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11.0 Radioactive Waste Management

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11.1 Source Terms

11.1.1 Primary Coolant Activities

11.1.1.1 Maximum Fission Product Activities

The maximum fission product activities in the reactor coolant during operation are computed using the following differential equations (Reference 1):

For parent nuclides in the coolant,

Note: This equation was revised per 2003 update.

$$\frac{dN_{wi}}{dt} = D\nu_i N_{ci} - \left(\lambda_i + Rn_i + \frac{B'}{B_o - B't} \right) N_{wi}$$

For daughter nuclides in the coolant,

Note: This equation was revised per 2003 update.

$$\frac{dN_{wj}}{dt} = D\nu_j N_{cj} - \left(\lambda_j + Rn_j + \frac{B'}{B_o - B't} \right) N_{wj} + \lambda_j N_{wi}$$

Where:

N	=	nuclide population (atoms)
D	=	fraction of fuel having defective cladding
R	=	purification flow (coolant system volumes per second)
B_o	=	initial boron concentration (ppm)
B'	=	boron concentration reduction rate by feed and bleed (ppm per second)
n	=	removal efficiency of purification cycle
λ	=	radioactive decay constant (sec^{-1})
ν	=	escape rate coefficient for diffusion into coolant (sec^{-1})
t	=	time (sec)
		Subscript c refers to core
		Subscript w refers to coolant
		Subscript i refers to parent nuclide
		Subscript j refers to daughter nuclide

The values of parameters utilized in the above equations for the determination of maximum fission product activities are summarized in Table 11-1, with the results of the calculations presented in Table 11-2. The fission product inventory in the reactor core and the diffusion to the fuel pellet-cladding gap are discussed in Section 15.1.

One percent defective fuel is used as the basis of maximum fission product activities to assure conservatism in design calculations. Experience to date has shown that the average fuel defect for all operating Westinghouse Electric Corporation reactors with zircaloy clad fuel is considerably lower than this value (Reference 2). Fuel failure and burnup experience are discussed in Chapter 4.

The radioactive gaseous fission products (e.g., xenon and krypton isotopes) listed in Table 11-2 do not take into account a continuous or intermittent purge of the volume control tank vapor space which transports fission product gases to the Waste Gas System.

11.1.1.2 Anticipated Fission Product Activities

The concentrations of fission products in the Reactor Coolant System under normal operating conditions, including anticipated operational occurrences, are calculated by the methods developed in ANSI Standard N237 (Reference 3). These concentrations are the basis for calculating routine radioactive releases in station effluents and for ensuring that occupational radiation exposures are as low as reasonably achievable (ALARA). The values of parameters utilized for the determination of anticipated fission product activities are summarized in Table 11-3, and the concentrations appear in Table 11-4.

The fission gases removed from the reactor coolant in the volume control tank are computed using the following equations:

$$SE = \frac{C_R - C_L}{C_R - C_{Leq}}$$

$$SF = \frac{C_R - C_L}{C_R}$$

Where:

SE = Stripping efficiency

SF = Stripping fraction

C_R = Gas concentration in the liquid phase entering the volume control tank

C_L = Gas concentration in the liquid phase leaving the volume control tank

C_{Leq} = Gas concentration in the liquid phase leaving the volume control tank assuming the ration of the gas concentration in vapor and liquid phases follow Henry's law.

When calculating anticipated gaseous activities, a stripping efficiency of .4 is used.

11.1.1.3 Activated Corrosion Products

The concentrations of activated corrosion products (i.e., Cr-51, Mn-54, Mn-56, Co-58, Co-60, and Fe-59) used in design calculations are included in Table 11-2 and are based on Westinghouse experience with operating reactors. Concentrations expected during normal operation, including anticipated operational occurrences, are listed in Table 11-4 and are based on the N237 model.

11.1.1.4 Tritium

There are two principal contributors to tritium production within the PWR system: the ternary fission source and the dissolved boron in the reactor coolant. Additional small contributions are made by Li^6 , Li^7 and deuterium in the reactor water. Tritium production from different sources is shown in Table 11-5 and is discussed below. Values in Table 11-5 are Westinghouse estimates performed to support station startup and are retained for historical information only. Actual tritium release data can be found in the Annual Effluent Release Report (AERR).

11.1.1.4.1 Fission Source

Tritium is formed within the fuel material and may

1. remain in the fuel rod uranium matrix,
2. diffuse into the cladding and become hydrided and fixed there,
3. diffuse through the clad into the primary coolant, or
4. be released to the coolant through microscopic cracks or failures in the fuel cladding.

The ratio of fission tritium released into the coolant to the total fission tritium formed has been reported to be in the range of 0.01-.10 (Refs. 4-6). Based on operating experience at other Westinghouse reactors using zircaloy clad fuel, a release fraction of ten percent is used for the values in Table 11-5.

11.1.1.4.2 Control Rod Source

The control rod materials used are B_4 C with Ag-In-Cd tips. The primary sources of tritium generation are the B10 (n,2α) H^3 and B10 (n,α) Li^7 (n,nα) H^3 reactions. During full power operation, the Ag-In-Cd tips of the control rods will be the only part of the rods which spend a significant amount of time in the high flux regions of the core; hence this source is negligible.

However, the B_4C portion of the outer bank (Bank D) of control rods can spend a significant amount of time in the high flux regions during load follow operations. The tritium generation from control rod sources presented in this section is based on continuous daily load follow operation (12-3-6-3 cycle) and total release to the coolant from the B_4C source. The length of the Ag-In-Cd tips of the B_4C/Ag-In-Cd hybrid control rods is 40 inches.

11.1.1.4.3 Soluble Boron Source

A direct contribution to the reactor coolant tritium concentration is made by neutron reaction with the boron in solution. The concentration of boric acid varies with core life and load follow so that this is a steadily decreasing source during core life. The principal boron reactions are B10 (n, 2α) H^3 and B10 (n,α) Li^7 (n, nα) H^3 reactions.

11.1.1.4.4 Burnable Absorber Source

There are two types of burnable poisons currently in the core: 1). Wet Annulus Burnable Absorbers (WABAs), and 2). Integrated Fuel Burnable Absorbers (IFBAs). The WABAs are incorporated in the manufactured fuel assembly and are only in the core for one cycle and, then, is replaced by thimble plugs or a control rod assembly. Their potential contribution to tritium production is limited to this period of time. The IFBA design uses a burnable absorber coating on the fuel pellet itself. Therefore, IFBAs remain in the core for life of the fuel – typically three cycles or more. Their contribution to tritium production varies over the life of the core. Further discussions of WABAs and IFBAs are addressed in Section 4.2.1.3.2 and Section 4.3.2.4.14 respectively.

11.1.1.4.5 Minor Sources

Lithium and deuterium reactions contribute only minor quantities to the tritium inventory. The Li^7 reaction is controlled by limiting the overall lithium concentration to approximately two ppm during operation. Li^6 is essentially excluded from the system by utilizing 99.9 percent Li^7.

11.1.1.4.6 Tritium Concentration

A tritium concentration of 1 µCi/gm in the reactor coolant is assumed as an average value over the life of the plant, although the instantaneous value may vary considerably due to feed and bleed operations or reactor coolant leakage. Westinghouse elected that the design objectives of 3.5µCi/gm in the reactor coolant and 2.5µCi/gm in the refueling water and spent fuel pool are the reasonable upper limits for tritium concentrations in the containment atmosphere during normal operation and under refueling operations (Reference 1). However, a maximum value of 2.5µCi/gm is listed in Table 11-2 for these systems, since it is expected that at higher concentrations, airborne levels of tritium will become restrictive. If concentrations appear to increase above 2.5 µCi/gm, reactor coolant may be processed and released through the Boron Recycle System (See Section 9.3.5) for tritium control.

11.1.1.5 Nitrogen 16

In a light water cooled reactor, the oxygen in the circulating coolant can become irradiated. Reactions occur with all three oxygen isotopes O-16 (99.759 percent), O-17 (.037 percent) and O-18 (.204 percent); however, the only reaction which results in significant quantities of penetrating radiation is:

O-16 (n,p) N-16

The N-16 isotope decays with a half-life of 7.35 seconds, emitting high energy gammas in 75 percent of the disintegrations (70 percent at 6.13 Mev and 5 percent at 7.11 Mev). Since the half-life of N-16 is so short, the reactor coolant concentration varies with location in the system. The values utilized in design calculations are shown in Table 12-4.

11.1.2 Secondary Coolant Activities

Primary-to-secondary leakage will result in the build-up of activity in the U-tube steam generators. The anticipated concentrations in Table 11-4 are based on the methods of ANSI Standard N237. Values of parameters utilized in the model are presented in Table 11-3.

11.1.3 References

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2. *Schreiber, R. E. and Lorii, J. A., Operational Experiences with Westinghouse Cores, WCAP-8183, Latest revision.*

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4. *Westinghouse Electric Corporation, Source Term Data for Westinghouse Pressurized Water Reactors, WCAP-8253, July, 1975.*

5. Uhl, D. L. et. al, Oconee Radiochemistry Survey Program Semiannual Report, July-December 1974, July, 1975.

6. Combustion Engineering, Radiation Design Guide for System 80 Plants, December, 1976.

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11.2 Liquid Radwaste System

This section describes the capabilities of the Liquid Radwaste System (WL) to control, collect, process, handle, store, and dispose of liquid radioactive waste generated as a result of normal operation, including anticipated operational occurrences. The WL System components are supplemented by the Monitor Tank System located in the Monitor Tank Building, which is discussed in Section 11.6.

11.2.1 Design Bases

The Liquid Waste System is designed to reduce radioactive material in liquid effluents to levels which assure that doses to individuals beyond the site boundary are within the limits of 10CFR 50, Appendix I. Since the Catawba construction permit application was docketed on October 27, 1972, these dose limits are taken from the Annex to Appendix I and a radwaste cost-benefit analysis is not performed per the option available in Paragraph II.D.

Annual quantities released from the WL system, listed by radionuclide, and the resulting doses to individuals at or beyond the site boundary are discussed in Section 11.2.3.

During operation with excessive reactor coolant leakage, equipment downtime or design basis fuel leakage, additional and/or alternate processing capacity is available and utilized in order to limit the releases to approximately the same as during normal operation. Single failure of active components, including pumps, strainers, and filters has been considered as required by ANSI N199, and redundant equipment is installed to prevent any single failure from stopping waste treatment capability.

Liquid Radwaste System component parameters are shown in Table 11-8. Component design objectives, criteria and alternate processing routes are discussed in Section 11.2.2.2. Design codes, seismic category, and ANS safety classes for the components are given in Chapter 3. Sufficient surge capacity exists in the WL System to handle the worst case maintenance - that of shutting down a unit, draining and flushing the radioactive water from a steam generator contaminated by a tube leak, and holding that water for decay and/or treatment prior to release to the environment.

General Design Criteria 60 and 64 are met by the design of the WL System capacity for holdup, processing, and controlled release of radioactive liquids from a single point.

Monitoring of releases from the WL System is discussed in Section 11.5.

All Liquid Radwaste System equipment is housed in the Auxiliary Building and Monitor Tank Building, with the exception of the Steam Generator Drain Tanks. The Auxiliary Building as well as the Steam Generator Drain Tank Building (except the roof) are seismic Category I structures to prevent tank overflows or tank or pipe ruptures from escaping to the environment. See Section 11.6.1 for a discussion of the Monitor Tank Building.

The following station design features have been incorporated to reduce maintenance and equipment downtime as well as reduce the quantity of liquid leakage and uncontrolled fission product gas releases:

1. Components normally containing reactor coolant either with or without entrained fission product gases have drain lines permanently piped to the appropriate collection tank. The drain lines have two valves in series with a telltale valve located between them. Vent lines have overflows also piped to the second drain valve and served by the telltale. The overflow prevents spillage when refilling the component prior to startup.

2. In addition to the double valves on vents and drains, components normally containing reactor coolant with entrained fission product gases also have a clean water flush arrangement. After the component is isolated, the flush inlet is opened and flush outlet is aligned to the Waste Drain Tank, which has a diaphragm and is designed to retain gases until they can be processed in the Waste Gas System (WG).
3. Packless valves are used in radioactive systems wherever possible to prevent stem leakage. Where size prohibits the use of packless stem valves, stem leakoffs are provided, which are piped to appropriate holding tanks.
4. Flow indication has been located at key points in the WL collection headers and sump pump discharge lines to establish base line leak rates and monitor daily leakage in an effort to locate minor leaks before they overload the system.
5. All WL tanks are provided with manways which were originally intended to allow the use of the Equipment Decontamination System (WE) to break up and remove radioactive contamination. However, the WE system is no longer in service. The tank manways are now used for inspection and maintenance purposes.
6. Resin sluicing lines are provided with lateral cleanout ports throughout the system. Portable equipment can be connected to these cleanout ports to break up and clean out any radioactive material. This function was originally to be performed by the WE system.
7. Redundant heat tracing is provided on evaporator concentrates lines to prevent boric acid crystallization; however, the evaporator has never been placed into service.

Instrumentation provided to monitor and alarm liquid level in tanks and sumps is described in Section 11.2.2.6. Uncontrolled releases to the environment are prevented by careful recirculation and sampling of all tanks before discharging radioactive water from the single discharge point. After the discharge rate has been calculated and the discharge control valve set, the valve will automatically isolate on either high activity setpoint or low dilution flow. Dilution flow is provided by the Low Pressure Service Water System. The radwaste discharge control valve is designed to fail closed.

Shielding design parameters are discussed in Section 12.3.2.2.

11.2.2 System Description and Functions

11.2.2.1 General Description

Portions of the Liquid Radwaste System common to both units (shared) are shown on Figure 11-1 through Figure 11-10. Those portions contained separately in each unit are shown on Figure 11-11 through Figure 11-17 for Unit 1 and Figure 11-18 through Figure 11-24 for Unit 2. The Monitor Tank Building and associated equipment are shown on Figure 11-37 through Figure 11-39.

Of prime importance to successful Liquid Radwaste System operation is the segregation of input streams so that large quantities of water with little or no radioactivity content can be swiftly monitored and released, while small, controlled quantities of dirty, contaminated, water can be collected, processed, and recycled or released. Deaerated, recyclable water can be simply collected and re-used.

The Liquid Radwaste System, as delineated in ANSI N199, begins at the interfaces with the Reactor Coolant System pressure boundary and at the second valve in lines from other systems, or at those sumps or floor drains provided for liquid waste with the potential of containing radioactive material and terminates at the point of controlled discharge to the environment, or at the point of interface with the Solid Radwaste System, and at the point of recycle back to storage for reuse.

The Liquid Radwaste System includes all piped aqueous equipment flush and drain lines with the exception of corrosion inhibited water drains, all floor drains, decontamination sink drains, ultrasonic cleaner drains, laundry drains, and ventilation equipment drains in the Auxiliary and Reactor Buildings. The Liquid Radwaste System does not include any sanitary sewer drains whatsoever. Drains from components containing corrosion inhibited water are piped to the component cooling drain sumps in the KC System.

