor provided laundry services for contaminated laundry may also be employed. This helps prevent the spread of highly contaminated particles throughout the laundry water system.

The laundry water stored in the laundry water storage tank may also be directed to the LHST for reprocessing or to the waste monitor tank "B" or one of the secondary liquid waste monitor tanks. Any planned releases from this system must be weighed with all other radioactive liquid releases to ensure total releases do not exceed the ODCM limits at the boundary of the restricted area.

The LRWS is operated so that the waste discharges are segregated. Waste monitor tank "B" is normally aligned for laundry water while waste monitor tank "A" is normally aligned for demineralized floor drains. Laundry water is normally low radioactivity waste, and does not require treatment other than the removal of organics. Provision is made to demineralize the laundry water, via the waste monitor tank demineralizer, prior to discharge, if necessary.

Floor drain wastes are relatively dirty and may contain moderately high radioactivity. Treatment of floor drain wastes prior to discharge consists of options for Ozone Injection, Ultra Filtration, Reverse Osmosis and demineralization. These options are provided using the (ZERO) liquid waste processing components.

The chemical drain tank (CDT) receives chemically contaminated tritiated water from the plant sample stations, and chemically contaminated decontamination wastes. Contents of the tank are sampled as process initiation levels are reached then drained to the FDT subsystem to dilute any high conductivity prior to being processed by the liquid waste process system. A high level alarm is provided from the CDT for operator information.

11.2.3 RADIOACTIVE RELEASES

This section describes the estimated liquid release from the plant for normal operation and anticipated operational occurrences.

11.2.3.1 Sources

Section 11.1 and Appendix 11.1A provide the bases for determining the contained sources inventory and the normal releases.

A survey has been performed of liquid discharges from different Westinghouse pressurized water reactor plants. The results are presented in Table 11.2-17 of Reference 2. The data includes radionuclides released on an unidentified basis, and are all within the permissible concentration for the release of liquid containing all unidentified radionuclide mixtures.

11.2.3.2 Release points

Radioactive plant wastes are treated inside the power block, where the majority of radioactive material is concentrated for offsite disposal. Water containing small concentrations of radioactivity is discharged from the power block to the environment as plant

effluent. The effluent normally discharges from the plant into the circulating water discharge piping, which dilutes the power block effluent and conveys it to the cooling lake. The point of discharge into the cooling lake for these effluents is at the circulating water discharge structure (See Figure 11.2-1). Three other potential discharge points to the cooling lake are directly from the lime sludge pond, the oily waste separator, and the Technical Support Center. The Technical Support Center decontamination shower would only be used by E-Plan personnel if access control and rad waste showers were unavailable. These three pathways have no dilution. Further discussion of concentrations of radioactivity in the cooling lake from normal operational releases is provided in Section 11.2.3.3. A discussion of concentrations of radioactivity in the cooling lake from accidental release of liquid effluents is discussed in Section 2.4.12.

This low level radioactive liquid effluent is stored in the power block in the primary and secondary waste monitor tanks (two each, four total) and the steam generator blowdown surge tank. Each of these tanks feeds into the liquid radwaste discharge line, which is connected to the circulating water discharge piping (See Figure 11.2-2). Tank discharge is initiated manually in all cases.

The minimum flow of dilution water which conveys the power block radioactive effluent to the cooling lake is 5,000 gpm. In the event that the dilution flow is less than 5,000 gpm, release of radioactive power block effluent is prohibited and is terminated through automatic controls at a point inside the power block.

Circulating water pumps and service water pumps provide dilution to discharge from the power block. The release of radioactive effluent from the power block is automatically terminated when no Circulating Water Pumps are in service. Minimum dilution flow necessary for the discharge of radioactive effluents is established through administrative controls to ensure compliance with Federal discharge limits.

11.2.3.3 Dilution Factors

Liquid radioactive releases are normally diluted by cooling water with a flow rate of 1114 cfs and service water with a flow rate of 90 cfs for a total discharge of 1204 cfs. This is the normal dilution assumed for dose calculations to the maximum individual interacting with the cooling lake environment.

11.2.3.4 Estimated Doses

Preoperational estimates of doses from liquid effluents were shown to be in conformance with 10CFR50, Appendix I requirements. Actual dose from liquid effluents during plant operation are calculated using the approved methodology presented in the Offsite Dose Calculation Manual (ODCM). The ODCM describes the methods used for calculating concentration of radioactive material in the environment and the estimated potential offsite doses associated with liquid and gaseous effluents. The ODCM also specifies controls for release of liquid and gaseous effluents to ensure compliance with NRC regulations.

11.2.4 CALCULATIONAL BASIS FOR LIQUID SOURCE TERMS

The Wolf Creek Generating Station, Unit No. 1 uses the mixed bed demineralizer option shown in Item 5 of Figure 11.1A-2 (Sheet 2). The original GALE code input and annual liquid effluent releases are shown in Tables 11.2-10 and 11.2-11 respectively.

11.2.5 SAFETY EVALUATION

Except for two associated containment penetrations and the CCW pressure boundary integrity at the reactor coolant drain tank, the LRWS is not a safety-related system.

SAFETY EVALUATION ONE - Sections 6.2.4 and 6.2.6 provide the safety evaluation for the system containment isolation arrangement and testability.

11.2.6 TESTS AND INSPECTION

Preoperational testing is discussed in Chapter 14.0.

The operability, performance, and structural and leaktight integrity of all system components are demonstrated by continuous operation.

11.2.7 INSTRUMENTATION DESIGN

The system instrumentation is described in Table 11.2-12 and shown on Figure 11.2-1.

The instrumentation readout is located mainly on the waste processing system panel in the radwaste building. Some instruments are read locally.

All alarms are shown separately on the waste processing system panel and further relayed to one common waste processing system annunciator on the main control board.

The waste processing system pumps are protected against loss of suction pressure by a control setpoint on the level instrumentation for the respective vessels feeding the pumps. The reactor coolant drain tank pumps and the spent resin sluice pump are, in addition, interlocked with flow rate instrumentation and stop operating when the delivery flows reach minimum setpoints.

Differential pressure indicators with local readout are provided for filters, strainers, and demineralizers.

11.2.8 REFERENCES

1. NUREG-0017, "Calculation of Releases of Radioactive Materials in Gaseous and Liquid Effluents from Pressurized Water Reactors" (PWR-GALE Code), NRC, April 1976, pg. 6-1.

2. "Appendix D to RESAR-3S, Liquid Waste Management System," WCAP 8665, March 1976.