The WL System is designed to collect liquid wastes as follows:

1. Deaerated recyclable liquids containing fission product gases and other radioactive materials including tritium are collected in the reactor coolant drain tank in the Reactor Building or the waste drain tank in the Auxiliary Building.
2. Aerated liquids containing radioactive materials including tritium are collected in the waste evaporator feed tank. These sources include but are not limited to the containment floor and equipment sumps. weft sumps, and the incore instrumentation sumps of both units.
3. Liquids from the floor drains in the Reactor Building and radiation areas of the Auxiliary Building that are potentially radioactive, and generally not suited for plant discharge without treatment, are collected in the floor drain tank. Liquid can enter the floor drain tank directly via the OGRT or via Floor Drain Sumps A and B through the OGRT. There is also an option to pass the fluid directly to the FDT and bypass the OGRT.
4. Liquids from Auxiliary Building floor drains in areas other than radiation areas are considered clean and are collected in floor drain sumps C and D. They are discharged to the Turbine Building sump through a monitor which alarms at monitor setpoint upon detectable radioactivity, diverting the flow to either the floor drain tank or the waste evaporator feed tank via the ND and NS Sump. In addition, there may be situations when water from floor drain sumps C & D may be waived to continue flow to TBS.
5. Liquids containing detergents that are potentially radioactive are collected in the laundry and hot shower tank.
6. Laboratory samples which contain reagent chemicals are drained to the floor drain tank via the chemical drain tank.
7. Radioactive liquid waste generated during shutdown for steam generator tube leaks as well as during steam generator testing and inspection are pumped to one of two steam generator drain tanks. The contents of these tanks are sampled and processed or discharged accordingly. These large tanks also provide excess storage capacity for surges due to radioactive contamination of floor drain sumps C or D or the normal inputs to the other WL System tanks when needed. The steam generator drain tanks may also serve as the feed tanks for the monitor tank building,
8. Turbine Building drains are completely separated from any Auxiliary Building drains and receive no normally contaminated drains. Condenser circulating water pump and piping drains, Turbine Building floor drains, and conventional sample drains are collected unmonitored. Steam generators are separately monitored for radioactivity by the CSAE radiation monitor. The sump pump discharge is passed through a radiation monitor by the WP Sump pumps and if radioactivity is detected above the monitor's alarm setpoint an alternate discharge route to the Monitor Tank Building may be used. A control room alarm indicates this radioactivity. Discharge from the Turbine Building sump pumps can be routed to the steam generator drain tanks via piping in the Monitor Tank Building.

9. The Service Building sump receives Service Building floor drains, Units 1 and 2 diesel generator room sumps, ultra-filtration backwash and RO reject from the water treatment equipment located in the Water Treatment Building, LPSW valve pit sump discharge, and conventional sample drains, none of which are contaminated. An alternate discharge for this sump for radioactive processing is not necessary.
10. Reactor Coolant System bleed and other reactor grade liquids from the RHTs during an NB System evaporator failure (or other infrequent occurrences) are transferred to the WEFT or the MTB/SGDT sub-systems for processing and release. RHT liquid activity can be reduced by the NB System feed filters and demineralizers or transfer to the WL System.

Maximum and normal anticipated daily flow rates from various sources to the WL System are listed in Table 11-6 and Table 11-9, respectively. Table 11-10 lists tanks outside containment which contain potentially radioactive liquids and shows provisions for overflow.

11.2.2.1.1 Reactor Coolant Drain Tank (RCDT) Subsystem

The reactor coolant drain tank collects deaerated recyclable liquids with entrained fission product gases that are generated in the Reactor Building. As shown on Figure 11-11, sources of these liquids are as follows:

1. Reactor coolant pumps' #2 and #3 seal leakoffs.
2. Piped up valve leakoffs located in the Reactor Building.
3. Excess letdown heat exchanger effluent generated during startup.
4. Miscellaneous Reactor Building equipment drains.

During normal plant operation, this deaerated liquid is sent to the recycle holdup tanks for reuse, without further processing by the Liquid Radwaste System.

The gas space above the liquid in the reactor coolant drain tank is pressurized slightly (2 - 5 psig) with a cover gas of hydrogen or nitrogen. Any fission product gases released from the liquid are carried off in a gas stream to the Gaseous Radwaste System (WG). In the WG System, the gases are compressed and hydrogen separated out in a hydrogen recombiner, leaving only fission product gases and nitrogen to be stored in the waste gas decay tanks.

During refueling operations when nearly all systems in the Reactor Building are aerated, the contents of the reactor coolant drain tank are pumped to the waste evaporator feed tank, waste drain tank, or the recycle holdup tank.

11.2.2.1.2 Waste Drain Tank (WDT) Subsystem

The waste drain tank collects deaerated recyclable liquids with entrained fission product gases that are generated in the Auxiliary Building. The sources of these liquids are appropriate valve leakoffs and equipment flushes, as shown on Figure 11-14. Equipment flushing with clean water also serves to reduce dosages to maintenance personnel upon entering the equipment cubicle.

Particular caution must always be used to flush the residual water from the equipment which contains entrained fission product gases into the waste drain tank. By flushing the liquid into this tank, no air will become entrained in the liquid going to the tank. The flush water remaining in the particular component is then drained into the waste evaporator feed tank. Normally the contents of the waste drain tank are sent to the recycle holdup tanks for reuse, without further processing by the Liquid Radwaste System. If the contents of the waste drain tank become aerated, they are pumped to the waste evaporator feed tank or drained to WEFT Sump B. The waste drain tank is shown on Figure 11-5.

11.2.2.1.3 Waste Evaporator Feed Tank (WEFT) Subsystem

Aerated tritiated liquid is collected in the waste evaporator feed tank, shown on Figure 11-5. Sources of this liquid are as follows:

1. Reactor coolant drain tank liquids.
2. Waste evaporator feed tank sumps.
3. Floor drain tank overflows via WEFT Sump B.
4. Miscellaneous Auxiliary Building equipment drains.
5. Containment Floor and Equipment sump water is normally routed to the waste evaporator feed tank, but can be routed to the floor drain tank if it is low in activity and contains large amounts of floor dirt.
6. Laundry and hot shower tank and the floor drain tank liquids can be pumped to the waste evaporator feed tank for processing in this subsystem if necessary.
7. ND and NS sump discharge, although a discharge path to the FDT via the OGRT is also available.
8. RHT contents during an NB System evaporator failure (or other infrequent occurrences).

One of two redundant waste evaporator feed tank pumps delivers the contents of the waste evaporator feed tank to the Monitor Tank building for processing via the steam generator drain tank. The evaporator, shown on Figure 11-6 and Figure 11-9 has never been placed into service and is not considered a part of the processing flowpath.

11.2.2.1.4 Laundry and Hot Shower Tank (LHST) Subsystem

Soapy liquids that are potentially radioactive and are not recyclable are collected in the laundry and hot shower tank shown on Figure 11-3. The sources of these liquids are the decontamination area showers, hand washes, Auxiliary Building service sinks, men's and women's lavatory sinks, and laundry machine effluent. A pre-strainer prevents the collection of lint and hair in the laundry and hot shower tank.

The radioactivity of these tanks should be below the level requiring processing to reduce radioactivity. However, in order to minimize the environmental effects of discharging this liquid, it can be processed through the following equipment:

1. Laundry and hot shower tank strainer.
2. Laundry and hot shower tank primary filters (A and B).
3. Laundry and hot shower tank secondary filter.
4. Floor drain tank primary or secondary demineralizer.
5. Floor drain tank demineralizer post filter.

After passing through the above equipment or directly from the laundry and Hot Shower Tank, the liquid is collected in either waste monitor tank. The waste monitor tanks' pumps are used to pump the contents of the waste monitor tanks into the Low Pressure Service Water discharge via the Nuclear Service Water System for dilution and discharge from the plant. A radiation monitor is located in the discharge line from the waste monitor tanks. This monitor controls the air-operated discharge valve in the line, and closes it automatically if the activity level in the discharge stream reaches a preset level, or if dilution flow from the Low Pressure Service Water discharge drops below a minimum allowable rate.

In order to keep the radioactivity in the laundry and hot shower tank as low as possible, highly radioactive water drained from various ultrasonic cleaning baths such as those used for decontaminating tools and equipment will normally be routed to the Mixing and Settling Tank shown on Figure 11-4.

11.2.2.1.5 Floor Drain Tank (FDT) Subsystem

Liquids that are potentially radioactive, but are generally suitable for plant discharge with minimal treatment, are collected in the floor drain tank and floor drain sumps. As shown on Figure 11-1 and Figure 11-4, the sources of this liquid are as follows:

1. Auxiliary Building floor drains.
2. Reactor Building sumps if low in activity with large amounts of floor dirt.
3. Auxiliary Building equipment drains containing non-tritiated water.
4. Low activity lab drains.
5. Waste evaporator feed tank overflow.
6. Decontamination area room sinks.
7. Overflow from the waste monitor tanks.
8. ND and NS Sumps, although a discharge path to the WEFT subsystem is also available.

In order to reduce the flow of "clean" floor drains to the floor drain tank, only special areas designated "radiation areas" are drained directly to the floor drain tank. Radiation areas above elevation 543 ft. are drained directly to the FDT while radiation areas on the 543 ft. level and below are drained to either floor drain sump A or B, or to the NS and ND pump room sump. Sump pumps return this flow to the FDT or the WEFT. "Radiation area" drains are shown on Figure 11-1.

Drains from general Auxiliary Building "non-radiation areas" are routed through a radiation monitor and directly to the Turbine Building sump, thus increasing the effective capacity of the floor drain tank to handle the "radiation areas". Control, cable, and equipment rooms, as well as areas occupied by cable runs, Component Cooling System equipment, Nuclear Service Water piping, and ventilation equipment, are drained to floor drain sumps C and D. Floor drain sump D receives flow from Unit 1 side "non-radiation areas" and the sump pumps 1D1 and 1D2 pump the water through a radiation monitor and air-operated valve (1WL848) to the Turbine Building sump. Likewise, flows from Unit 2 side "non-radiation areas" are piped to floor drain sump C, where sump pumps 2C1 and 2C2 pump the water through another radiation monitor and air-operated valve (2WL848) to the Unit 2 Turbine Building sump. Upon detecting radioactivity above monitor setpoint in the discharge, a signal closes the valve WL848 and opens valve WL847 to divert the discharge to the ND and NS Sump. Discharge from the ND and NS Sump is then aligned for routing to the MTB. "Non-radiation areas" are shown routed to floor drain sumps D and C on Figure 11-13 and Figure 11-20, respectively. (See 11.2.2.1.4)

The contents of the FDT are discharged: to a waste monitor tank through the floor drain tank strainer, filter and demineralizers, or to the steam generator drain tanks via the WEFT or processed directly through the monitor tank building.

11.2.2.1.6 Mixing and Settling Tank (MST) Subsystem

The mixing and settling tank serves not only the Liquid Radwaste System, but also several other systems in the station. It can be used as a batching tank for chemical and thermal treatment of problem fluids in the floor drain tank, the laundry hot shower tank, and the waste evaporator feed tank. In addition to this duty, the mixing and settling tank can be used to prepare decontamination solutions for various systems throughout the station. An agitator and heating coil are provided, as well as pumps to pump liquid from the midplane of the vessel and sludge from the funnel shaped bottom. Temporary piping will be used to route decontamination chemicals to their point of use. Crossover valve 1WL883 allows the mixing and settling tank pump to pump a tankfull of liquid from the funnel shaped bottom back to various points throughout the WL System. Ultrasonic cleaner drains are piped to the MST so they can be collected for treatment as described in Section 11.2.2.1.4.

11.2.2.1.7 Ventilation Unit Condensate Drain Tank (VUCDT) Subsystem

Condensation from the containment ventilation units is collected in a 5,000 gallon tank in the Auxiliary Building outside each Reactor Building. When incoming water raises the VUCDT level to a pre-determined level, the contents are then treated in WL Subsystems. If the VUCDT inlet is closed, the inputs will eventually overflow ventilation unit drip pans to the containment floor and equipment sumps. The VUCDT itself overflows through a vent to its respective units floor drain sump.

11.2.2.1.8 Steam Generator Drain Tank (SGDT) Subsystem

Two 50,000 gallon tanks have been provided to collect, recirculate and sample the waste generated by draining and flushing a steam generator for maintenance, testing, and/or inspection. The steam generator drain pump, located inside the containment, has permanently installed suction lines from the low point on each steam generator blowdown line and a discharge line penetrating the containment to deliver sufficient flow to empty the steam generator's contents in two hours. Inside the containment, blind flanges are provided downstream of the Unit 1 SGD pump for the installation of a temporary fire hose to complete the connection necessary to pump to the steam generator drain tanks. The pump can also be used for transferring steam generator contents for periodic testing and inspection. The SGDTs are normally used as the feed tanks for the monitor tank building process equipment.

[Note: The above description is retained for historical purposes. It describes subsystem functions that are not anticipated to be used again. If desired, this subsystem is available for post-steam generator tube rupture long-term recovery water management.]

Interconnections are provided into the waste evaporator feed tank subsystem and the waste monitor tank pump suction crossover. Each SGDT is recirculated and sampled independently. If sampling reveals that the SGDT contents may be released without treatment, the contents are transferred to a WMT for release.

For normal or emergency station operation, the contents of any of the following can be pumped out to the SGDT for holdup or processing:

Waste Evaporator Feed Tank (WEFT)

Floor Drain Tank (FDT)

Laundry & Hot Shower Tank (LHST)

Contaminated WP System sumps (see section 11.6)

11.2.2.1.9 Steam Generator Drain Tank Pumps

The SGDT pumps transfer waste from the SGDTs to the auxiliary monitor tanks (AMTs) via processing equipment in the MTB. The pumps can be aligned to take suction from either SGDT.

11.2.2.2 Design Bases

A radioactive waste management system is required by the NRC General Design Criteria 60.

ANSI N18.2, Section 5, provides some design criteria for radioactive waste disposal systems, which are further detailed in proposed American National Standard for PWR liquid radioactive waste processing, ANSI N199. This draft standard was followed in the design of the Catawba WL System. Tankage and processing requirements have beem implemented, as well as a single failure analysis, as required by Chapter 8. Redundancy has been achieved by the use of parallel pumps and filters, or filter bypasses, and duplex strainers, as well as alternate holdup capacity for waste liquids in the event of a tank rupture. Various processing streams are available for waste liquids.

11.2.2.2.1 Pumps

The majority of pumps supplied for the Liquid Radwaste System are of two basic types: a canned-rotor pump design (with two different size impellers which suit the pump to the various performance conditions required) and a mechanical seal design for use in applications where the canned-rotor pump is unsuitable. The canned-rotor pump design is used in the majority of cases, which minimizes overall leakage from the system.

Each processing subsystem of the WL System has been designed in accordance with ANSI N199, which requires that the system be designed "with redundancy or crossconnections, or both, such that a single active or passive failure in any subsystem will not limit the ability of the total system to process the liquid wastes". Piping and manual valves are not included in the active or passive components. Therefore, two pumps in parallel are installed at each point where pumping is required to continue processing. Spare pumps are kept on hand for quick replacement. It is imperative that the two pumps performing the same function be physically separated, so one pump can be isolated, decontaminated, and repaired while the second pump continues to process the waste. In most cases a lead blanket may be temporarily installed between pumps to perform maintenance on the disabled pump. Two basic head-flow requirements are specified:

1. 100 gpm at 300 feet of head with runout capability to 140 gpm at 150 feet of head. Applications for this pump are the reactor coolant drain tank pumps, which are canned-rotor pumps.
2. 35 gpm at 250 feet of head with runout capability to 100 gpm at 200 feet of head. Applications for this pump are the recycle monitor tank pumps, waste drain tank pumps, waste monitor tank pumps, mixing and settling tank pump, and the mixing and settling tank sludge pump. The aforementioned are all canned-rotor pumps. These conditions also apply to the waste evaporator feed pumps, floor drain tank pump and the laundry and hot shower tank pump, which are mechanical seal pumps, due to the potential for dirt and lint to make a canned-rotor pump unsuitable.

The runout capability specified for these pumps is based on providing reasonable flow for transfer functions within the system. The lower-capacity design point provides sufficient process flow for all system operations. The specifications of a single canned-rotor design for most applications in the system further simplifies spare parts problems. The only pumps different from the two basic types mentioned are the various sump pumps, the mixing and settling tank metering pump, the containment ventilation unit condensate drain tank pumps, the steam generator drain pumps, and the steam generator drain tank pumps.

Globe valves are installed in pump discharge lines to control pump performance, based upon the discharge piping layout. Design bases for individual pumps are given below.

11.2.2.2.1.1 Reactor Coolant Drain Tank Pump 1A, 1B, 2A, & 2B

The design basis for these pumps is that they must perform a Reactor Coolant System drain, such that the coolant level is to the reactor vessel nozzles within an eight hour period. Since two pumps are furnished due to the inaccessibility of the containment during plant operation, both pumps will be operated to meet the draining time requirement. The design performance is 100 gpm at 300 feet of head. One pump will provide sufficient flow for normal operation of the RCDT portion of the waste processing system. The RCDT pumps are of the canned-rotor design.

11.2.2.2.1.2 Waste Evaporator Feed Pump A & B

Each pump was originally designed to be capable of transferring feed to the evaporator as a function of the level in the evaporator. However, the waste evaporator has not been placed into service at CNS. Pump head requirements included fifty feet of elevation loss, the head loss through the feed filter, and the required evaporator package feed supply pressure of 50 psig. Since the evaporator has never been placed into service, the above design basis for the waste evaporator feed pumps is no longer valid. The waste evaporator feed tanks now serve as a collection point for equipment drains, valve and pump seal leakoff, anc other tritiated aerated water sources. The operating characteristics for the pumps are adequate for transferring the fluid in the tank to the downstream processing equipment.

The waste evaporator feed pumps' piping was originally designed to allow continuous duty of one pump for evaporator feed while using the other pump to recirculate and sample one steam generator drain tank. The waste evaporator feed pumps are provided with independent recirculation lines to the SGDT Subsystem so that with the WEFT outlet isolated, one SGDT's contents can be recirculated and sampled while the other SGDT's contents are continuously fed to the waste evaporator.

11.2.2.2.1.3 Recycle Monitor Tank Pump A & B

The recycle monitor tank pumps must be capable of transferring the entire contents of the recycle monitor tanks in approximately two hours. The standard canned pump design of 35 gpm at 250 feet is suitable for this application. The RMT recirculation line is sized for a flow rate of 100 gpm to allow two tank volumes to be recirculated in less than two hours as required prior to sampling for release. Each pump is capable of pumping from either tank, as well as recirculating either tank for sampling.

11.2.2.2.1.4 Laundry and Hot Shower Tank Pump

This pump is supplied as a mechanical seal type, due to the unsuitability of the canned-rotor type for use in pumping laundry and shower water with its expected high solids content. The pump supplied must be able to pump at an adequate rate through the filters and demineralizers in this system. The standard pump design of 35 gpm at 250 feet meets this criteria. This pump may also be realigned to take suction from the floor drain tank, recirculate to the floor drain tank, and process FDT contents if the floor drain tank pump is disabled.

11.2.2.2.1.5 Floor Drain Tank Pump

The design requirements of this pump are similar to the laundry and hot shower tank pump. This pump may be realigned to take suction from the laundry and hot shower tank and process LHST contents if the LHST pump is disabled.

11.2.2.2.1.6 Waste Monitor Tank Pump

One canned-rotor pump of 35 gpm capacity at 250 feet developed head is used for each waste monitor tank. These pumps must be capable of discharging water to the Low Pressure Service Water System or recycling it for further processing. Each pump is capable of pumping from either tank. The WMT recirculation line is sized for a flow rate of 100 gpm to allow two tank volumes to be recirculated in less than two hours as required prior to sampling for release.

A single line from the SGDT subsystem to the suction line crossover between WMT pumps A and B allows one SGDT at a time to be discharged via the WL System discharge monitor. The WEFT pumps can be used for recirculation of the SGDT for sampling while the WMT pumps can be used only for discharging SGDT contents.

11.2.2.2.1.7 Mixing and Settling Tank Pump

One canned-rotor pump of 35 gpm capacity at 250 feet developed head is used for this application. This pump is required to transfer the liquid processed in this tank to either the floor drain tank, the laundry and hot shower tank or the waste evaporator feed tank. A blind flange is provided on MST pump discharge header for temporary connection of a hose to transfer decontamination agents prepared in the MST to other locations in the station.

11.2.2.2.1.8 Mixing and Settling Tank Sludge Pump

One canned-rotor pump of 35 gpm capacity at 250 feet developed head is used for this application. This pump is required to transfer the sludge from the mixing and settling tank to the Radwaste Batching Tank (WS System). Three gpm of flush water + 1 gpm is required for this pump to operate. The starting of the pump is interlocked with flush water valve 1WL217 so that the valve opens 20 seconds prior to pump start.

11.2.2.2.1.9 Mixing and Settling Tank Metering Pump

This pump is designed to accurately feed chemicals at a predetermined rate into the contents of the mixing and settling tank. A variable feed rate of three to 30 gallons per hour should accomplish the required chemical concentration and a simultaneously suitable processing rate between 15 and 100 gpm. The metering pump can also be used in a batch type operation to precipitate chromates from contaminated component cooling water (should they be used), to neutralize decontamination solution waste, etc.

11.2.2.2.1.10 Ventilation Unit Condensate Drain Tank Pump 1A, 1B, 2A, & 2B

Each ventilation unit condensate drain tank pump must be capable of transferring the entire contents of the ventilation unit condensate drain tank in approximately two hours. The pumps are designed to discharge VUCDT contents to the Low Pressure Service Water discharge, to the waste monitor tanks for further processing, or to a vendor demineralizer processing train. They will also be used to drain the ice condenser area in the Ice Condenser Refrigeration System (NF).

11.2.2.2.1.11 Steam Generator Drain Pumps

One pump per unit is located inside the containment, and is a vertical inline pump to eliminate base and anchoring requirements. It will pump the water from any selected steam generator in approximately 2 hours, averaging approximately 200 gpm. The SGD pump takes suction from the low point in the steam generator blowdown piping and discharges to either of the two steam generator drain tanks located in the yard. Inside the containment, blind flanges are provided downstream of the Unit 1 SGD pump for the installation of a temporary fire hose to complete the connection necessary to pump to the steam generator drain tanks.

During steam generator wet layup, the steam generator drain pump will pump the full contents of any one steam generator to completely fill any other steam generator which had been previously pumped out to the SGDT. This is to recover the water which has valuable chemical additives while successively testing and inspecting steam generators. Blind flanges are provided on the SGD pump discharge line and on each steam generator drain line to accomplish these transfers with temporary fire hoses rather than extensive permanent piping and valves. If a steam generator contains water within acceptable limits for secondary chemistry the contents of that steam generator may be pumped via the steam generator drain pump to the condensate storage tank located in the Turbine Building.

11.2.2.2.2 Heat Exchangers

The reactor coolant drain tank heat exchanger must meet the following requirements:

1. Maintain the RCDT fluid at 170°F or less with a nominal 10 gpm in-leakage of 600°F reactor coolant.
2. Maintain the RCDT fluid at 170°F or less with a 25 gpm flow from the excess letdown exchanger during heatup or draining operations.
3. Cool the contents of the pressurizer relief tank from 200°F to 120°F in less than 8 hours.

The heat exchanger is cooled by component cooling water on the shell side.

11.2.2.2.3 Tanks

11.2.2.2.3.1 Reactor Coolant Drain Tank

One 350 gallon stainless steel tank is provided for each unit. The purpose of this tank is to collect leakoff drains from inside the containment for further disposition through a single containment penetration via the RCDT pump.

Sources of water entering the tank include the reactor vessel flange leakoffs, valve leakoffs, reactor coolant pumps #2 and #3 seal leakoffs, and excess letdown heat exchanger flow.

The tank level control system maintains a constant liquid inventory in the tank by controlling the position of a proportional control valve in the discharge line from the RCDT pumps, one of which runs continuously. Flow out to the system is normally directed to the recycle holdup tanks; the balance of the flow is recirculated to the tank. Continuous flow is maintained through the heat exchanger in order to prevent loss of pump NPSH resulting from a sudden influx of hot liquid into the RCDT.

11.2.2.2.3.2 Waste Evaporator Feed Tank

One 5,000 gallon vented stainless steel tank is provided for collection of equipment drains, valve and pump seal leakoffs (outside containment), and other tritiated aerated water sources. The design bases for the required tankage are:

1. Provide storage capacity to accept a 10 gpm leak from one unit for 8 hours (4800 gallons).
2. Provide additional 200 gallon margin.

11.2.2.2.3.3 Waste Drain Tank

One 5,000 gallon stainless steel tank with a diaphragm is provided to collect all deaerated recyclable liquids with entrained fission product gases. The sources of these liquids are appropriate valve leakoffs and equipment drains. The design bases for the size are essentially the same as that for the waste evaporator feed tank.

11.2.2.2.3.4 Recycle Monitor Tanks

Ten thousand gallons of volume are provided to collect distillate from the waste evaporator. The RMTs are used as general purpose monitor tanks similar to the waste monitor tanks. Due to space limitations, two 5,000 gallon tanks are provided to meet the volume requirements.

11.2.2.2.3.5 Waste Evaporator Reagent Tank

This tank is provided to add chemicals directly to the evaporator if required for pH and foam control. The evaporator however has never been placed into service.

11.2.2.2.3.6 Oil and Grit Removal Tank

One 240 gallon tank is provided between the floor drain tank prestrainers and the floor drain tank to remove oil and grit which would otherwise contaminate the floor drain tank. It is designed for easy access so that oil and grit can be removed expeditiously by plant personnel.

11.2.2.2.3.7 Floor Drain Tank

The floor drain tank is a 10,000 gallon vented tank which collects floor drains from the "radiation areas" of both units. The tank is sized to provide surge capacity for the floor drains within the collection area, and in connection with the waste evaporator feed tank, provide surge capacity for abnormal primary system leaks.

11.2.2.2.3.8 Laundry and Hot Shower Tank

One 10,000 gallon tank is utilized to collect controlled area laundry, hot shower, and lavatory sink drains. The tank is sized to furnish a 15 day surge capacity for such drains from a twin unit station, during normal operation of both units, and a 4 day surge capacity during refueling of one unit.

11.2.2.2.3.9 Waste Monitor Tanks

Two 5,000 gallon vented tanks are provided for liquid storage and monitoring prior to discharge from the plant. One tank is usually used to discharge laundry wastes and floor drain tank effluent which cannot be recycled to the primary system.

Laundry and hot shower tank liquids are normally directed exclusively to Waste Monitor Tank A. The liquids in this tank are sampled and discharged or processed as required. Cross-over connections between tanks are provided, however, for flexibility, during continuous evaporation of non-recyclable water.

The volume furnished is large enough to provide a lengthy period between sampling prior to discharge.

11.2.2.2.3.10 Mixing and Settling Tank

This 800 gallon stainless steel tank is provided for mixing specialty chemicals or for treating liquids collected in the laundry and hot shower tank, floor drain tank, or the waste evaporator feed tank. Utilizing water from the reactor makeup water storage tank, specialty chemicals can be mixed in the mixing and settling tank and pumped via temporary piping to any required location. The mixing and settling tank also receives highly radioactive water drained from various cleaning baths such as those used for decontamination of tools and equipment.

A heating coil is also provided for the tank. The requirements for this coil are to heat the contents of the tank from 32°F to 165°F in two hours.

11.2.2.2.3.11 Mixing and Settling Tank Reagent Tank

This is a twenty gallon tank that feeds the suction of the mixing and settling tank metering pump with the chemicals being added to the liquid in the mixing and settling tank.

11.2.2.2.3.12 Ventilation Unit Condensate Drain Tank

One 5,000 gallon tank per unit is utilized to collect condensate from the containment ventilation units. The containment ventilation unit condensate drains can amount to 700 gph. The tanks thus have a minimum of 6 hour surge capacity.

11.2.2.2.3.13 Steam Generator Drain Tanks

Two 50,000 gallon tanks are provided to hold the water drained from one steam generator at normal operating level plus three normal level volumes of rinse water during a unit outage for primary to secondary tube leaks. The tanks are stainless steel linings inside a seismic - Category I concrete structure which acts to support the tanks, as well as shield station personnel from their design basis reactor-coolant activity contents. A painted concrete roof (which is not Seismic-Category 1) is also provided which serves as the top of the tank.

Heat tracing is required on all water filled lines to and from steam generator drain tanks for freeze protection. No additional heat tracing is required for boric acid due to the dilute concentration. Insulation is used as required to supplement heat tracing.

Tank ventilation is provided to Auxiliary Building carbon filters via the WL System tank vent header to filter fission product gases before release out the unit vent. A tank ventilation inlet is provided to protect the top of the tank from damage due to excessive negative pressure pulled by the Auxiliary Building fans. A particulate filter over the ventilation inlet prevents dust and dirt from entering the SGDT.

The SGDT vent header also acts as its overflow, discharging any liquid in the vent stream into the WEFT.

Either tank can be recirculated by a SGDT pump for sampling while the other tank is being recirculated, sampled, and processed. For normal or emergency station operation, the contents of any of the following tanks can be pumped out to the SGDT for holdup or processing (via their associated filter trains to prevent soap and sediment in the SGDT):

Waste Evaporator Feed Tank (WEFT)

Floor Drain Tank (FDT)

Laundry & Hot Shower Tank (LHST)

11.2.2.2.4 Sumps

11.2.2.2.4.1 Floor Drain Sumps A, B, C, & D

Each sump serves as the collecting point for certain floor drains as shown on Figure 11-1, Figure 11-13 and Figure 11-20. Each has a capacity equal to that needed to accept a 50 gpm leak for approximately ten minutes. Using both sump pumps, this leak rate requires six starts per hour. These sumps are stainless steel lined to aid in their decontamination.

11.2.2.2.4.2 Waste Evaporator Feed Tank Sumps A and B

These sumps serve as the collecting points for certain equipment too low to drain by gravity directly into the WEFT. Figure 11-2 shows the components which drain into each sump. These sumps are stainless steel lined and overflow into the nearest floor drain sump.

11.2.2.2.4.3 Containment Spray and Residual Heat Removal Pump Room Sump

This is a stainless steel lined sump serving as the collection point for all leakage in the NS and ND pumps area. The sump is located external to the shielded pump areas and connected by embedded floor drains to each compartment. It is sized to accept 50 gpm of leakage from one ND or NS pump with one sump pump making six starts per hour assuming single failure of the other channel sump's pump or power supply.