3. Attachment to Concluding Statement of Position of the Regulatory Staff. Public Rule-making Hearing on: Numerical Guides for Design Objectives and Limiting Conditions for Operation to Meet the Criterion "As Low as Practicable" for Radioactive Material in Light-Water-Cooled Nuclear Power Stations, USAEC, Docket No. RM-50-2, February 20, 1974.

4. Fletcher, J. F., and W. L. Dotson (compilers). HERMES-A Digital Computer Code for Estimating Regional Radiological Effects from the Nuclear Power Industry, USAEC. Report HEDL-TME-71-168, Hanford Engineering Development Laboratory, 1971.

5. Final Environmental Statement Concerning Proposed Rule Making Action: Numerical Guides for Design Objectives and Limiting Conditions for Operation to Meet the Criterion "As Low as Practicable:" for Radioactive Material in Light-Water-Cooled, Nuclear Power Reactor Effluents, USAEC Report WASH-1258, Washington, D.C., July 1973.

6. Lyon, R. J., Shearin, R. L., 1976, EPA-520 Radionuclide Accumulation in a Reactor Cooling Lake: USEPA, Office of Radiation Programs.

7. Regulatory Guide 1.109, Calculation of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10 CFR 50, Appendix I, Office of Standards Development.

8. Regulatory Guide 1.113, Estimating Aquatic Dispersion of Effluents from Accidental and Routine Reactor Releases for the Purpose of Implementing Appendix I, Office of Standards Development.

9. Simpson, D. B., McGill, B. L., 1980, NUREG/CR-1276 User's Manual for LADTAP II Computer Program: U.S.N.R.C. and Oak Ridge National Laboratory.

11.3 GASEOUS WASTE MANAGEMENT SYSTEMS

The gaseous radwaste system (GRWS) and the plant ventilation exhaust systems control, collect, process, store, and dispose of gaseous radioactive wastes generated as a result of normal operation, including anticipated operational occurrences. This section discusses the design, operating features, and performance of the GRWS and the performance of the ventilation systems. The plant ventilation exhaust systems accommodate other potential release paths for gaseous radioactivity due to miscellaneous leakages, aerated vents from systems containing radioactive fluids, and the removal of noncondensables from the secondary system. Systems which handle these gases are not normally considered gaseous waste systems and are discussed in detail in other sections. These systems are included here to the extent that they represent potential release paths for gaseous radioactivity.

11.3.1 DESIGN BASES

11.3.1.1 Safety Design Basis

The GRWS and other gaseous waste management systems serve no safety-related function.

11.3.1.2 Power Generation Design Bases

POWER GENERATION DESIGN BASIS ONE - The GRWS and the ventilation exhaust systems are designed to meet the requirements of the discharge concentration limits of 10 CFR 20 and the as low as reasonably achievable dose objective of 10 CFR 50, Appendix I.

POWER GENERATION DESIGN BASIS TWO - The GRWS includes design features to preclude the possibility of an explosion where a potential for an explosive mixture exists.

POWER GENERATION DESIGN BASIS THREE - The GRWS uses design and fabrication codes consistent with quality group D (augmented), as assigned by Regulatory Guide 1.143 for radioactive waste management systems.

POWER GENERATION DESIGN BASIS FOUR - The ventilation exhaust system complies with Regulatory Guide 1.140 to the extent specified in Table 9.4-3.

POWER GENERATION DESIGN BASIS FIVE - Gaseous effluent discharge paths are monitored for radioactivity.

POWER GENERATION DESIGN BASIS SIX - The Radwaste Building (including the Waste Bale Drumming Area) is equipped with a monitored ventilation system which ensures that the potential release pathways are controlled and monitored as per 10 CFR 50, Appendix A, in case of a breach of container.

11.3.2 SYSTEM DESCRIPTIONS

11.3.2.1 General Description

This section describes the design and operating features of the GRWS. The performance of the GRWS and other plant gaseous waste management systems with respect to the release of radioactive gases is discussed in Section 11.3.3. Detailed descriptions of the plant ventilation systems and main condenser evacuation system are presented in Sections 9.4 and 10.4.2, respectively.

The piping and instrumentation diagram for the GRWS is shown in Figure 11.3-1.

The main flow path in the GRWS is a closed loop comprised of two waste gas compressors, two catalytic hydrogen recombiners, six gas decay tanks for normal power service, and two gas decay tanks for service at shutdown and startup. The system also includes a gas decay tank drain collection tank, drain pump, four gas traps to handle normal operating drains from the system, and a waste gas drain filter to permit maintenance and handle normal operating drains from the system. All of the equipment is located in the radwaste building.

The closed loop has nitrogen for a carrier gas. The primary influents to the GRWS are combined with hydrogen as the stripping or carrier gas. The hydrogen that is introduced to the system is recombined with oxygen, and the resulting water is removed from the system. As a result, the bulk of all influent gases is removed, leaving trace amounts of inert gases, such as helium and radioactive noble gases to build up.

The primary source of the radioactive gas is via the purge of the volume control tank with hydrogen, as described in Section 9.3.4. The operation of the GRWS serves to reduce the fission gas concentration in the reactor coolant system which, in turn, reduces the escape of fission gases from the reactor coolant system during maintenance operations or through equipment leakage. Smaller quantities are received, via the vent

connections, from the reactor coolant drain tank, the pressurizer relief tank, and the recycle holdup tanks.

Since hydrogen is continuously removed in the recombiner, this gas does not build up within the system. The largest contributor to the nonradioactive gas accumulation is helium generated by a B10 (n,a)Li7 reaction in the reactor core. The second largest contributors are impurities in the bulk hydrogen and oxygen supplies. Stable and long-lived isotopes of fission gases also contribute small quantities to the system gas volume accumulation.

Operation of the system is such that fission gases are distributed throughout the six normal operation gas decay tanks. Separation of the GRWS gaseous inventory in several tanks assures that the allowable site boundary dose will not be exceeded in the event of a gas decay tank rupture. Radiological consequences of such a postulated rupture are discussed in Section 15.7.1.

The GRWS also provides the capacity for indefinite holdup of gases generated during reactor shutdown. Nitrogen gas from previous shutdowns is contained in the shutdown gas decay tank for use in stripping hydrogen from the reactor coolant system. The shutdown tank is normally at low pressure and is used to accept relief valve discharges from the normal operation gas decay tanks.

For all buildings where there is potential airborne radioactivity, the ventilation systems are designed to control the release. Where applicable, each building has a vent collection system for tanks and other equipment which contain air or aerated liquids. The condenser evacuation system discharge is filtered and discharged to the unit vent in addition to the discharges from the reactor building, auxiliary building, and fuel building. The radwaste building, which houses the GRWS, has its own release vent. The turbine building has an open ventilation system, and the steam packing exhaust discharges outside the turbine building.