11.2.2.2.4.3.1 Backup Cooling for Centrifugal Charging Pump 1A (2A)

In order to improve the total core damage frequency, backup cooling was provided to Centrifugal Charging Pump (CCP) 1A per NSM CN-11389/00 and 2A per NSM CN-21389/00. The backup cooling water to CCP 2A is supplied by a non-safety-related four inch YD System Header in the Auxiliary Building on the 543' - 00" Elevation. If the scenario occurs that results in a loss of normal KC System cooling to the CCP 1A (2A), the supply from the YD System will be aligned to provide the cooling water for the CCP 1A (2A) motor coolers and oil coolers. The return lines from the coolers will be aligned to flow to the ND/NS Sump. The flow into the ND/NS Sump will be processed by Radwaste Chemistry. Radwaste Chemistry will process this water through the WL System. In addition, an alternate discharge connection will be provided at the common return on Elevation 543' - 00" to reduce the quantity of YD System water flowing into the ND/NS Sump. The alternate discharge connection would typically not be used until after setting up the return flow into the ND/NS Sump. This is due to the time constraints of setting up the alternate flowpath. This connection may be used to divert the NV Pump YD Backup Cooling discharge flow or part of the flow to the WZ System Auxiliary Building Groundwater Drainage Sump C (preferred) or other location as deemed suitable by Radwaste Chemistry. Catawba Nuclear Station has obtained authorization from the Department of Health and Environmental Control (DHEC) to allow the discharge of YD System water into the WZ System Sump C which could potentially discharge directly to Lake Wylie. For the preferred location, a fire hose is connected and routed from the alternate discharge connection to the WZ

Sump C. This "loss of normal KC System cooling" scenario is assumed to last for no more than 24 hours after which the KC System normal cooling supply will be available again.

11.2.2.2.4.4 Auxiliary Feedwater Pump Pit Sumps

Each auxiliary feedwater (CA) pump is located in a pit below floor elevation to meet NPSH requirements. The pits are completely separated so a pipe break or water jet from one CA pump will not flood the redundant CA pump. The pit for each CA pump, both motor and steam turbine driven, has a stainless steel lined sump capable of collecting 500 gallons, or the amount equal to a 50 gpm leak for ten minutes.

11.2.2.2.4.5 Containment Floor and Equipment Sumps 1A, 1B, 2A, 2B

There are two stainless steel lined sumps in each Reactor Building located diametrically opposite from each other, serving to collect both piped up equipment drains and leakage that runs into the sump off the floor, where sump pumps return it to the floor drain tank, or WEFT as required. A drain header leads to each sump from equipment drain connections inside the crane wall. Piping from each component inside the crane wall leads to the centralized connections which drain under the crane wall to the containment floor and equipment drain sump. Each sump holds approximately 600 (including pipe volumes) gallons.

11.2.2.2.4.6 Incore Instrumentation Room Sumps 1 and 2

The incore instrumentation tunnel is the lowest point inside the Reactor Building and has a sump pump to return leakage to the floor drain tank, or WEFT, as required. The sump holds approximately 200 gallons and is stainless steel lined.

11.2.2.2.4.7 Upper Head Injection Room Sumps 1 and 2

There is no drainage or leakage expected in the Upper Head Injection Building; however, during maintenance there may be some drain requirements. A small sump is provided which receives both floor drainage and several piped up equipment drains. The contents of this sump are pumped via loop seals, to the Auxiliary Building floor drain header through the annulus drain header.

11.2.2.2.4.8 Monitor Tank Building Sumps

See Section 11.6 for information pertaining to the monitor tank building and its associated sumps and equipment.

11.2.2.2.5 Sump Pumps

In the non-safety related applications, sump pumps with conventional cutless rubber are used in the floor drain sumps, which are the deepest sumps, while cantilevered sump pumps are used in all the shallow sump applications. Experience at other Duke Power stations has indicated cantilevered pumps up to 4 or 5 feet long are more maintenance-free than pumps with lower bearings.

Longer cantilevered pumps have developed severe vibration problems, however, which is why the conventional bearing pump with discharge water lubrication was chosen for floor drain sump applications.

Safety-related sump pump applications are provided with N-stamped pumps having carbon faced lower bearings with forced water lubrication for high temperature service. Clean water is assured by a centrifugal separator which takes supply from its corresponding sump pump discharge and by cyclone action discharges a clean stream to the bearings and discharges particles out the conical bottom nozzle back to the sump.

11.2.2.2.5.1 Floor Drain Sump Pumps 1A1, 1A2, 1B1, 1B2, 2C1, 2C2, 1D1, 1D2

There are four floor drain sumps for the purpose of collecting those floor drains too low to drain by gravity directly into the floor drain tank. Each sump contains two pumps each capable of controlling a 50 gpm leak until it can be isolated. The pumps alternate duty to assure equal wear. Floor drain sump pumps 1A1, 1A2, 1B1, and 1B2 discharge directly to the FDT. Floor drain sump pumps 2C1, 2C2, 1D1, and 1D2 are located in the "non-radiation area" sumps and as such discharge normally to the Turbine Building sump through a radiation monitor. Upon detection of radioactivity above at the monitor setpoint, an air-operated valve isolates the discharge to the Turbine Building sump and opens the air-operated valve to divert sump pump discharge to the floor drain tank via the ND and NS sump for further processing. (See 11.2.2.1.4)

11.2.2.2.5.2 Waste Evaporator Feed Tank Sump Pumps 1A and 1B

There are two WEFT sumps for the purpose of collecting primary equipment drains which are too low to gravity drain directly into the waste evaporator feed tank. Each sump has one pump capable of returning 50 gpm into the WEFT.

11.2.2.2.5.3 Containment Floor and Equipment Sump Pumps

Each of two containment floor and equipment sumps per unit holds approximately 600 gallons and has two 50 gpm sump pumps, which alternate starting on high sump level signal and stop on low sump level. The pumps return flow to the waste evaporator feed tank with an alternate line to the floor drain tank.

11.2.2.2.5.4 Incore Instrumentation Room Sump Pumps

Each incore instrumentation tunnel has a low point sump capable of holding approximately 200 gallons and a 50 gpm sump pump capable of discharging to the waste evaporator feed tank. An alternate line is provided to the floor drain tank.

11.2.2.2.5.5 Upper Head Injection Room Sump Pumps

Each upper head injection tank room has a low point sump for floor drainage, equipment drains, and a grab sample drain. A 25 gpm sump pump is provided to discharge water via a loop seal with automatic makeup to the annulus drain header, where it flows by gravity to the Auxiliary Building floor drain header.

11.2.2.2.5.6 Residual Heat Removal and Containment Spray (ND and NS) Pump Room Sump Pumps 1A, 1B, 2A, 2B

These four pumps are located in a common sump on the 522 ft. level. This represents the lowest point anywhere in the station, so it is the end point for all leakage. The sump pumps, therefore, are nuclear safety related in that they protect safety equipment from flooding. Each pump is supplied with emergency diesel power from the diesel of the corresponding channel.

These pumps represent redundant means for removing at least 50 gpm from each ND or NS pump compartment assuming a seal failure. The sump is located external to the pump compartments and receives leakage flows through a system of floor drains and equipment drain pipes. Each pump is rated at 100 gpm, to meet the requirement for 50 gpm of leakage from each ND or NS pump room plus 50 gpm of undefined leakage. The pumps discharge can be aligned to either the WEFT or the FDT. The pumps can be alternated manually to assure equal wear. If and when the WEFT and FDT can no longer receive this pump discharge, water is allowed to flood the ND/NS sump area as described in Section 9.3.3.3.

In the event of a large leak of non-radioactive or slightly radioactive water anywhere in the Auxiliary Building, the WL System tanks fill and overflow, and water will collect in this sump. Up to 500 gpm of water can be discharged with these pumps at runout condition. A seismically designed line has been installed from the ND and NS pump room sump pump discharge header to the Turbine Building sump for the purpose of disposing of large amounts of non-contaminated or slightly contaminated water. The Turbine Building sump can be isolated, if need be, until waste treatment is possible, or can be discharged if it meets station Selected Licensee Commitments.

11.2.2.2.5.7 Auxiliary Feedwater Pump Pit Sump Pumps

Each auxiliary feedwater pump is mounted in a separate pit to meet NPSH requirements, so each pit has a sump and safety-related sump pump of corresponding channel to prevent flooding of the CA pump, assuming a 50 gpm leak. The steam driven CA pump pit has two sump pumps, so one can deliver 50 gpm discharge assuming single failure of the other pump or power supply. These pumps all discharge into the same header as the non-radiation area floor drain sump pumps (identified as C and D), as they do not contain significant radioactivity. The flow passes through the radiation monitor and to the Turbine Building sump unless a high radiation signal diverts the discharge to the floor drain tank or the WEFT via the ND/NS Sump for further processing. Both turbine driven auxiliary feedwater pump sump pumps start on sump high level to assure that during station blackout at least one will function, assuming single failure.

11.2.2.2.6 Filters

All filters are of the disposable cartridge type. All filter bodies are of stainless steel construction. The laundry and hot shower tank secondary filter must retain 98% of 3 micron particles and 100% of 23 micron or larger particles. The following filters are designed to retain 98% of 25 micron particles and 100% of 49 micron or larger particles:

1. Waste evaporator feed filters A and B.
2. Waste evaporator condensate filter.
3. Laundry and hot shower tank primary filters (A and B).
4. Floor drain tank demineralizer post filter.
5. Floor drain tank filters (A and B).

During cartridge replacement of the FDT filter, the second FDT filter may be used with either the LHST or FDT pump to process FDT waste. During LHST primary filter replacement, the second LHST filter may be used with either the LHST or FDT pump to process waste. During LHST secondary filter cartridge replacement, the bypass is opened.

The waste evaporator condensate filter and floor drain tank demineralizer post filter are only used intermittently in conjunction with their respective demineralizer to catch resin fines. If processing cannot be stopped for cartridge replacement, these filters may be temporarily bypassed.

All filters are designed to take a maximum 75 psi drop without bursting or unloading, but in most cases, pump head is not capable of providing this high a pressure. Therefore the filters may be changed out on either high radiation, as measured by a portable probe inserted into the shielded cubicle, or on high pressure drop when the ΔP gage provided for each filter exceeds 25 psid or pump flow rate begins to decrease.

11.2.2.2.7 Strainers

The following strainers, all of which are constructed of stainless steel, are provided in this system:

1. Laundry and hot shower tank strainer.
2. Laundry and hot shower tank pre-strainer.
3. Floor drain tank strainer.
4. Floor drain tank pre-strainers A and B.

The laundry and hot shower tank strainer and the floor drain tank strainer are simplex strainers with 40 mesh screen. Redundancy is provided by alternate process streams exactly as explained for the FDT and LHST filters.

Duplex type pre-strainers are provided at the inlet to the LHST and FDT to prevent debris and particles one-thirty second inch or larger from entering the respective tanks and settling out on the tank bottom. Since inputs to these two tanks cannot be scheduled or easily controlled, duplex strainers are necessary to quickly switch in a clean basket without isolating the flow. The dirty basket is then removed for manual cleaning. Basket area is large compared to inlet and outlet area in order to maximize run time between cleanings.

FDT pre-strainer A serves the floor drains from all elevations 577 ft. and higher, as well as floor drain sump pump discharges to the FDT. FDT Prestrainer B serves only the floor drains from elevation 560 ft., so that drainage from the upper elevations will not back up on the 560 ft. floor.

11.2.2.2.8 Demineralizers

11.2.2.2.8.1 Waste Evaporator Condensate Demineralizer

One mixed bed demineralizer with 30 cubic feet of H^+, OH^- form resin was provided to remove both cations (cobalt, manganese) and anions (chloride, fluoride) from evaporator distillates when it is intended to recycle this to the primary systems. However, the waste evaporator was never put into service at CNS. The demineralizer may be bypassed to conserve its capacity. Liquids from the WEFT, LHST, and FDT may be treated by this demineralizer after evaporation for reuse as reactor makeup water. The waste evaporator condensate demineralizer is normally used only for special cleanup needs.

11.2.2.2.8.2 Floor Drain Tank Primary Demineralizer

One demineralizer holding 50 ft^3 of resin can be used to remove halides and organic chemicals from LHST contents by the process of ion exchange. The liquid leaving this demineralizer should be satisfactory for plant discharge or for processing through the FDT secondary demineralizer and eventually through the waste evaporator if necessary. This should improve the life of the resins in the FDT secondary demineralizer. FDT liquids may also be treated by this method. Its process flow rate of 35 gpm is compatible with all other waste processing equipment in the WL System.

11.2.2.2.8.3 Floor Drain Tank Secondary Demineralizer

One mixed bed demineralizer with 30 cubic feet of H^+, OH^- form resin is provided to remove trace ionic contaminants in the waste evaporator condensate which is to be discharged from the plant. It may be used to remove radioactive cations from either LHST or FDT waste after removal of organics by the demineralizer. It may also be used in a recirculation loop from either waste monitor tank simply to reduce ionic contaminants prior to discharge.

11.2.2.2.9 Loop Seals

Loop seals are provided wherever through line gaseous leakage is unacceptable due to fission product gas containment, deaerated water storage or a maintained pressure differential. The following paragraphs list such applications and explain how each such loop seal design minimizes maintenance.

11.2.2.2.9.1 Tank Loop Seals

Loop seals are provided on all tanks in the WL System which have the possibility of containing entrained fission product gases, noxious fumes, or tanks which contain deaerated water. A water seal is assured by design since the nozzles containing such seals for overflow lines are located near the bottom of the tanks, extend downward for the required height of seal, then upward to the top of the tank or diaphragm flange before tying into the floor drain header. Makeup is not required as liquid in the tank provides the loop seal. Siphon breaker valves are provided at the top of the loop seals to prevent siphon action from emptying the tank's contents once overflow level is reached. The siphon breaker valves also seal against release of any fission product gas bubbling out the loop seal and entrance of air to deaerated water tank loop seals. Incoming lines which are protected by loop seals are kept full of water by incoming flow. These loop seals contain enough water that evaporation will not deplete the seal between usages. Required seal dimensions are given on the flow diagrams.

11.2.2.2.9.2 Annulus Drain Header Loop Seals

After the postulated loss of coolant accident, the annulus is drawn to a negative pressure to assure any gaseous leakage from the containment is filtered before being released. Drains must be provided in this space, however, due to the amount of piping and valves located there. Where this drain header exits into the Auxiliary Building and Upper Head Injection Building, seismic loop seals assure an airtight seal against inleakage. In case normal leakage flow does not keep the seals full, automatic makeup water valves are provided to make up water lost by evaporation. Siphon breaker valves also assure an airtight shutoff but prevent loss of the loop seals when flowing water creates a siphon. Required seal dimensions are given on Figure 11-13 and Figure 11-20.

11.2.2.2.9.3 Containment Ventilation Unit Condensate Drain Header Loop Seal

The containment ventilation units remain operative during a small reactor coolant or steam leak inside the containment, when the internal pressure is elevated from 1 to 3.2 psig (maximum Sp signal set-point per Technical Specifications). Their condensate flow may increase due to increased heat load. A seismic loop seal is provided on this drain line where it exits the Reactor Building to prevent the escape of containment-atmosphere gases to the Auxiliary Building. A siphon breaker valve protects this loop seal. Ice melt each refueling outage ensures the loop seals remain filled as evaporation effects have been found to be negligible. Required seal dimensions are given on Figure 11-12 and 11-19.

11.2.2.2.9.4 Air Handling Filter Train Loop Seals

All air handling filter trains are required to have internal sprinkler systems for fire protection. For filter units which perpetually yield condensate, a continuous drain path must be maintained. The filter trains have negative internal pressure since as a rule they are located upstream of their associated fan. Therefore a loop seal is required on the units with filter drain headers to prevent filter bypass leakage and inleakage from the Auxiliary Building floor drain header. Since there is normally no leakage, loop seal water would eventually be lost by evaporation, so automatic makeup water valves are provided individually on all filter drain headers. These are shown with required seal dimensions on Figures 11-16 and 11-23.

11.2.2.2.9.5 Unit Vent Drain Loop Seal

Rainwater as well as condensation is expected to collect in the plenum at the bottom of the unit vent stack. During normal station operation, however, this plenum is expected to operate at a negative pressure. A drain with automatic makeup water valve is provided, also shown on Figures 11-16 and 11-23.

11.2.2.2.9.6 Various Air Handling Fan-Coil Unit Drain Loop Seals

Condensate from all the air handling unit cooling coils is collected and routed to the "non-radiation area" sumps (floor drain sumps C and D). These units operate at negative pressure since they are on the suction side of the various fans, and are provided with loop seals. It is not essential that these remain full of water, as inleakage is not harmful, so automatic makeup is not provided to these loop seals. These seals are shown on Figure 11-8.

11.2.2.2.10 Miscellaneous Equipment

11.2.2.2.10.1 Waste Evaporator

One 15 gpm evaporator was provided in the Liquid Radwaste System. The waste evaporator has not been placed into service at CNS and has been partially abandoned. See section 9.3.5 for more information regarding evaporator operation as the NB and WL evaporator packages were identical.

11.2.2.2.10.2 Waste Evaporator Condensate Return Unit

The condensate return unit collects condensed steam from the waste evaporator feed preheater and evaporator at atmospheric pressure and returns the condensate to the condensate system. The unit consists of a 100 gallon receiver, two 25 gpm pumps, valves, piping, instrumentation, and automatic controls.

11.2.2.3 Electrical Power Requirements

Most electrically powered equipment in the Liquid Radwaste System is supplied from plant non-vital buses, as it is not required to be operated under emergency conditions. Only the ND and NS pump room sump pumps and auxiliary feedwater pump sump pumps are supplied with emergency diesel power to prevent the flooding of safety-related components.

11.2.2.4 Water Chemistry

The waste evaporator distillate water chemistry for water suitable for recycling should be equivalent to makeup demineralized water chemistry. See Table 11-7 for water quality requirements.

The waste evaporator feed boron concentration should range between 10 and 2500 ppm as dilute boric acid. The waste evaporator bottoms boron concentration should range between 7,000 and 21,000 ppm as dilute boric acid.

11.2.2.5 Thermal Insulation and Heat Tracing

11.2.2.5.1 Thermal Insulation

Thermal insulation is provided on certain valves, piping, and equipment in the system for personnel protection, to prevent heat losses and for heat tracing.

All equipment and piping containing concentrated boric acid, and waste evaporator components using process steam, are insulated where necessary. The materials used are compatible with stainless steel piping and equipment.

11.2.2.5.2 Heat Tracing

Electrical heat tracing is installed under the insulation of the components, lines, and valves containing boric acid solution concentrated to more than 7000 ppm. The heat tracing maintains fluid temperature above that of boric acid crystallization.

Heat tracing is normally only installed on lines containing waste evaporator concentrates, i.e. from the discharge of the waste evaporator concentrates pump to the waste evaporator concentrates tank on to the radwaste batching tank for solidification. However, since the evaporator has not been placed into service, the heat tracing in these lines has been de-energized. These components are described in Section 11.4.2.1.

Heat tracing is thermostatically controlled to maintain adequate temperature in the lines containing concentrated boric acid. Redundancy is provided by having two channels of heat tracing wire with the backup channel set to cut in if the primary channel does not maintain setpoint temperature. Heat tracing is contained in stainless steel sheathing for protection from pipe leakage.

11.2.2.6 System Instrumentation and Control

There are two local control panels provided for WL System instrumentation and control. The waste processing panel supplied by Westinghouse contains those controls necessary for the basic Westinghouse portion of the WL system. The auxiliary waste processing panel contains controls for all the redundant pumps, filters, and other Duke modifications and improvements upon the design. Any alarm originating on either of these two panels is relayed to the common annunciator on the station main control board. Design basis pressure and temperature for each piece of instrumentation is given on Figure 11-1 through Figure 11-24 and Figure 11-37 through 11-39. Design basis flow rate is also given for flow instrumentation, where applicable.

The Liquid Radwaste System is operated manually except for some functions of the reactor coolant drain tank subsystem, the floor drain tank subsystem, and the WL System discharge automatic control valve as described below. The system includes adequate control equipment to protect the system components and instrumentation and alarm functions to provide operator information and insure proper system operation. All sumps have level instrumentation to start the sump pumps on high level and alarm on hi-hi level. All tanks in the system have high level alarms; and once the pumps are manually or automatically started for processing, they have interlocks to shut off on tank low level.

All filters, heat exchangers, and demineralizers have pressure drop indication to indicate fouling, and all pumps have discharge pressure indication.

11.2.2.6.1 Reactor Coolant Drain Tank Automatic Level and Flow Controls.

Reactor Coolant Drain Tank Level (1WLLT5630)

This instrumentation provides main control board indication of RCDT level, as well as high and low level alarms. The position of valve 1WL802 is controlled by signals from this channel, to maintain level in the RCDT within a specified band with one RCDT pump continuously operating. Should tank level fall below a predetermined value a signal from this level instrumentation will automatically stop any operating RCDT pump.

Reactor Coolant Drain Tank Pump Discharge Flow (1WLFE5670)

This instrument indicates the total RCDT pump flow and is located on the Main Control Board. A low-flow signal from this instrument will automatically stop any operating RCDT pump.

Reactor Coolant Drain Tank Recirculation Flow (1WLFE5730)

This instrument indicates the recirculation flow to the RCDT from the RCDT heat exchanger and is located on the main control board. A low-flow alarm is also provided to alert the operator that recirculation flow has been lost.

11.2.2.6.2 WL System Discharge Automatic Control Valve

WL System Discharge Flow (0WLFE6160)

This instrumentation indicates the flow rate being discharged from any of the following tanks to the Low Pressure Service Water System discharge line for dilution: Waste Monitor Tank A or B, or Recycle Monitor Tank A or B, Ventilation Unit Condensate Drain Tank 1 or 2.

This flow instrumentation also serves to modulate automatic control valve 1WL124 to control the discharge rate to a predetermined value as calculated by the station operator, based on isotopic and/or chemical concentration and dilution flow available. This controller is located in the main control room, and also integrates total volume discharged.

Liquid Radwaste Discharge Monitor (EMF49)

This instrumentation is designed to monitor the radioactivity of all liquids discharged from the WL System originating from tanks in the Auxiliary Building. The monitor alarms on a high radiation setpoint based on the most limiting nuclide and 10 times EC of 10CFR20, App. B. limit for the release. High radiation alarm is interlocked to terminate discharge by automatically closing valve 1WL124.

11.2.2.7 System Operation

11.2.2.7.1 Normal Operation

Operation of the system 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, contingency, or accident conditions. The system is not regarded as an engineered safety features system, however, the ND and NS pump room sump pump, and the CA pump pit sump pumps are supplied with emergency diesel power to prevent flood damage to safety equipment. Portions of equipment drain piping and certain loop seals are also safety related as required by ANSI N18.2 and succeeding revisions.

11.2.2.7.1.1 Reactor Coolant Drain Tank Subsystem Operation

Normal operation of the reactor coolant drain tank subsystem is automatic, and requires no operator action. The system can be put in the manual mode if desired. The leakage rate into the tank can be estimated by putting the system in the manual mode, stopping the pump, and watching the rate of level change. The venting system is automatic but the hydrogen or nitrogen bottle must be replaced when its pressure drops to approximately 100 psi.

If the temperature in the pressurizer relief tank rises above 120°F due to the actuation of the pressurizer safety valves or the power operated relief valves, the water in the tank can be cooled by using the reactor coolant drain tank heat exchanger. During this operation, the reactor coolant drain tank is isolated and the normal operation of this subsystem is temporarily suspended. After the PRT temperature has been reduced, the normal operation of the subsystem can be reinitiated.

During refueling, the reactor coolant drain tank pumps can be used for the following functions:

1. Drain the loops of the Reactor Coolant System to the recycle holdup tanks.
2. Recirculate and empty refueling canal water through the Spent Fuel Cooling System demineralizer and filters by using connections in the Refueling Water System.
3. Recirculate and empty refueling canal water through the Boron Recycle System demineralizers and filters by using connections in the Refueling Water System.

During refueling operations when nearly all systems in the Reactor Building are aerated, the contents of the reactor coolant drain tank are pumped to the waste evaporator feed tank.

11.2.2.7.1.2 Waste Drain Tank Subsystem Operation

The waste drain tank collects deaerated recyclable liquids with entrained fission product gases that are drained in the Auxiliary Building. The only systems that contain these liquids are the Boron Recycle System, and the Chemical and Volume Control System. The sources of these liquids are appropriate valve leakoffs and equipment drains.

The liquids from this tank are normally processed in the recycle evaporator package and all entrained gases are collected in the waste gas decay tanks. For this reason, special care is taken to exclude nitrogen from the liquid collected in this tank. The procedure to drain equipment in the systems listed above in order to exclude nitrogen from the liquids in this tank is as follows:

1. Close all equipment isolation valves.
2. Open the flush line from the reactor makeup water storage pumps.
3. Open the line to the waste drain tank and leave open until liquids with entrained fission product gases have been flushed from the tank.
4. Close the line to the waste drain tank.
5. Close the flush line from the reactor makeup storage pumps.

6. Open the equipment vent line.
7. Open the equipment drain line to the waste evaporator feed tank.

This procedure insures that no nitrogen gases enter the waste gas decay tank and that no fission product gases are released to the environment. In many instances, system maintenance occurs during refueling when systems are often aerated after circulating aerated reactor coolant. In these cases, equipment is drained directly to the waste evaporator feed tank and the above procedure is not used.

Once the WDT is filled, the contents of the tank are sampled to insure that they are satisfactory for recycling. If the contents are suitable for recycling, they are pumped to one of the recycle holdup tanks for evaporation. If the contents are not satisfactory for recycling, they are pumped to the waste evaporator feed tank for further processing. Liquids not satisfactory for processing through the recycle evaporator package include those that have become aerated.

Because hydrogen is dissolved in the reactor coolant, a portion can be expected to come out of solution along with some fission product gases in the waste drain tank under the diaphragm. After the waste drain tank has been filled and emptied twice (10,000 gal.), the hydrogen and fission product gases under the diaphragm are vented to the Waste Gas System. The waste drain tank is also vented before and after it is used to hold aerated liquids from any source.

11.2.2.7.1.3 Waste Evaporator Feed Tank Subsystem Operation

Water is accumulated in the waste evaporator feed tank until sufficient quantity exists to warrant processing.

11.2.2.7.1.4 Laundry and Hot Shower Subsystem Operation

Laundry and hot shower water flows through the laundry and hot shower tank pre-strainer and enters the laundry and hot shower tank for holdup. The laundry and hot shower tank strainer, the laundry and hot shower primary filters (A and B), the laundry and hot shower tank secondary-filter, the FDT post filter, and the FDT primary demineralizer are available to process the liquid from the laundry and hot shower tank if required to prevent the release of soapy liquids from the plant. If radioactivity dictates that further processing is required, the floor drain tank demineralizer can be used. Water from the waste monitor tank is discharged into the low pressure service water discharge via the Nuclear Service Water System at a rate determined by the dilution flowrate available versus radioactivity of the contents.

The contents of WMT A should be recirculated twice to assure a uniform mixture which will give a reliable sample prior to discharge.

11.2.2.7.1.5 Floor Drain Tank Subsystem Operation

The water in the floor drain tank can be sampled to determine the degree of processing required. Normally the contents of the floor drain tank are sent to the SGDT for processing in the MTB. If activity levels allow, the contents of the floor drain tank can also be returned to a Waste Monitor Tank for recirculation, sampling, and discharge into the low pressure service water discharge via the Nuclear Service Water System at a rate determined by the dilution flowrate available.

Upon accumulation of a predetermined volume of waste in the FDT, valves can be aligned for recirculation and the FDT Pump started. A sample can be taken to gain a rough estimate of activity and concentrations of contaminants such as nitrites, glycol, boron, iron, detergents, and decon chemicals. The rough sample results indicate the type of treatment needed according to the level of contamination as well as identify the source in the event of unusual leakage. The waste is normally transferred to the SGDT via the WEFT for processing in the MTB.

Inputs to the FDT can be isolated, but such an option would result in drain and sump backup in the Reactor and Auxiliary Buildings. For this reason, unobstructed, continuous sump operation is essential to uninhibited plant operation and waste processing, and will be carefully monitored. See Section 11.2.2.7.2.3 for discussion of Auxiliary Building flooding.

11.2.2.7.1.6 Mixing and Settling Tank Subsystem Operation

Although rarely done, the contents of the floor drain tank, the laundry and hot shower tank, and the waste evaporator feed tank can be further processed by using the mixing and settling tank. MST operations are done strictly by batch. The MST metering pump can be set to deliver a given amount of reagent, then stop. Of course it delivers reagents at a metered rate so that its operation can be monitored and it can be manually stopped when a precipitate forms.

Drains from the ultrasonic cleaning tanks are piped to the mixing and settling tank to keep the acidic chemicals in this waste segregated from the WEFT or FDT. This waste can be neutralized by adding other decon solution or agents via the MST metering pump. A precipitate is formed, leaving clear water as the supernatant. The clear water is then pumped via the MST Pump to the WEFT. This pump stops automatically on low level. The precipitate is then pumped to the radwaste batching tank in the Solid Radwaste System via the MST sludge pump, which must be stopped manually.

It is practical to consider making a specialty chemical for decontamination purposes in the mixing and settling tank and piping it by temporary piping to the required area. After use, the chemical can then be collected in the laundry and hot shower tank, waste evaporator feed tank or the floor drain tank. The chemical can then be passed through the mixing and settling tank for further processing before being drummed, discharged or recycled. The mixing and settling tank can be thought of as a tank that provides a contingency capability for the plant's miscellaneous chemical processing requirements.

11.2.2.7.1.7 Ventilation Unit Condensate Drain Tank Subsystem Operation

It has been calculated that while purging the containment on a summer day, the condensate from the containment vent units will amount to 700 gallons per hour of water. This water will be routed from drip pans through loop seals to a common header and through a containment penetration which isolates on Safety Injection.

The condensate then goes through a loop seal and into the 5000 gallon VUCDT. A high level signal will automatically start one of the two VUCDT pumps. A mechanical alternator assures equal pump wear. Since the condensate is expected to be radioactive, it is normally aligned to either of the recycle monitor tanks through air-operated valve 1WL874 (2WL874) and isolation valve 1WLE11 (2WLE11). The radiation activity level will be evaluated while in the RMTs. If the level is suitable for discharge, the RMT pumps will be used to discharge the tank's contents through the WL system's discharge monitor (EMF49) and control valve 1WL124. If the activity level is too high to discharge, the RMTs' contents will be transferred to the floor drain tank (FDT) subsystem for further processing. While the VUCDT inlet valve is isolated, the ventilation unit drip pan overflows are routed to the WEFT or the FDT via the Containment Floor and Equipment Sump Pumps.

Blind flanges are provided on the SGD pump discharge line and on each steam generator drain line to accomplish these transfers with temporary fire hoses rather than extensive permanent piping and valves. If a steam generator contains water within acceptable limits for secondary chemistry the contents of that steam generator may be pumped via the steam generator drain pump to the condensate storage tank located in the Turbine Building.

[Note: The above description is retained for historical purposes. It describes subsystem functions that are not anticipated to be used again. If desired, this subsystem is available for post-steam generator tube rupture long-term recovery water management.]