The vent collection systems receive the discharge of vents from tanks and other equipment in the radwaste and auxiliary buildings which contain air or aerated liquids. These components contain only a very small amount of fission product gases. Prior to release via the radwaste or auxiliary building ventilation system, the gases are monitored, as described in Section 11.5, and passed through a prefilter, HEPA filter, charcoal filter, and another

HEPA filter in series which reduce any airborne particulate radioactivity to negligible levels and provide a decontamination factor of at least 10 for radioactive iodines and 100 for particulates. Expected efficiencies for iodine removal are better than 99 percent for elemental iodine and 95 percent for organic iodine at 70-percent relative humidity. However, for gaseous effluent release calculations, 70-percent efficiency is conservatively used for radioiodine isotopes.

Although plant operating procedures, equipment inspection, and preventive maintenance are performed during plant operations to minimize equipment malfunction, overall radioactive release limits have been established as a basis for controlling plant discharges during operation with the occurrence of a combination of equipment faults of moderate frequency. These faults include operation with fuel defects in combination with steam generator tube leaks and malfunction of liquid or gaseous waste processing systems or excessive leakage in reactor coolant system equipment or auxiliary system equipment. Operational occurrences such as these can result in the discharge of radioactive gases from various plant systems. These unscheduled discharges may be from plant systems which are not normally considered gas processing systems or from a gas decay tank after a 90-day holdup period. These potential sources are tabulated in Table 11.1-2. The bases for assumed releases, the factors which tend to mitigate the release of radioactivity, and the release paths are given in Appendix 11.1A.

A further discussion of the gaseous releases from the plant is provided in Section 11.3.3.

11.3.2.2 <u>Component Description</u>

Codes and standards applicable to the GRWS are listed in Tables 3.2-1 and 11.3-1. The GRWS is designed and constructed in accordance with quality group D (augmented). The GRWS is seismically designed to the requirements of Reg. Guide 1.143, as discussed in Table 3.2-5. The GRWS is housed within a building also seismically designed to the requirements of Reg. Guide 1.143. The GRWS design complies with Regulatory Guide 1.143, as specified in Table 3.2-5.

WASTE GAS COMPRESSOR - The waste gas compressor is a water-sealed centrifugal displacement unit which maintains continuous circulation of nitrogen around the waste gas loop. The compressor is provided with a mechanical shaft seal to minimize water leakage. The compressor moisture separator normal water level is maintained to keep the shaft immersed at all times.

Two waste gas compressor packages are provided. One compressor is normally used, and the other compressor is on standby. The packages are self-contained and skid-mounted. Construction is primarily of carbon steel.

CATALYTIC HYDROGEN RECOMBINER - The catalytic recombiner disposes of hydrogen brought into the GRWS. This is accomplished by adding a controlled amount of oxygen to the recombiner which reacts with the hydrogen as the gas flows through a catalyst bed. The control system for the recombiner is designed to preclude the possibility of a hydrogen explosion. This is further discussed in Section 11.3.6.

Two hydrogen recombiner packages are provided. One recombiner is normally used, and the other is on standby. The packages are self-contained and skid-mounted. The recombiner is located in the system where the hydrogen concentration and pressure are optimum with respect to hydrogen removal.

DECAY TANK - Eight gas decay tanks are provided, six for normal power operation and two for service at shutdown and startup. The tanks are of the vertical-cylindrical type and are constructed of carbon steel.

MISCELLANEOUS COMPONENTS - The gas decay drain collection tank provides a collection point for condensation drained from the gas decay tanks, recombiners, and gas compressors.

All control valves, with the exception of those on the recombiner, are provided with bellow seals to minimize the leakage of radioactive gases through the valve bonnet and stem. Valves on the recombiner package are provided with leakoffs.

Relief valves have soft seats and are exposed to pressures which are normally less than two-thirds of the relief valve set pressure. The relief valves of the major components discharge to the shutdown tanks. This permits decay and controlled disposal of all discharges less than about 3,000 scf. The relief valves are designed to relieve full flow from both waste gas compressors.

To maintain leakage from the system at the lowest practicable level, diaphragm-type manual valves are used throughout the waste gas system. For low temperature, low pressure service valves with a synthetic rubber-type diaphragm are used. This application includes all parts of the system, except the recombiners. Because of the high temperature that may exist in the recombiner, globe type valves with a metal diaphragm seal in the stem are used. There should be no measurable stem leakage from either type of valve.

The gas decay tank drain pump directs water from the gas decay drain collection tank (due to condensation or maintenance) to the waste holdup tank or recycle holdup tanks. It is used when there is insufficient pressure in the gas system to drive the fluid. All parts of the pump in contact with the drain water are of austenitic stainless steel. The pump is a canned-motor type.

The waste gas drain filter is a disposable cartridge filter provided to prevent particulate matter, including rust, from entering the LRWS and BRS. Parts of the filter in contact with the drain water are of austenitic stainless steel.

The waste gas traps are designed to prevent gases from leaving the GRWS. There are four gas traps - two in the gas decay tank drain line and one each in the recombiner drain lines and compressor drain lines.

The component description for the ventilation systems is provided in Section 9.4.

11.3.2.3 System Operation

Operation of the ventilation systems is described in Section 9.4. The following is a description of the GRWS.

NORMAL OPERATION - During normal power operation, nitrogen gas, with contained fission gases, is circulated around the GRWS loop by one of the two compressors. Fresh hydrogen gas is introduced into the volume control tank where it is mixed with fission gases stripped from the reactor coolant by the action of the volume control tank letdown line spray nozzle. The gas is vented from the volume control tank into the circulating nitrogen in the waste gas system, at the compressor suction. Normal operational mode of the system is dependent on the reactor coolant system (RCS) gas concentration and the RCS status. A purge of the Volume Control Tank is performed as directed by Chemistry. During a VCT purge using the same Gas Decay Tank is advantageous. However, switching GDTs may be required, depending on the high operating pressure parameters of the system.

The resulting mixture of nitrogen, hydrogen, and fission gases is pumped by one of the compressors to one of the two catalytic hydrogen recombiners where enough oxygen is added to react with and reduce the hydrogen to a low residual level. Water vapor formed in the recombiner by the hydrogen and oxygen reaction is condensed and removed, and the cooled gas stream (now composed primarily of nitrogen, helium, and fission gases) is discharged from the recombiner, routed through a gas decay tank, and sent back to the compressor suction to complete the loop circuit.