11.2.2.7.1.8 Steam Generator Drain Tank Subsystem Operation

Two 50,000 gallon tanks have been provided to collect radioactive drain and flush water resulting from maintenance on a leaking steam generator. The first tank will receive the radioactive contents and first rinse, while the second tank will receive only flush water, which can probably be sampled and released. The steam generator drain pump, located inside the containment has permanently installed suction lines from the low point on each steam generator blowdown line and a discharge line penetrating the containment to deliver 200 gpm to either SGDT. Inside the containement, blind flanges are provided downstream of the Unit 1 SGD pump for the installation of a temporary fire hose to complete the connection necessary to pump to the steam generator drain tanks. The pump can also be used to transfer each steam generator's contents to another, successively, for steam generator inspections without wasting makeup water and valuable chemicals. An interconnection to the condensate storage tank is provided for reclaiming non-radioactive steam generator contents.

[Note: The above description is retained for historical purposes. It describes subsystem functions that are not anticipated to be used again. If desired, this subsystem is available for post-steam generator tube rupture long-term recovery water management.]

Each SGDT has independent recirculation and sampling interconnections to the WEFT subsystem. The contents of SGDT A can be recirculated and sampled while the contents of SGDT B are being recirculated and sampled. Valve interlocks are provided such that the SGDT being processed cannot also be accidentally discharged to the environment.

The SGDT subsystem also serves to prolong station operation with the NB System evaporator out of service. The contents of the recycle holdup tanks, floor drain tank, laundry and hot shower tank, and waste evaporator feed tank can be pumped out to the SGDT for emergency holdup or processing. Shielding is adequate for reactor coolant activity contents. This function means that should a surge occur in any WL System, including those subsystems not normally radioactive, the SGDT can be utilized for storage, recirculation and sampling, and processing or release. Water containing detergents and sediment can be prevented from contaminating the SGDT by routing the contents of the above-mentioned tanks via their respective filter trains.

A SGDT is normally transferred via the SGDT pumps to the MTB for processing. After demineralization, the processed water is contained in the auxiliary monitor tanks prior to sampling and release.

11.2.2.7.2 Faults of Moderate Frequency

11.2.2.7.2.1 Malfunction in the Liquid Radwaste System

Malfunction in this system could include such things as pump or valve failures. Because of pump redundancy and standardization throughout the system, the backup pump can be started and spare pumps kept in stock can be used to replace most pumps in the system. There is sufficient surge capacity in the system to accommodate waste until repairs can be effected and normal plant operation resumed.

Should any normally non-radioactive sump or tank contain liquid with radioactivity above monitor setpoint, the radiation monitors provided will either terminate its discharge or divert to another normally radioactive tank for proper treatment. In addition, there may be situations whereby the water from clean area sumps may be valved to continue flow to TBS.

11.2.2.7.2.2 Excessive Leakage in Reactor Building Equipment

The system is designed to handle a l gpm reactor coolant leak in addition to the expected leakage during normal operation. Operation of the system is almost the same as for normal operation except the load on the system is increased. A l gpm leak into the reactor coolant drain tank is handled automatically but will increase the load factor of the recycle evaporator. If the l gpm leak enters the WEFT, operation is the same as normal except for the increased load on the system. If a 1 gpm leak enters the floor drain tank via the containment floor and equipment sumps, the system will be operated the same as for a 1 gpm leak into the waste evaporator feed tank. If excessive leakage cannot be processed immediately and the WEFT and FDT become full, they may be pumped out to a SGDT.

The containment floor and equipment sumps input to a plant computer program designed to detect one gpm of unidentified leakage inside containment in less than one hour as required by NRC Regulatory Guide 1.45. Since all reactor coolant pump seal leakoffs as well as other normally discharging fluids are routed to the RCDT, all liquid entering the floor sumps during station normal operation is unidentified leakage. In conjunction with the operator aid computer, containment floor and equipment sump level instrumentation monitors water level between the low and high setpoints and calculates rate of change, which is converted to a volume input rate. These values for both sumps are totaled and yield a computer alarm if the sum is greater than 1 gpm. Also, the computer provides gross leakage alarms based on the duration of high and high-high level signals from the sump level instruments. These arrangements will detect unidentified leakage in excess of 1 gpm within an hour.

Incore instrumentation room sump pump is located under the reactor in the tunnel area where no leakage is expected. Therefore, an alarm is initiated should this pump ever start.

The quantity and activity of VUCDT contents will also be an indicator of excessive reactor coolant leakage, as this condensate is normally clean, noncontaminated water. A sudden increase in the flow rate of ventilation condensate is an indicator of increased relative humidity in the containment. Such an increase of clean condensate in the absence of containment purge is unusual and is an indicator of leakage from a non-radioactive system, probably a steam leak. Increased radioactivity of ventilation condensate simultaneous with increased flow probably signals a reactor coolant leak. The VUCDT alarms on high level.

11.2.2.7.2.3 Excessive Leakage in Auxiliary Building Equipment

Excessive leakage from components and flanges in the Auxiliary Building enters the floor drain tank subsystem (see Section 11.2.2.1.5) or the ND/NS sumps (see Section 9.3.3.3). Leakage in "radiation areas" flows directly to the FDT or indirectly to the FDT via floor drain sumps pumps A and B. The FDT overflows to the WEFT sumps, which pump to the WEFT, which overflows to the floor drain sumps, by which time the leaking component should be isolated. Sump pump and tank status help the operator detect the location of the leaking component and magnitude of the leakage. The ND/NS sump area is allowed to flood until the leak source can be isolated and the sump contents transferred to the FDT, WEFT, and/or the SGDT's (see Section 9.3.3.3).

Leakage in "non-radiation areas" flows to floor drain sumps C and D which automatically start on high level and discharge through a radiation monitor to the Turbine Building sump. If the leakage contains radioactivity at the monitor setpoint, air operated valves divert the flow to the

FDT via the ND and NS sump. Sump pump status helps the operator detect the location and magnitude of the leakage. (See 11.2.2.1.4)

Pipe trenches entering the Auxiliary Building are designed to prevent externally-caused flooding from entering the Auxiliary Building, as in the case of earthquake. Seismically designed piping and isolation valves serve to isolate drains and non-safety class lines and prevent them from becoming a leak path into the Auxiliary Building after such an earthquake.

Refer to Section 3.4.1 for a discussion of the safe water-holding capacities of various areas inside the Auxiliary Building.

11.2.2.7.3 Station Blackout

The system will not normally operate during a blackout. Only the containment spray and residual heat removal pump room sump pumps and auxiliary feedwater pump pit sump pumps are supplied with diesel power; these pump any leakage to the floor drain tank and the Turbine Building sump, respectively. A radiation monitor, powered from the battery backed 120 VAC Auxiliary Control Power System, is provided to divert the auxiliary feedwater pump pit sump pump discharge to the floor drain tank on high radioactivity.

11.2.2.7.4 Loss of Coolant Accident

The system need not operate during, or immediately following, a loss-of-coolant accident. As in the case for a station blackout, equipment may be started manually as required when electrical power is available. As above, the containment spray and residual heat removal pump room sump pumps and auxiliary feedwater pump pit sump pumps are provided with emergency diesel power to protect their respective safety related components from flooding.

To preclude inadvertently pumping liquid radwaste outside Containment following a LOCA, discharge isolation valves WL825A and WL827B (Figure 11-15 and Figure 11-22), are automatically closed and Containment Floor and Equipment Sump Pumps and Incore Instrumentation Sump Pumps trip on the following signals: high radiation detected by one of two redundant area radiation monitors inside Containment or a high Containment pressure signal (1.2 psig). As a backup to these measures, should radwaste be inadvertently pumped to the Auxiliary Building, the capability exists to pump radwaste into Containment via the WL System sump pumps.

11.2.3 Estimated Radioactive Releases

Section 11.2.3, and its associated figures and tables such as Tables 11-11 and 11-12, include the bases and results of an analysis of estimated radioactive releases in liquid effluents and estimated doses from such releases. Unless specifically indicated otherwise, this is a prospective analysis performed prior to initial system operation, based upon estimates, and yielding expected results. A corresponding retrospective analysis is performed annually, based upon routinely updated information contained in the Offsite Dose Calculation Manual (ODCM) and the Annual Radiological Environmental Operating Report, and yielding actual results which are reported in the annual Radioactive Effluent Release Report. Both of these annual reports, and all changes to the ODCM, are submitted to the NRC as required.

HISTORICAL INFORMATION IN ITALICS BELOW NOT REQUIRED TO BE REVISED.

The estimated quantity of radioactivity released in liquid effluents from each unit during normal operation, including anticipated operational occurrences, is shown in Table 11-11.

The methodology of NUREG-0017 (Reference 1) was used in determining liquid radioactive releases. In addition, the following assumptions were made:

1. *The volumes of liquid and the fraction of reactor coolant activity input to each subsystem of the Liquid Waste System are as delineated in Table 11-9.*
2. *Shim bleed, when averaged over the year, occurs at a rate of 1000 gpd. The shim bleed stream flows to the recycle holdup tank through the recycle evaporator feed demineralizer which has a DF of 2 for cesium and rubidium and a DF of 100 for other isotopes.*
3. *The reactor coolant drain tank is pumped to the recycle holdup tank through the recycle evaporator feed demineralizer.*
4. *Valve stem leakoffs flow directly to the recycle holdup tank at a rate of gpd and at approximately reactor coolant concentration.*
5. *Based on the above values, the recycle holdup tank has collection time of 29.17 days, assuming 40% capacity. Recycle holdup tank discharge is to the reactor makeup water storage tank through the boron recycle evaporator and evaporator condensate demineralizer, which have a collective DF of 10E3 for iodines and 10E3 for other isotopes. Process time is 4.15 days. Ten percent (≈180,000 gal.) of the boron recycle input is assumed to be released to the environment. This value is considered conservative enough to include any deliberate discharges for tritium control.*
6. *Waste collected by the waste evaporator feed tank is transferred via the SGDTs to the MTB for processing and release. Collection time is 2.1 days assuming 40% capacity of the waste evaporator feed tank. One hundred percent of the stream is released to the environment.*
7. *Floor drain tank contents can be sampled, then processed through the floor drain tank strainer and filter. The contents of the FDT are normally transferred to the MTB via the WEFT and SGDTs for processing and release. One hundred percent of the steam is released to the environment. This is discussed in Section 11.2.2.7.1.5.*
8. *Laundry and hot shower tank contents may be discharged through the waste monitor tank demineralizer, as required. However, since use of the demineralizer is not continuous, no credit for reduction of laundry waste activity is taken.*
9. *Blowdown occurs at a rate of 280 gpm through the steam generator blowdown tank, where liquids are directed upstream of the condensate polishing demineralizers and gases are vented to the "D" heaters. There is no release of wastes from the blowdown system.*

11.2.3.1 Release Points

All routine discharges of detectable radioactivity from WL System are through the Low Pressure Service Water System into Lake Wylie. In addition, very low levels of radioactivity are released through WC System into Lake Wylie. The location of the discharge can be seen on Figure 2-4.

11.2.3.2 Dilution Factors

Low pressure service water will provide dilution for liquid wastes with a flow that will vary depending, among other things, on the station power output and Lake Wylie water temperatures. For the purpose of dose evaluations, an average dilution with 54,000 gpm is assumed. Estimates of near-field and far-field dilution are discussed in Chapter 5 of the Catawba ER-OLS.

The rate of radioactive discharges will be based on the available dilution and the concentrations of 10CFR 20, Appendix B, Table 2.

11.2.3.3 Estimated Doses

The doses received by individuals as a result of radioactive liquid releases are presented in Table 11-12 and compared with the corresponding limits of 10CFR 50, Appendix I. The equations in Regulatory Guide 1.109 were implemented in the calculations. In addition, it has been assumed that

1. *Fishing and shoreline activities for the maximum exposed individual occur in the immediate vicinity of the Low Pressure Service Water discharge. No additional dilution is considered.*
2. *Drinking water for the maximum exposed individual is taken from the Rock Hill municipal water supply.*
3. *For population dose estimates, the population within 50 miles of the station is grouped into age brackets as follows, based on the year 2000 projections: 0-12 years, 17%; 12-18 years, 11%; over 18 years, 72%.*
4. *Location of downstream riverbank wells are shown in ER-OLS Figure 2.1.3-6 and populations served in ER-OLS Table 2.1.3-7.*
5. *Location of downstream municipal water intakes are shown in ER-OLS Figure 2.1.3-4 and populations served in ER-OLS Table 2.1.3-5.*
6. *Approximately 4000 acres of Lake Wylie, 3370 acres of Fishing Creek Lake, and approximately 10,500 acres of Wateree Lake are within a 50 mile radius of the station and affected by liquid radioactive discharges. Estimates of the sport fish harvest in these areas is 35,000 kg/yr, 30,000 kg/yr and 120,000 kg/yr, respectively, assuming an average mass of 0.37 kg/fish.*
7. *Swimming, boating, and shoreline usages are 674,000 hrs./yr, 338,000 hrs/yr, and 151,000 hrs/yr, respectively, in the areas of Lake Wylie affected by radioactive discharges, 512,000 hrs/yr, 256,000 hrs/yr, and 115,000 hrs/yr for Fishing Creek and 2,840,000 hrs/yr, 1,420,000 and 635,000 for Wateree Lake.*

11.2.4 References

1. Calculation of Releases of Radioactive Materials in Gaseous and Liquid Effluents from Pressurized Water Reactors (PWR-GALE code), USNRC report *NUREG-0017*, April, 1976.
2. Fletcher, J.F., and Dotson, W.L. (compilers), "HERMES - A Digital Computer Code for Estimating Regional Effects from the Nuclear Power Industry," USAEC Report HEDL-TME-71-168, Hanford Engineering Development Laboratory, 1971.

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11.3 Waste Gas System

This section describes the design and operating features of the Waste Gas System. The purpose of the Waste Gas System is to remove fission product gases from radioactive fluids. Decay tanks are provided to contain these gases for a relatively long period of time. Also, the system is designed to reduce the fission product gas concentration in the reactor coolant, which will minimize the escape of radioactive gases during maintenance operations or from equipment leaks.

11.3.1 Design Bases

The principal design objectives and design criteria of the Waste Gas System are:

1. To protect the plant personnel, the general public, and the environment by insuring that gaseous releases of potentially radioactive materials both in-plant and to the environment are in accordance with 10CFR 20 (assuming operation at design basis fuel leakage), and are as low as is reasonably achievable in accordance with 10CFR 50.

   Applications for construction permits for these nuclear units were filed on or after January 2, 1971, and prior to June 4, 1976. Therefore the numerical design objectives for plant releases during normal operation, including anticipated operational occurrences, from each unit, will conform to the Annex to Appendix I of 10CFR 50, i.e.

   a. The calculated annual external dose from gaseous effluents to any individual in an unrestricted area will not exceed 5 mrem to the total body, or 15 mrem to the skin, and

   b. The calculated annual dose or dose commitment for any individual in an unrestricted area from all pathways of exposure will not exceed 15 mrem to any organ.

      Analysis of normal releases from the Waste Gas System and associated doses to individuals are supplied in Section 11.3.3.

2. To provide a waste gas system with the capabilities to handle startups, shutdowns, purging of containment, back-to-back refueling, and equipment downtime. These capabilities are given in Section 11.3.2.5. Component design parameters are shown in Table 11-13.

3. To provide a means for collecting, storing, sampling, and monitoring potentially radioactive gaseous wastes from the two nuclear units during plant operation, in accordance with 10CFR 50 - Appendix A, Criterion 60 - 64.

   Seismic design criteria and analytical procedures for equipment support elements and structures housing the gaseous waste treatment system are given in Chapter 3. Design codes, seismic design and ANS safety classes for components and piping are given in Chapter 3.

4. To provide design features that reduce maintenance, equipment downtime, leakage, and gaseous releases of radioactive material to the building atmosphere or to facilitate cleaning or otherwise improve radwaste operations.

5. To incorporate provisions that will control the release of radioactive materials in gaseous effluents as the result of equipment malfunction or operator error. Waste Gas Discharge control from the waste gas tank is described in Section 11.3.2. Process and effluent radiological monitoring systems are described in Section 11.5.

6. To provide a plant ventilation system to protect the plant personnel, the general public, and the environment in accordance with 10CFR 20 and 10CFR 50. The plant ventilation system is described in Section 11.3.2.6.
7. To provide instrumentation and alarms to preclude the buildup of an explosive mixture. Instrumentation and control for the Waste Gas System are given in Section 11.3.2.4.

11.3.2 System Description

11.3.2.1 System Design

The Waste Gas System is a closed loop comprised of two waste gas compressors, two catalytic hydrogen recombiners, six (6) gas decay tanks for normal power service and two gas decay tanks for service at shutdown and startup. The system is shared between Catawba 1 & 2. All of the system equipment is located in the Auxiliary Building.

Piping and instrumentation diagrams which indicate system interconnections and seismic and quality group interfaces for the Waste Gas System are given on Figure 11-25 through Figure 11-28.

The Waste Gas System transfers, receives, processes, and contains the following radioactive gases: mixed fission/hydrogen gas purge from the volume control tank prior to cold shutdown, waste gases from the recycle and waste evaporators, gases from the degasification of the reactor coolant in the reactor coolant drain tanks, and gases vented from under the diaphram of the recycle holdup tanks and waste drain tank.

The Waste Gas System has the capacity to process gaseous wastes during periods when major processing equipment may be down for maintenance (single failure) and during periods of excessive waste generation.

11.3.2.2 Component Design

The Waste Gas System equipment parameters are given in Table 11-13. Quality assurance requirements for all components within Westinghouse scope are in accordance with Westinghouse Administrative Specifications for the Procurement of Nuclear Steam Supply System Components.

11.3.2.2.1 Waste Gas Compressors

The two waste gas compressors are provided for continuous removal of gases discharged to the vent header. They are also provided to maintain continuous circulation of nitrogen around the waste gas loop. Hydrogen and fission gases, which make up the volume control tank purge stream, mix with the circulating nitrogen stream at the compressor suction. The compressor pumps this mixture through the recombiner where hydrogen is removed, and then through one of the gas decay tanks to complete the loop.

The units are water-sealed centrifugal displacement compressors which are skid-mounted as a self-contained package. Each is constructed primarily of stainless steel. A mechanical shaft seal is provided to minimize leakage and the normal moisture separator water level is maintained so as to keep the shaft immersed at all times.

11.3.2.2.2 Recombiners

Two catalytic hydrogen recombiners are provided. One of the two recombiners is normally used to remove hydrogen from the hydrogen-nitrogen-fission product gas mixtures by oxidation to water vapor. Condensation removes the water vapor as it is produced.

The other recombiner is available on a standby basis. Both units are selfcontained and designed for continuous operation.

Design parameters for the catalytic recombiner are established to a large extent by limitations imposed by other components in the system. The control system is designed with careful consideration for the potential hazards involved in processing a gas mixture containing hydrogen and oxygen contaminated with radioactive fission gases.

To preclude the possibility of an explosion in the waste gas system, the oxygen feed valve to the recombiner is automatically closed if the hydrogen content of the inlet gas rises to 9 volume percent, or if the oxygen content of the outlet stream rises to the high-high alarm setpoint. The oxygen supply flow rate is automatically restricted if the oxygen content of the feed stream reaches 3 volume percent.

The recombiner is operated slightly lean on oxygen to insure virtually complete reaction of all oxygen in the reactor feed stream. If the outlet concentration of hydrogen reaches the high alarm setpoint, an alarm is annunciated to alert the operator in sufficient time to allow him to isolate the operating recombiner train and to switch to the alternate train.

11.3.2.2.3 Waste Gas Decay Tanks

Fission gases accumulated in the system are distributed in the six normal power service gas decay tanks to limit the site boundary dose in the event of tank rupture. One shutdown/startup gas decay tank will normally contain nitrogen from the initial station cold shutdown, ready to be reused during subsequent cold shutdown procedures. The other shutdown/startup gas decay tank will normally be at low pressure, and thus ready to accept relief valve discharges from the Waste Gas System.

The eight gas decay tanks are vertical cylindrical with a volume of 600 ft^3 each.

11.3.2.2.4 Valves

All control valves are provided with bellows seals to minimize outleakage of radioactive gases through the valve topworks, except those in the recombiner package which are provided with leakoffs to return any process gas into the system.

Relief valves are used on the gas decay tanks. During normal operation, the six gas decay tanks are designed to contain significantly higher concentrations of fission gases than the two tanks used during startup/shutdown. Therefore, relief discharge from normal operation tanks are piped to shutdown tanks. Design discharge pressure is 150 psig into a shutdown tank with a constant backpressure of 0-15 psig. Developed back pressure may reach 100 psig, the set pressure for shutdown tank relief valves. By cascading the more concentrated gases into the shutdown tanks, direct release of highly concentrated fission gases is virtually eliminated. Furthermore, since the relief valve set pressure is 150 psig, 50 psi higher than any pressure source to the system, it is unlikely that any release will occur. Bellows are provided to eliminate leakage through the relief valve topworks. Seat leakage is minimized by using soft-seated valves at set pressures 50 psi above the maximum source pressure available to the system. These valves are constructed with carbon steel bodies, and are designed to relieve full flow from both waste gas compressors (100 scfm).

Manual and air operated packless valves are used throughout the Waste Gas System to maintain leakage from the system at the lowest practicable level. For low temperatures, low pressure service, Saunders type diaphragm valves are used on skid mounted equipment. All other valves in this service are packless plug valves. This application includes all parts of the system except the recombiners. Because of the high temperature that exist in the recombiner, Kerotest type valves are used. These valves are globe type with a metal diaphragm seal in the stem. There is no measurable stem leakage from any of these valves.

11.3.2.2.5 Piping

The piping of the Waste Gas System is carbon and stainless steel; all piping joints are welded except where flanged connections are necessary for maintenance.

11.3.2.3 Instrumentation Design

The main system instrumentation is described in Section 11.3.2.4 and shown on Figure 11-25 through Figure 11-29.

The instrumentation readout is located mainly on the Waste Gas System (WG) panel in the Auxiliary Building. Some instruments are read at the equipment location.

All alarms are shown separately on the WG panel and further relayed to one common WG annunicator on the main control board.

The catalytic recombiner system is designed for automatic operation with a minimum of operator attention. Each package includes four on-line gas analyzers which are the primary means of recombiner control. A multipoint temperature recorder monitors temperatures at several locations in the recombiner packages.

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

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

11.3.2.4 System Instrumentation and Control

11.3.2.4.1 Volume Control Tank Purge Flow Control

The volume control tanks purge lines into the Waste Gas System are equipped with trip valves 1WG3 and 1WG14; pressure reducing valves 1WG4 and 1WG15; and hand operated flow control valves 1WG5 and 1WG16. This arrangement will maintain a constant purge flow as selected by the operator.

Pressure fluctuations caused by changes in the volume control tank water level are absorbed by the pressure regulating valves 1WG4 and 1WG15 which maintain a constant 13 psig downstream pressure. This provides a constant head loss across hand operated control valves 1WG5 and 1WG16. Design flow is 0.7 scfm hydrogen, with a range of 0.3 scfm to 1.2 scfm. When mixed with the 40 scfm nitrogen stream, the maximum hydrogen content in the recombiner feed is 3.0 volume percent.

Purge line trip valves 1WG3 and 1WG14 prevent depressurizing the volume control tank on loss of hydrogen supply pressure to the tank. These valves trip closed on a low pressure signal from the tank pressure control. Reset from trip is performed manually by re-opening the valve at the waste processing system control panel.

11.3.2.4.2 Waste Gas Discharge Control

The waste gas discharge control consists of pressure reducing valve 1WG159 and hand operated flow control valve 1WG160. This arrangement will maintain a constant discharge flow as established by the operator. As the pressure decreases in the gas decay tank, the pressure reducing valves open to maintain a constant downstream pressure of 15 psig. This provides a constant head loss across the hand operated flow control valve 1WG160.

Control valve 1WG160 is provided with a pressure switch and a manual loader, both located on the Waste Gas System control panel. The valve position controller must be set to zero before energizing the circuit to open the valve. During a waste gas discharge, the waste gas discharge radiation monitor and flow meter 0WGFE5940 are used together to set control valve 1WG160 and establish discharge flow. Since activity level does not necessarily increase with increased flow, readout from the waste gas discharge monitor is provided on the Waste Gas System panel. If a high radiation signal is received from the monitor during release, the control valve trips closed. After trip, the valve must be reset manually by returning the position controller to zero. The valve can be re-opened only if the trip is cleared.

Flow

0WGFT5190, Reactor Makeup Water Flow to Gas Decay Tank.

Local indication of the total reactor makeup water and the flow rate to the gas decay tanks is measured. A high alarm with a variable setpoint provides indication of excessive makeup water in the gas system.

Pressure

0WGPT 5080, 5090, Shutdown Waste Gas Decay Tank Pressure Indication.

0WGPT 5100, 5110, 5120, 5130, 5140, 5150, Waste Gas Decay Tank Pressure Indication.

This dual range system provides an indication of the pressure in each gas decay tank on the gas processing panel. Upon high or low pressure, an alarm is activated.

0WGPG5900 Reactor Makeup Water Pressure.

Local pressure indication of demineralized water supply to the gas decay tanks.

0WGPT5170, Waste Gas Compressor Inlet Pressure.

Pressure indication at the inlet of the compressors is provided both locally and on the gas processing panel. Low pressure in this line activates an alarm, trips off the compressor, and terminates H2 purge flow from both volume control tanks. (Valves 1WG3 and 1WG14 are closed).

11.3.2.4.3 Catalytic Hydrogen Recombiner Package

Control Panel and Analyzer Rack

The catalytic hydrogen recombiner system has been designed for automatic operation with a minimum of operator attention. Each package includes two dual hydrogen/oxygen in-line gas analyzers which are the primary means of system control. This rack must be located in a limited access area adjacent to the skid assembly to reduce instrument response times. Instrument readout and other system controls are mounted on a remotely located control panel which is provided with each recombiner package. This panel also annunciates all alarms from the recombiner system. When an alarm signal arrives at this control panel, a common alarm signal is relayed to the station main control room through the waste processing system control panel.

Temperature

All temperature elements are installed in thermowells to minimize potential release of radioactive gases by leakage or during maintenance operations.

Multipoint Recorder

A multipoint recorder (0WGCR5290 or 0WGCR5460) monitors temperatures from various locations in the recombiner package. One control function is associated with this instrument channel. On a high catalyst bed temperature, solenoid valve (0WGSV1711 or 0WGSV1911) is closed in the instrument air line to the oxygen control valve (1WG171 or 1WG191) to prevent any increase in oxygen flow. Reset is automatic when the temperature returns to the normal range. Recombiner temperatures are monitored at the following locations:

1. 0WGTE5200, 5370 Feed gas temperature at recombiner package inlet

   This thermocouple indicates temperature of gas entering the recombiner.

2. 0WGTE5210, 5380 Preheater outlet temperature

   This thermocouple determines the temperature of gas leaving the preheater. Temperature reading is taken prior to oxygen addition.

3. 0WGTE5220, 5390 Hydrogen recombiner vessel inlet temperature

   Preheater operation is controlled by a thermocouple located downstream of the oxygen feed line and upstream of the hydrogen recombiner vessel. The thermocouple signal operates a heater control switch, turning the heater on and off to maintain hydrogen recombiner vessel inlet temperature. There is a heater high shutoff and alarm to prevent the gas temperature from exceeding 350°F.

4. 0WGTE 5350, 5520 Hydrogen recombiner outlet temperature

   A thermocouple in the hydrogen recombiner vessel outlet piping prevents catalyst overheating by tripping the oxygen feed control valve closed. An alarm signal is generated simultaneously indicating hydrogen recombiner vessel high high temperature. Manual reset is required to recover from this trip condition.

5. 0WGTE5680, 5690 Recombiner HX outlet temperature

   A local temperature indicator is provided at the recombiner HX outlet for use with the local-manual cooling water control valves and flow meter.

6. 0WGTE5230-5340, 5400-5510 Catalyst bed temperature

   The catalyst bed of the hydrogen recombiner vessel has 12 thermocouples arranged in two sets of six. If any thermocouple senses a high temperature, the recorder switch will close oxygen supply valve 1WG171 or 1WG191 and halt the temperature rise.

7. 0WGTS5640, 5650 Recombiner heater temperature

   A temperature instrument in the preheater vessel senses the outlet temperature and turns the heater off. A high preheater temperature alarm signal is generated simultaneously.

8. 0WGTE5360, 5530 Phase separator inlet temperature

A thermocouple in the phase separator inlet line generates an alarm signal and trips the oxygen feed control valve (1WG171 or 1WG191) closed on high temperature. Manual reset is required from trip condition.

Flow

0WGFE5620, 5630 Recombiner Flow Control

Process gas flow rate is measured by an orifice located upstream of the preheater. At 15 scfm, a low flow signal is generated which turns the preheater off and annunciates low flow heater shutdown. Reset is automatic when flow returns to normal. At 10 scfm, a low-low flow signal trips the oxygen feed control valves closed, and annunciates low-low flow, oxygen shutdown. Recovery from this condition is by manual reset. An eccentric orifice is used to permit drainage of any condensate that might accumulate upstream of the orifice plate. Pressure taps on both sides of the orifice plate are equipped with diaphragm seals to eliminate discharge of radioactive gases by leakage or during maintenance operations.

Pressure

To minimize potential release of radioactive gases by leakage or during maintenance on instruments, all process gas pressure taps are equipped with diaphragm seals downstream of the root valve.

0WGPG5540, 5550 Recombiner Inlet Pressure

A local gauge is provided to indicate pressure at the recombiner inlet.

0WGPT5560, 5570 Recombiner Inlet Pressure Control

A pressure transmitter located at the recombiner inlet operates a pressure controller for the inlet pressure regulating valve. This valve absorbs inlet pressure fluctuations and maintains a constant downstream pressure of 30 psig. The transmitter also provides remote readout on the recombiner panel.

0WGPG5860, 5870 Nitrogen Supply Pressure

0WGPG5880, 5890 Nitrogen Delivery Pressure

Local pressure gauges are provided with the nitrogen supply pressure regulator to indicate both supply pressure at the nitrogen source and delivery pressure to the recombiner skid.

0WGPG5760, 5910 Recombiner Outlet Pressure

A local gauge is provided to indicate pressure at the recombiner outlet.

Hydrogen & Oxygen Analysis

0WGMT6540, 6560 Inlet Hydrogen and Oxygen Analyzer

An in-line analyzer is provided to continuously monitor the hydrogen and oxygen content of the inlet gas. Each analyzer consists of a processor, sensor block, hydrogen sensor, oxygen sensor, and pressure compensation sensor. The hydrogen sensor is a thermal conductivity detector and the oxygen sensor is optical detector, both sensors are mounted in a panel near their respective Catalytic Hydrogen Recombiner (CHR) skid. Inlet gas samples are returned to the waste gas compressor suction after analysis. Remote indication is provided on the associated CHR panel.

To keep the hydrogen content below the Technical Specification limits, alarms are provided on the CHR control panel for high and high-high inlet hydrogen concentration. The analyzer automatically trips the oxygen feed valve closed at the high-high inlet hydrogen setpoint. Trip recovery is accomplished by manually resetting the oxygen feed valve.