Only one gas decay tank is valved into the waste gas loop at any time. By switching tanks when tank pressure nears the upper operating parameters, this will allow for more decay time for the gases stored in the tanks. This practice will result in fewer radioactive curies released.

If it has been determined that excessive nitrogen buildup is occurring within the system or when other occurrences require it, one tank can be valved out of service and allowed to decay for a period of 90 days, and then discharged.

STARTUP - At plant startup, the system is first flushed free of air and filled with nitrogen at atmospheric pressure. One compressor, one recombiner, and one shutdown decay tank are in service. The reactor is at the cold shutdown condition. Fresh hydrogen is charged into the volume control tank, and the volume control tank vent gas mixes with the circulating nitrogen in the GRWS. This circulating mixture enters the compressor suction, passes through the recombiner and shutdown gas decay tank, and returns to the compressor suction. When the reactor coolant system hydrogen concentration is within operating specifications, the shutdown gas decay tank is isolated and the gas flow directed to one of the gas decay tanks provided for normal power operation. Gases accumulated in the shutdown tank will be retained for reuse during hydrogen stripping from the reactor coolant system during subsequent shutdown operations.

SHUTDOWN AND DEGASSING OF THE REACTOR COOLANT SYSTEM - Plant shutdown operations are essentially startup operations in reverse sequence. The volume control tank hydrogen purge is maintained until after the reactor is shut down and coolant fission gas concentrations have been reduced to specified level. During this operation, hydrogen purge flow may be increased to speed up coolant degassing. The gas decay tank in service for normal power operation is valved out, and a nitrogen purge from the shutdown tank to the volume control tank is begun. The shutdown tank is placed in the process loop at the compressor discharge so that the gas mixture from the volume control tank vents to the compressor suction and passes through the shutdown tank and to the recombiner where hydrogen is removed and returned to the compressor suction. The nitrogen purge continues until the reactor coolant hydrogen concentration reaches the required level. Degassing is then complete, and the reactor coolant system may be opened for maintenance or refueling.

11.3.3 RADIOACTIVE RELEASES

This section describes the estimated gaseous release from the plant for normal operation and anticipated operational occurrences.

11.3.3.1 <u>Sources</u>

Section 11.1 and Appendix 11.1A provide the bases for determining the contained source inventory and the normal releases.

11.3.3.2 Release Points

Potential release paths for gaseous radioactivity are illustrated schematically in Appendix 11.1A. The general location of potential gaseous radioactivity release points is depicted in Figure 1.2-1. A description of potential release points for radioactive gaseous effluents is given in Appendix 11.1A, along with the physical characteristics of the gaseous effluent streams. Release points from the gaseous waste processing systems are shown on Figure 11.3-2.

11.3.3.3 Dilution Factors

The annual average dilution factors used in evaluating the release of gaseous radioactive effluents are derived and justified in Section 2.3.

11.3.3.4 Estimated Doses

The GASPAR computer code, which calculates doses due to normal gaseous effluents in accordance with Regulatory Guide 1.109, was used to determine the doses listed herein. This code was validated and verification is maintained on file.

The doses due to normal gaseous effluents from WCGS are listed in Tables 11.3-2, 3 and 4. Doses attributable to radioactive iodines and particulates at the controlling sector Exclusion-Restricted Area boundary are contained within Table 11.3-3 (Hypothetical Worst Case). Doses from iodines and particulates at the controlling residence are contained within Table 11.3-4 (Controlling Existing Resident). Table 11.3-2 contains doses from noble gases at the Exclusion-Restricted Area boundary.

The doses in these tables were calculated assuming intermittent purge operation. Intermittent purge mode release rates were taken from Section 11.1. The values of the dispersion and deposition coefficients, X/Q (non-decayed), X/Q (depleted and non-decayed) and D/Q used in the calculations were taken from Section 2.3 and Table 2.3-75. A comparison of the half lives of the radionuclides released to the time needed for released nuclides to disperse to any point within the 5-mile radius of interest shows that the effect of decay during this dispersion period is negligible. Thus, the values for X/Q (decayed) and X/Q (decayed and depleted) were taken to be equivalent to the corresponding X/Q (non-decayed) and X/Q (depleted and non-decayed) values.

A survey of the area within a five-mile radius of the site was conducted during June 1980 and was used to determine the pathways present at the controlling locations. A 1986 survey of the same area indicates the pathways present at the controlling locations are still the same. X/Qs for the controlling locations were used in calculating doses from iodines and particulates as well as noble gases.

The total doses for Table 11.3-3 and 11.3-4 were calculated by summing the doses from each pathway present. It was conservatively assumed that all age groups were present at each controlling location.

Doses due to noble gases and radioactive iodines and particulates in no case exceed 10 CFR 50 Appendix I limits.

Actual doses from gaseous effluent during plant operation will be calculated using the approved methodology presented in the Offsite Dose Calculation Manual.

11.3.4 SAFETY EVALUATION

The GRWS serves no safety-related function.

11.3.5 TESTS AND INSPECTIONS

Preoperational testing is described in Chapter 14.0.

The operability, performance, and structural and leaktight integrity of all system components are demonstrated by continuous operation.

11.3.6 INSTRUMENTATION APPLICATION

The GRWS instrumentation, as described in Table 11.3-5, is designed to facilitate automatic operation and remote control of the system and to provide continuous indication of system parameters.

The instrumentation readout is located mainly on the waste processing system panel in the radwaste building. Some instruments are read where the equipment is located. Alarms are shown separately on the waste processing system panel and further relayed to one common waste processing system annunciator on the main control board of the plant. Where suitable, instrument lines are provided with diaphragm seals to prevent fission gas outleakage through the instrument. Figure 11.3-3 shows the location of the instruments on the compressor package.

The compressors are interlocked with the seal water inventory in the moisture separators and trip off on either high or low moisture separator level. During normal operation, the proper seal water inventory is maintained automatically.

Figure 11.3-4 indicates the location of the instruments on the recombiner installation.

The catalytic recombiner system is designed for automatic operation with a minimum of operation attention. The Train A package includes two online gas analyzers, one to measure hydrogen and oxygen in and one to measure hydrogen and oxygen out. The Train B package includes four online gas analyzers, one each to measure hydrogen in, oxygen in, hydrogen out, and oxygen out. The analyzers are the primary means of recombiner control. Each of these online gas analyzers is independently controlled. In the event that these analyzers are declared inoperable, operation of the system may continue provided grab samples are taken and analyzed at least once per 24 hours. With both oxygen channels or both the inlet oxygen and inlet hydrogen channels inoperable, suspend oxygen supply to the recombiner. Addition of waste gas to the system may continue provided grab samples are taken and analyzed at least once per 4 hours during degassing operations and at least once per 24 hours during other operations.

The GRWS is designed to operate with hydrogen concentrations above 4 percent by volume. Flammable mixtures of gases in the system are prevented by monitoring and controlling the oxygen concentration to appropriate levels. The setpoints for oxygen concentration in the catalyst bed inlet stream are 3 percent for the hi-alarm and 3.5 percent for the hi-hi alarm and isolation of the oxygen supply. The setpoint for oxygen concentration downstream of the catalyst bed is 60 ppm oxygen for the hi-hi alarm and isolation of inlet oxygen supply. Thus the oxygen supply to the recombiner would be terminated before the concentration in the GRWS would reach levels favorable for hydrogen flammability.

Since the GRWS is designed to operate with hydrogen concentrations up to 6 percent by volume, up to 3 percent oxygen is necessary for operation of the catalytic recombiner. Termination of oxygen feed at 2 percent as suggested by regulatory guidance is inappropriate. Further, since the minimum oxygen concentration necessary to support combustion at 4 percent by volume hydrogen concentrations is 5 percent, the hi-alarm setpoint of 3 percent provides sufficient margin (i.e., 60 percent of the limit) to flammability.

A multipoint temperature recorder monitors temperatures at several locations in the recombiner packages.

The process gas flow rate is measured by an orifice located upstream of the recombiner preheater. Local pressure gauges indicate pressure at the recombiner inlet and oxygen supply pressure.

The following controls and alarms are incorporated to maintain the gas composition outside the range of flammable and explosive mixtures:

a. If the recombiner feed concentration exceeds 6 percent by volume, a high-hydrogen alarm sounds to warn that all hydrogen entering the recombiner is not reacted. This alarm is followed by a second alarm indicating high hydrogen in the recombiner discharge. These alarms warn of a possible hydrogen accumulation in the system.

b. If the hydrogen concentration in the recombiner feed reaches 9 percent by volume, a high-high hydrogen alarm sounds, the oxygen feed is terminated, and the volume control tank hydrogen purge flow is terminated. These controls limit the possible accumulation of hydrogen in the GRWS to 3 percent by volume.

c. If the oxygen concentration in the recombiner feed reaches 3 percent by volume, an alarm sounds and oxygen feed flow is limited so that no further increase in flow is possible. This control maintains the system oxygen concentration at 3 percent or less, which is below the flammable limit for hydrogen-oxygen mixtures.

d. If the oxygen concentration in the recombiner feed reaches 3.5 percent by volume, an alarm sounds and the oxygen feed flow is terminated.

e. If hydrogen in the recombiner discharge exceeds 0.25 percent by volume, an alarm sounds. This alarm warns of high hydrogen feed, possible catalyst failure, or loss of oxygen feed.

f. If oxygen in the recombiner discharge exceeds 60 ppm, an alarm sounds and oxygen feed is terminated. This control prevents any accumulation of oxygen in the system in case of hydrogen recombiner malfunction.

g. On low flow through the recombiner, oxygen feed is terminated. This control prevents an accumulation of oxygen following system malfunction.

h. High discharge temperature from the cooler-condenser (downstream from the reactor) terminates oxygen feed. This protects against loss of cooling water flow in the cooler-condenser.

i. High temperature indication by any one of six thermocouples in the catalyst bed limits oxygen feed so that no further increase is possible.

j. High temperature indication at the recombiner reactor discharge terminates oxygen feed to the recombiner.

11.3.7 REFERENCES

Published References

1. Eckerman, K.F. and Lash, D G, 1978, GASPAR version marked "revised 8/19/77": U S Nuclear Regulatory Commission, Radiological Assessment Branch.

2. Eckerman, K.F., Congel, F.J., Roecklein, A.K. and Pasciak, W.J., 1980, NUREG-0597 Users Guide to GASPAR Code: U.S. Nuclear Regulatory Commission, Radiological Assessment Branch.

Personal References

1 Warminski, N C, 1979, Horticulture agent for the Sedgwick County Extension Office of the Kansas State University Cooperative Extension Service, Wichita, Kansas, telephone conversation (25, 26 January), written communication (29 January).

11.4 SOLID WASTE MANAGEMENT SYSTEM

The solid radwaste system (SRS) is designed to meet the functional requirements of the solid waste management system. The SRS is designed to collect, process, and package low-level radioactive wastes (LLW) generated as a result of normal plant operation, including anticipated operational occurrences, and to store this packaged waste until it is shipped offsite to a waste processor for treatment and/or disposal or to a licensed burial site. The process and effluent radiological and sampling systems are described in Section 11.5.

11.4.1 DESIGN BASES

11.4.1.1 Safety Design Bases

The SRS performs no function related to the safe shutdown of the plant, and its failure does not adversely affect any safety-related system or component; therefore, the SRS has no safety design bases.

11.4.1.2 Power Design Bases

POWER GENERATION DESIGN BASIS ONE - The SRS is designed to meet the following objectives:

a. Provide remote transfer and hold-up capability for spent radioactive resins from the chemical and volume control system, fuel pool cooling and cleanup system, boron recycle system, liquid radwaste system, steam generator blowdown system, and secondary liquid waste system and for spent radioactive activated charcoal from the liquid radwaste system and the secondary liquid waste system.

b. Provide a means to semiremotely remove and transfer the spent filter cartridges from the filter vessels to the solid radwaste processing system in a manner which minimizes radiation exposure to operating personnel and the spread of contamination.

c. Provide a means for compacting and packaging miscellaneous dry radioactive materials, such as paper, rags, and contaminated clothing.

d. Provide a means for dewatering primary and secondary resin storage and shipment offsite.

POWER GENERATION DESIGN BASIS TWO - The SRS is designed and constructed in accordance with Regulatory Guide 1.143, as described in Table 3.2-5, and Branch Technical Position ETSB 11-3, as described in Table 11.4-1. The seismic design classification of the radwaste building, which houses the solid waste management system, and the seismic design and quality group classification for the system components and piping are provided in Section 3.2.

POWER GENERATION DESIGN BASIS THREE - The SRS design parameters are based on the radionuclide concentrations and volumes consistent with reactor operating experience for similar designs and with the source terms of Section 11.1.

POWER GENERATION DESIGN BASIS FOUR - Collection, packaging, and storage of radioactive wastes are to be performed so as to maintain any potential radiation exposure to plant personnel during system operation or during maintenance to "as low as is reasonably achievable" (ALARA) levels, in accordance with the intent of Regulatory Guide 8.8 in order to maintain personnel exposures well below 10 CFR 20 requirements. Design features incorporated to maintain ALARA criteria include remote system operation, remotely actuated flushing, and equipment layout permitting the shielding of components containing radioactive materials. Additionally, access to the solid waste processing and storage areas is controlled to minimize personnel exposure.

POWER GENERATION DESIGN BASIS FIVE - The onsite storage facilities for solid wastes have a capacity for temporary storage of solid wastes resulting from approximately 5 years of plant operation. Temporary onsite storage and shipping offsite of solid radwaste do not present a radiation hazard to persons onsite or offsite, for either normal conditions or extreme environmental conditions, such as tornados, floods, or seismic events. Greater detail on interim on-site storage is provided in section 11.4.A.

POWER GENERATION DESIGN BASIS SIX - The SRS is designed to meet the requirements of General Design Criterion 60 of 10 CFR 50, Appendix A. Packaging and shipment of radioactive wastes is performed in accordance with the requirements of 10 CFR 61, 10 CFR 71, 49 CFR 173, and applicable state regulations.

POWER GENERATION DESIGN BASIS SEVEN - Temporary storage, on a concrete slab or within a building addition located West of the IOS facility and South of the Radwaste Building provides temporary indoor/outdoor storage of large waste material which becomes activated during reactor operation. Each stored item will be unique, therefore procedures for storing items outdoors will be determined on a case by case basis.

11.4.2 SYSTEM DESCRIPTION

11.4.2.1 General Description

The SRS consists of the following subsystems which are illustrated in the piping and instrumentation diagrams provided in Figure 11.4-1:

a. Dry waste system

b. Resin handling system

c. Filter handling system

d. Waste disposal system

The activity of the influents to the SRS is dependent on the activities of the various fluid systems, such as the boron recycle system, secondary liquid waste system, liquid waste management system, chemical and volume control system, fuel pool cooling and cleanup system, floor and equipment drain system, and the steam generator blowdown system. Reactor coolant system activities and the decontamination factors for the systems given above also determine theinfluent activities to the solid radwaste system.

Table 11.4-2 lists the estimated expected and maximum activities of waste to be processed on an annual basis and their physical form and source. The isotopic makeup and curie content of the expected influents to the SRS are given in Table 11.4-2. The estimated maximum annual quantities of solid radwaste generation are presented in Table 11.4-3. The estimated annual expected and maximum curie and isotopic content is presented in Table 11.4-4, for each waste category. Packaged waste volumes are based on the following:

a. Waste content volume in Table 11.4-3, when based on packaging in 55-gallon and solidified with concrete, are:

   (1) 3.5 ft3 primary spent resin, primary charcoal, and primary evaporator bottoms per drum

   (2) 4.8 ft3 secondary spent resin and charcoal per drum

   (3) 5.3 ft3 secondary evaporator bottoms

   (4) 4.0 ft3 chemical waste per drum

   (5) 1 filter cartridge per drum

   (6) 7.5 ft3 shipped volume per drum (including cement

b. Disposal volumes are based on packaging in the following typical containers:

Waste Stream	Container Type	Container Volume
Primary Resin	PL8-120	120.3 cuft
Secondary Resin	PL14-215	205.8 cuft
Filters	PL6-80	83.4 cuft
DAW	85 Gallon Drum	11.6 cuft
	79 Gallon Drum	10.8 cuft
	55 Gallon Drum	7.5 cuft
	B-25 Box	96 cuft

Section 11.1 and Appendix 11.1A provided the bases for determination of liquid source terms which are used to calculate the solid waste source terms The sources presented in Tables 11.4-2 and 11.4-4 are conservatively based on Section 11.1, Appendix 11.1A and the following additional information:

a. As a basis for the activities given in Table 11.4-4, 30 days decay is assumed.

b. The miscellaneous dry and compacted waste volume will reflect the historical increases since the issuance of Case 6 in Table 2-49 of WASH-1258, July 1973.

11.4.2.2 Component Description

Codes and standards applicable to the SRS are listed in Tables 3.2-1 and 11.4-5. The SRS is housed within a seismically designed building. Regulatory Guide 1.143 is complied with to the extent specified in Table 3.2-5.

SRS component parameters are presented in Table 11.4-5. The following is a functional description of the major system components:

SPENT RESIN STORAGE TANK (PRIMARY) - Provides for storage and decay of the spent resins from the demineralizers in the chemical and volume control system, fuel pool cooling and cleanup system, boron recycle system, and liquid radwaste system.

SPENT RESIN STORAGE TANK (SECONDARY) - Provides for storage and decay of the spent resins and spent activated charcoal from the demineralizers and charcoal adsorbers in the steam generator blowdown system, secondary liquid waste system, and charcoal adsorbers in the liquid radwaste system.

EVAPORATOR BOTTOMS TANK (PRIMARY) - Provides for storage, decay, sampling, and chemistry control of the concentrated wastes from the liquid radwaste system.

EVAPORATOR BOTTOMS TANK (SECONDARY) - Provides for storage, decay, sampling, and chemistry control of the concentrated wastes from the secondary liquid waste system.

SPENT RESIN SLUICE PUMPS (PRIMARY AND SECONDARY) - Provides the motive flow to transfer spent resin or spent activated charcoal from the various demineralizers or adsorbers to the appropriate spent resin storage tank.

EVAPORATOR BOTTOMS TANK PUMPS (PRIMARY AND SECONDARY) - Are available to transfer the concentrated liquid wastes from the evaporator bottoms tanks to the solid radwaste disposal station.

ACID ADDITION TANK AND METERING PUMP - Provides chemistry control to the chemical drain tank, and floor drain tank.

CAUSTIC ADDITION TANK AND METERING PUMP - Provides chemistry control to the chemical drain tank, floor drain tank, waste holdup tank, evaporator bottoms tank (primary), and evaporator bottoms tank (secondary).

RESIN CHARGING TANKS - Provides remote means of gravity sluicing clean resin and activated charcoal into the demineralizer and adsorber units.

WASTE DISPOSAL STATION - The waste disposal station provides the capability to transfer primary/secondary spent resins and evaporator bottoms, and liquid radwaste demineralizer skid spent resins, to a HIC for storage/shipping. A return header provides a path for decanted water to be returned to the liquid radwaste system or the Secondary Spent Resin Storage Tank or the Primary Spent Resin Storage Tank. The waste disposal station also provides necessary interface support requirements for mobile vendor processing systems.

RADWASTE BRIDGE CRANE - A crane, remotely operated from the solid radwaste control console, which provides the means of moving containers to the processing area, from the processing area to the solid waste storage area, and from the solid waste storage area to the shipping area. The crane is equipped with a television camera system to facilitate the remote handling operation.

DRY WASTE COMPACTORS - Hydraulic power mechanical ram devices that are used to reduce the volume of compressible dry wastes by a factor of approximately five. They are designed with exhaust fan and filter to control the airborne dust during dry waste compaction operations.

11.4.2.3 System Operation

11.4.2.3.1 Waste Disposal System

The waste disposal station provides the capability to transfer primary/secondary spent resins and evaporator bottoms, and liquid radwaste demineralizer skid spent resins, to a HIC for storage/shipping. A return header provides a path for decanted water to be returned to the liquid radwaste system or the Secondary Spent Resin Storage Tank or the Primary Spent Resin Storage Tank. The waste disposal station also provides necessary interface support requirements for mobile vendor processing systems.

Evaporator concentrates are stored in either the evaporator bottoms tank (primary) or the evaporator bottoms tank (secondary). Each tank is provided with a mixer, and the piping system contains a relatively high flow pump for recirculation of the tank's contents to maintain the concentrates in the homogeneous
state. Each tank is supplied with external strip heaters, and all piping that can contain the concentrated waste is heat traced to preclude crystallization and eventual plugging within the piping system.

Spent resins are stored in either the primary or secondary resin storage tank. Each tank is supplied with nitrogen gas for sluicing the spent resin to the waste disposal station. Spent resin from the liquid radwaste demineralizer skid is also sluiced to the waste disposal station using Reactor make-up water or the associated system pump. Spent resins are normally sluiced into a High Integrity Container (HIC) for disposal. Resins are dewatered in accordance with the Process Control Program using approved procedures.

The waste disposal station area consists of a segmented concrete shield with nine inch walls, capable of containing the largest anticipated HIC, 60 inch diameter and 73 inch height, with 630 curies of activitie without disturbing normal operations.

The waste disposal station utilizes the necessary system controls to prevent improper system operation to preclude the spillage of waste. Because of these system design features, waste spillage is not anticipated although provisions are made for processing waste spillage. A drain system is provided in the waste disposal station for handling waste spillage. Provisions are also contained in the drain system to feed waste to a mobile vendor solidification system/mobile vendor resin dewatering system.

11.4.2.3.2 Dry Waste System

Low-level dry wastes are collected in drums at appropriate locations throughout the plant, as dictated by the volume of these wastes generated during operation or maintenance. Dry wastes, which can be compressed by a factor of five to minimize the volume, may be compacted in 55-gallon drums with a dry waste compactor. Compactors are located in the radwaste building and the auxiliary building. The dry waste compactors have an integral shroud which directs any airborne dusts created by the compaction operation through an exhaust fan and filter, and then to the respective building's ventilation system.

The filled drums are sealed and moved to the storage area in the radwaste building, or other designated areas, where they are stored until shipment offsite.

Dry wastes can also be processed/compacted offsite by contractor as part of the shipment and waste disposal contract. The low level dry waste collected can be placed in a NRC/DOT approved waste container (e.g., sea van) which is shipped offsite when filled. The container is placed outside the radwaste building within the radiological controlled area.

Large components and equipment which have been activated during reactor operation and which are not amenable to solidification or compaction are handled either by qualified plant personnel or by outside contractors specializing in radioactive materials handling, and are packaged in shipping casks or appropriate shipping packages of an appropriate size.

Dry noncompressible radwaste (such as hoses, buckets, etc.) will be packaged in approved containers and shipped as Low Specific Activity (LSA) or Type A waste.

11.4.2.3.3 Resin Handling System

The resin handling system provides the capability for remote removal of spent radioactive resin and activated charcoal from the demineralizer and charcoal adsorber vessels in the chemical and volume control system, fuel pool cooling and cleanup system, boron recycle system, liquid radwaste system, steam generator blowdown system, and secondary liquid waste system and to transfer them to the associated spent resin storage tank.

In the resin transfer mode, the spent resin sluice pumps take suction from the storage tank via a screened connection on the tank and pump water through the respective vessel to first backflush the resin and then sluice the resin to the spent resin storage tank. Positive indication that the resin has been sluiced to the spent resin storage tank is provided by an ultrasonic density element located in the spent resin sluice header. Alternate Sluice water may be provided by the Reactor Makeup Water system, if the sluice pumps are inoperable.

The spent resin storage tank (primary), which accepts resins from the reactor purification systems, is capable of accommodating at least 60 days' waste generation at normal generation rates. The spent resin storage tank (secondary), which accepts spent resin and spent activated charcoal from the remaining vessels, is capable of accommodating at least 30-days' waste generation at normal generation rates.

Spent resin and spent activated charcoal are transferred from the spent resin storage tanks to the waste disposal station by pressurizing the storage tank with nitrogen and supplying sluice water at the outlet nozzle on the tank. Positive indication that resin has been transferred is provided by a local camera, monitoring at the container entry at the solid radwaste disposal station. Upon completion of the resin transfer, the tank is vented to the radwaste building ventilation system.

The empty demineralizer or charcoal adsorber vessels are filled with clean resin or activated charcoal by gravity sluicing from the resin charging tank into the associated vessels. The filling operations are performed remotely from the vessels being filled.

11.4.2.3.4 Filter Handling System

The filter handling system is a semiremote system which provides the capability to remove spent radioactive cartridge filters from their filter housings and to transport them to the solid radwaste processing area in the radwaste building.

The system, requires the operator to be in the proximity of the filters; however, they are protected by distance which minimizes operator exposure.

The filter handling system consists of long handled tools for removal of the filter housing top and assemblies. As necessary, shielded drums are used for transport and storage of the filter assembly.

The steps required by the operator for the removal of the filters are as follows:

a. Using a monorail hoist, the shield plug above the filter housing is removed and set aside. Any time the plug hole is uncovered, the operators must take care to stay well away from the proximity of the hole, to avoid exposure. This necessitates that the monorail hoist be operated with a remote pendant controller.

b. Using long-handled tools the operator loosens the housing head bolts and flips them back out of the way.

c. With another tool, he engages the housing head and flips it back out of the way.

d. The filter is lifted part way out of the housing and allowed to drip for a while. It is then drawn all the way up and, when necessary, placed into a shielded drum.

e. A new cartridge is installed in the filter housing, either by reversing the previous sequence or, if filter housing radiation levels permit, by manually loading and securing the head.

11.4.2.3.5 Mixed Waste Handling System

Mixed waste (MW) is defined as radioactive waste that has hazardous characteristics or components as defined by 40 CFR 260/261. MW (liquid and solid) is collected in the plant and placed in the appropriate containers. The containers are then stored in the Mixed Waste Storage Facility (MWSF) in the Owens Corning Building (Figure 1.2-44). The MWSF meets the EPA requirements for storage of hazardous wastes, and the NRC requirements for storage of radioactive wastes.

The MW will be processed (if required) and shipped for disposal. Radioactive content of the MWSF will be limited to prevent exceeding the limits in 10 CFR 20 and 10 CFR 50 Appendix I during normal operation, including anticipated operational occurrences.

11.4.2.4 Packaging, Storage, and Shipment

Solidified radwaste, or waste meeting the no free standing water criteria of Branch Technical Position ETSB 11-3 (i.e., dewatered), shall be stored in the Waste Bale Drumming Area. These wastes satisfy all applicable transportation and disposal requirements.

Wet radioactive waste, defined as any waste which does not meet receiving burial site free liquid requirements may be temporarily stored in the Waste Bale Drumming Area. Wet waste storage containers are designed to withstand the corrosive nature of the wet waste for the expected duration of the storage. Temporarily stored wet waste will be processed (i.e., dewatered) or shipped to a waste processor for treatment prior to disposal.

DRY ACTIVE WASTE (DAW) - includes contaminated trash (paper, cloth, plastic, etc.)

SOLIDIFIED/DEWATERED WASTES - includes resin, filter cartridges and filter sludges transferred into HICs, and dewatered to less than 1% free standing water.

UNCOMPACTIBLE CONTAMINATED WASTE - other wastes not suitable for packaging in drums or HICs may be packaged in LSA boxes (B-25 or equivalent) or packaged into modular storage containers and stored on the temporary outdoor storage slab.

Spent resins, evaporator bottoms, spent charcoal, spent filter cartridges, and solid compactable waste such as contaminated paper, rags, and clothing are packaged in approved containers in accordance with 10CFR61 and shipped in accordance with applicable NRC (10CFR71) and DOT (49CFR173) regulations.

The 55-gallon drums used in the solid radwaste system meet the requirements of DOT approved containers.

Packaged solid radwaste is stored in the Waste Bale Drumming Area of the existing radwaste building prior to shipment offsite. The NRC/DOT approved waste container (e.g., sea van) is placed outside the radwaste building within the radiological controlled area prior to shipment offsite for processing.

The radwaste building storage areas have the ability to store 1,450 fifty-five gallon drums. However, other container sizes and storage configuration may be used.

Containers with radwaste are inventoried and their location recorded prior to being placed in storage.

Primary radwaste normally consists of:

- Spent resins, primary
- Filter cartridges, primary

Secondary waste normally consists of:

- Spent resins, secondary
- Filter cartridges, secondary
- Dry and compacted wastes
- Chemical wastes

Of the secondary waste, it is possible that Most or all of it will be surveyed and released, rather than stored as radioactive waste.

Refer to Table 11.4-3 for Estimated Maximum Annual Quantities of Solid Radwaste.

11.4.3 SAFETY EVALUATION

Packaged solid radwastes containing, or potentially containing, significant quantities of radioactivity (i.e., spent resins, evaporator bottoms, are in a form that is highly resistant to release and spread of radioactivity during an extreme environmental event, such as a tornado or earthquake. This configuration provides, in effect, a double barrier against the release of radioactivity.

The containers that require radiation shielding are stored in the waste bale drum area which is resistant to tornados as described in Section 11.4-A. The containers with significant quantities of radioactivity remain in place during any extreme environmental event. The drums or other approved containers for the storage of dry active waste (DAW) have a low specific activity. See Section 11.4A for further details.

The packaged radwaste storage areas protect the containers from rainfall and corrosion. As described in Chapter 2.0, flooding is not a potential concern in grade-level buildings at the Wolf Creek site.

Although compacted and solidified wastes are expected to be stored onsite for some period of time prior to shipment, normally no credit other than 30-day decay is taken for radioactive decay realized by such storage when filling containers for shipping in accordance with 49 CFR 173 dose limitations. That is, once filled, containers can normally be shipped immediately, with the proper shielding, without exceeding Department of Transportation radiation limits. If 49 CFR 173 dose limitations cannot be met with the available shielding, however, the applicable containers are stored in the shielded storage area until the doses are acceptable for shipping in accordance with Department of Transportation requirements.

The normal onsite residence time for low level solid radwaste prior to shipping, such as dry compacted waste, steam generator blowdown spent resins, evaporator bottoms, spent charcoal, and ranges from several days to a few months. The normal onsite residence time for primary solid radwaste prior to shipping, such as primary spent resins and spent filter cartridges from the primary system, ranges from a few months to a few years. Onsite residence time is based on the initial activity of the container, the time required to have sufficient containers to completely load a transporting vehicle, the thickness of the shields available, the number of containers which can be stored in the available shipping casks, the availability of a transporting vehicle, and the availability of ultimate disposal facilities.

Solid radwaste is shipped from the site in Department of Transportation-approved containers by Department of Transportation-approved carriers. Containers with any significant surface dose rate are moved remotely from the shielded storage areas to the transporting vehicle.

Radiation measurements made at the time of shipment of any radioactive waste material ensure that all shipments leave the site well within prescribed limits. Similarly, external contamination measurements are made to detect any potential release of radioactive material from the container prior to shipment.

Mixed waste will be stored in liquid and solid form in the MWSF. The total Curie content of the MWSF will be restricted accordingly to maintain doses to the maximally exposed individual during an extreme environmental event (e.g. fire, tornado, etc.) below the applicable limits in 10 CFR 20 and 10 CFR 100.

11.4.4 TESTS AND INSPECTIONS

The SRS is in intermittent use throughout normal reactor operation. Periodic visual inspection and preventive maintenance are conducted using normal industry practice. Refer to Chapter 14.0 for information on preoperational and startup testing.

11.4.5 INSTRUMENTATION APPLICATION

Two control panels are provided for the equipment in the SRS which contains or processes potentially radioactive fluids or slurries. One control panel is located in the radwaste building control room and contains the instrumentation for the equipment which interfaces the influent systems (i.e., evaporator bottoms tank - primary, evaporator bottoms tank - secondary, spent resin storage tank - primary, and spent resin storage tank - secondary) and for the equipment used for process control (i.e., acid addition tank, acid addition metering pump, caustic addition tank, and caustic addition metering pump).

The second control panel (radwaste crane control panel) is located in a separate room in close proximity to the solid radwaste processing area. The control panel contains all instrumentation, including television monitors, required for remote operations. Pertinent instruments and controls for the transferring of the wastes from the tanks containing the wastes are duplicated on this panel so that the solid radwaste system operator can transfer the waste from these tanks to the waste disposal station.