To keep the feed stream oxygen content to a value below the flammability limit, alarms are provided on the CHR control panel for high and high-high inlet oxygen concentration. The analyzer automatically trips the VCT purge outlet valve closed at the high-high inlet oxygen setpoint.

0WGMT6550, 6570 Outlet Hydrogen and Oxygen Analyzer

A second in-line analyzer is provided to continuously monitor the hydrogen and oxygen content of the outlet gas. Each analyzer consists of the same components as listed above for the inlet analyzer. The hydrogen sensor is a thermal conductivity detector and the oxygen sensor is optical detector, both mounted in a panel near their respective Catalytic Hydrogen Recombiner (CHR) skid. Outlet gas samples are returned to the waste gas compressor suction after analysis. Remote indication is provided on the associated CHR panel.

To keep the hydrogen content below the Technical Specification limits, an alarm is provided on the CHR control panel for high outlet hydrogen concentration.

To keep the oxygen content in the discharge steam at concentrations compatible with carbon steel equipment, alarms are provided on the CHR control panel for high and high-high outlet oxygen concentration. At the high-high setpoint, a timer is activated that will trip the oxygen feed control valve and the VCT purge valves if the concentration has not decreased within the allotted time.

0WGMT6160, 6161

This analyzer, located at the recombiner inlet, provides a warning of excessive oxygen in the system. A local annunciator on the recombiner panel alarms on high and high-high oxygen concentration.

11.3.2.4.4 Waste Gas Compressor Package

Control systems for the two waste gas compressors are identical. There is no interaction between the two compressors.

<u>Level</u>

0WGLT5040, 5050 Phase Separator Level

A moisture separator level transmitter, a panel mounted level indicator and five level switches are provided per compressor. The compressor trips off on either high or low moisture separator pressure signals; a time delay in the low moisture separator trip circuit prevents trip off while moisture separator pressure builds up during compressor startup.

The compressor can be operated by manually holding the switch open even if a trip signal exists. If the operating compressor trips off, the backup compressor must be started manually.

<u>Switches</u>

Control Panel

A switch is provided on the waste processing system control panel to permit manual control of the makeup water valve to fill the seal water loop during startup. During normal operation, the makeup water valve is opened and closed automatically as required to maintain the proper seal water inventory. A switch is also provided on the waste processing system panel to permit remote manual drain of the moisture separator. During normal operation, the moisture separator drain valve is opened and closed automatically as required to maintain the proper seal water inventory.

Compressor Three Position Switch

A three position switch for each compressor is located on the waste processing system control panel. Spring return is provided from the "on" position to the "auto" position.

11.3.2.5 System Operation

11.3.2.5.1 Startup

The initial system startup is coincident with Unit 1 startup. For this operation, the system is flushed free of air by utilizing the nitrogen supply.

The reactor in the shutdown unit is at cold shutdown, and the volume control tank contains nitrogen in the gas space. The reactor coolant contains neither hydrogen nor fission gases, but may be saturated with air. The other unit is operating normally, with the volume control tank being continuously or intermittently purged to the Waste Gas System.

When the reactor startup procedure requires that a hydrogen blanket be established in the volume control tank gas space, the operating unit is valved out of the Waste Gas System. Then a shutdown decay tank is valved into the circuit with one compressor and one recombiner, and the gas decay tank which was in service is valved out of the circuit. Now, fresh hydrogen is charged into the volume control tank of the shutdown unit. The hydrogen-nitrogen mixture vented manually from the tank enters the circulating nitrogen stream at the compressor suction. Since all system components except the decay tank are controlled to operate at constant pressure, nitrogen added to the loop volume will accumulate in the tank causing the tank pressure to rise.

Initially, the volume control tank vent gas will be very lean in hydrogen, and almost all the influent gas will accumulate in the tank. As the operation continues, the vent gas hydrogen content will gradually increase until it is almost entirely hydrogen at the point when all of the nitrogen has been removed from the coolant.

When the reactor coolant nitrogen concentration is within operating specifications, the shutdown tank is isolated and flow is routed to one of the decay tanks provided for normal power service. The other unit is then valved into the gas system, and the continuous or intermittent purge of this volume control tank is reinstated.

The gas accumulated in the shutdown tank will be retained for use during operations to strip hydrogen from reactor coolant during the next shutdown operation.

11.3.2.5.2 Normal

During normal power operation, a continuous or intermittent purge of fresh hydrogen will be maintained through both volume control tanks at a rate of 0.7 scfm per tank. This purge will serve to reduce the concentration of long lived fission gases in the reactor coolant to low residual levels. The hydrogen-fission gas mixture vented from the volume control tank to the compressor suction enters the circulating nitrogen stream and virtually all of the hydrogen is removed, leaving a net accumulation of fission gas in the loop. Only one gas decay tank is valved into the waste gas loop at any time. By switching tanks at one or two day intervals, the radioactive gas inventory can be distributed so that each gas decay tank contains less than the Selected Licensee Commitment limit, even after fission gases have accumulated in the system over the full 40 year station life.

11.3.2.5.3 Shutdown

Unit shutdown operations are essentially startup operations conducted in the reverse sequence. The purge of both volume control tanks is maintained until after the reactor in the shutdown unit is down and the coolant fission gas concentrations have been reduced to specified levels. Before operation is switched to a shutdown decay tank (which contains nitrogen removed from coolant during the last startup), the unit which is to continue operation is valved out of the system and the volume control tank purge ceases. Then, for the shutdown unit, a nitrogen purge is established using a small side stream from the shutdown tank to the volume control tank and then back to the Waste Gas System through a manual vent. This is accomplished by manually raising and lowering the water level in the volume control tank. This purge continues until analysis indicates that the coolant hydrogen concentration has been reduced to the required level.

When the shutdown operation is terminated, the operating unit is valved into the system, and the continuous or intermittent volume control tank purge is reinitiated.

11.3.2.5.4 Refueling

When preparing the plant for a cold shutdown prior to refueling, the hydrogen purge flow through the volume control tank is used to decrease the concentration of radioactive gases in the reactor coolant. The hydrogen concentration in the reactor coolant must be reduced to less than 5 cc/kg (this can be accomplished mechanically or chemically), the gaseous radioactivity to less than 1.0 µCi/cc (Xe-133) and the Cs-137 activity to less than 0.05 µCi/cc if the system is to be opened for refueling. The operation involves the following steps:

1. Open the Volume Control Tank vent to the vent header.
2. Raise the water level, forcing gases out of the Volume Control Tank, then close tank vent to vent header.
3. Lower the water level and introduce nitrogen to restore normal gas pressure.
4. Repeat steps 1 to 3 at three-hour intervals until H_2 and Xe-133 concentrations are at desired levels.

Gas evolved from the volume control tank during this operation is pumped by the waste-gas compressors to the gas-decay tanks.

11.3.2.6 Plant Ventilation Systems

Plant ventilation systems are described in Chapter 9. Inplant concentrations of airborne radioactive material expected during normal and anticipated operational occurrences are given in Table 12-9 through Table 12-14.

11.3.2.7 Performance Tests

Initial performance tests are performed to verify the operability of the components, instrumentation, and control equipment. During reactor operation the system is used at all times and requires no additional periodic tests. Periodic visual inspections and preventative maintenance are conducted according to normal industrial practices.

11.3.3 Radioactive Releases

Section 11.3.3, and its associated figures and tables such as Tables 11-14, 11-15, 2-42, 2-43, and 2-45, include the bases and results of an analysis of estimated radioactive releases in gaseous effluents and estimated doses from such releases. Unless specifically indicated otherwise, this is a prospective analysis performed prior to initial system operation, based upon estimates, and yielding expected results. A corresponding retrospective analysis is performed annually, based upon routinely updated information contained in the Offsite Dose Calculation Manual (ODCM) and the Annual Radiological Environmental Operating Report, and yielding actual results which are reported in the annual Radioactive Effluent Release Report. Both of these annual reports, and all changes to the ODCM, are submitted to the NRC as required.

HISTORICAL INFORMATION IN ITALICS BELOW ARE NOT REQUIRED TO BE REVISED

11.3.3.1 Releases

The estimated gaseous releases from plant sources during normal operation, including anticipated operational occurrences are shown in Table 11-14.

The total annual average concentration is 4.1E-ll μCi/ml at the exclusion area boundary, or 0.019% of the 10CFR 20, Appendix B limit. Doses from these releases are well below the numerical design objectives of 10CFR 50, Appendix I as shown in Table 11-15.

The acceptable release rates and criteria are discussed in Chapter 16.

The bases for the estimated plant release are as follows:

1. *All assumptions used are consistent with those of NUREG-0017 with the exception of the volume control tank stripping fraction which is discussed in Section 11.1.1.2.*
2. *Source terms are based on primary and secondary system activity during normal operation in Table 11-4. The parameters used for calculating these source terms are in Table 11-3.*
3. *Primary coolant leakage to the Reactor Building is 1.0 percent per day of the noble gas inventory and 0.001 percent per day of the iodine inventory. Primary coolant leakage to the Auxiliary Building is 160 lb/day with an iodine partition factor of .0075.*
4. *Secondary system steam leaks to the Turbine Building at a rate of 1700 lb/hr with an iodine partition factor of 1.0.*
5. *It is assumed that there is a primary to secondary leak of 100 lb/day.*
6. *It is assumed that the containment is purged 4 times per year (2 hot + 2 cold shutdowns) with a filter DF of 10 for iodines and 100 for particulates. Prior to purge, it is assumed that the containment cleanup system (flowrate is 16,000 CFM) functions for 16 hrs., again with a filter DF of 10 and 100 for iodines and particulates, respectively. The containment mixing efficiency is assumed to be 33%.*
7. *The Containment Air Release and Addition system, which will actually operate intermittently with an estimated total exhaust of 3.2E7 scf per year, is assumed to have a continuous flowrate of 60 scfm and a filter DF of 10 for iodines and 100 for particulates.*
8. *The Auxiliary Building ventilation system filters have a DF of 10 for iodines and 100 for particulates.*
9. *Holdup time in the waste gas decay tanks is conservatively assumed to be 90 days.*
10. *Waste Gas System particulate release fraction is 1.0.*
11. *The steam generator blowdown tank is vented to the "D" heaters and, as such, there is no gaseous release from this system.*
12. *The air ejector carbon filter has a DF of 10 for iodines.*

11.3.3.2 Release Points

Gaseous effluents are released for the most part through the unit vent with relatively small quantities released through the Turbine Building vents. The unit vent release point is approximately 125¼ feet above grade and will have a normal exit velocity of 4,115 fpm. The unit vent is described in ER Appendix 3. Turbine Building exhaust is discussed in Section 9.4.7.

11.3.3.3 Dilution Factors

Atmospheric dilution factors and relative deposition at various offsite locations are presented in Table 2-42, Table 2-43, and Table 2-45.

11.3.3.4 Estimated Doses

Estimated doses from radioactive airborne releases are presented in Table 11-15 and are compared to 10CFR 50, Appendix I limits. The methods for calculating individual and population doses follow the guidelines of Regulatory Guide 1.109. In addition, the following site specific data was employed:

1. *The residence which results in the highest offsite dose via the plume submersion and inhalation pathways is 0.7 miles NNE of the station. The atmospheric dilution expected for routine effluent releases is 3.5E-7 sec/m^3.*
2. *The location of the milk producing cow which results in the highest offsite doses via the milk ingestion pathway is 1.3 miles NW of the station. The relative deposition expected for routine effluent releases is 5.7 E-l0/m^2.*
3. *The location of the milk producing goat which results in the highest offsite dose via the milk ingestion pathway is 1.4 miles NW of the station. The relative deposition expected for routine effluent releases is 5.4 E-l0/m^2*
4. *The garden (greater than 500 sq. ft.) that results in the highest offsite dose via the ingestion pathway is located 1.5 miles SSW of the station. The relative deposition expected for routine effluent releases is 7.7 E-l0/m^2.*
5. *The annual truck farming, milk, and meat production from ER Tables 2.1.3-2, 2.1.3-3, and 2.1.3-4 and the relative deposition factors from Table 2.3.5-4 are used to estimate the integrated dose within a 50 mile radius of the plant resulting from radioiodine and particulate releases.*
6. *Average atmospheric dispersion factors from Table 2-42 and year 2000 populations from ER Tables 2.1.2-6 and 2.1.2-13 are used to estimate the integrated dose within a 50 mile radius of the station resulting from noble gas releases.*

THIS IS THE LAST PAGE OF THE TEXT SECTION 11.3.

11.4 Solid Radwaste System

11.4.1 Design Bases

The Solid Radwaste System provides capacity to contain and store radioactive waste materials as they are produced in the station and prepares the waste for eventual shipment to an NRC or Agreement State licensed, offsite disposal facility. This system is shared by the two units and is designed to handle the following waste types:

1. Concentrates from the recycle evaporator of the Boron Recycle System.
2. Spent radioactive resins generated by replacement of the demineralizer resins in various station systems.
3. Contaminated filter elements removed from various station systems.
4. Wastes from the Hot Lab which are non-recyclable due to chemical contamination and radioactivity.
5. Miscellaneous solid materials which become contaminated.

The portions of the system which collect, store and prepare the above wastes for solidification are located in the Seismic Category I portion of the Auxiliary Building. Radwaste is pumped to a shipping area called the Waste Solidification Facility for processing and conversion to a form acceptable for shipment and burial at a licensed disposal facility. The seismic design and quality group classifications of the individual components are given in Section 3.2; Section 11.4.2 gives this information for the piping.

Adequate shielding is provided in the storage areas of wastes which require solidification. In addition, all of the equipment used to transport and prepare these wastes for solidification is adequately shielded and operating procedures are written to keep doses to plant personnel and the general public "As low as reasonably achievable". The shielding design source terms for components associated with the Solid Radwaste System are discussed in Chapter 12.

11.4.2 System Description

The Solid Radwaste System is shown on Figure 11-30 through Figure 11-35. Inputs to and discharges from the Solid Radwaste System are similar, except that the activity of spent resins and chemical wastes are reduced by hold up and the volume of miscellaneous solids is reduced by compaction. System outputs are discussed in Section 11.4.3.

Evaporator concentrates can be an input to the Solid Radwaste System. Table 11-16 details the maximum specific activity level of a concentrates batch under design operating conditions, based on the following assumptions:

1. Evaporator input stream is reactor coolant which has experienced DF of 10 for fission and corrosion products (for instance, as across a feed demineralizer).
2. Input stream is concentrated by a factor of 42. (Basis: a nominal 500 ppm boron concentration is processed until the concentrates reach 12 wt. percent boric acid).
3. Total process time, for which decay credit is taken, is 30 hours. Fission gases are removed by the gas stripper.

Spent resins are considered input to the Solid Radwaste System when they are sluiced to the spent resin storage tank. Table 11-16 gives the maximum specific activity level of a resin batch under design operating conditions, based on the following assumptions:

1. The cation bed and one mixed bed from the Chemical and Volume Control System's demineralizers are sluiced to the storage tank at approximately the same time.
2. Both demineralizers (mixed bed and cation) are operated for one year at 75 and 7.5 gpm respectively, processing design basis reactor coolant.
3. Demineralizer DF values are as shown in Table 11-1.

Filter elements are input to the Solid Radwaste System when removed from the filter housing. Estimated filter activities, based on design basis contact dose rates, are discussed in Section 12.1.3. It is expected that the principal contaminants of filters will be cesium and cobalt isotopes. Filters in the lower activity systems are ordinarily changed because of excessive pressure drop rather than radioactivity.

Non-recyclable chemical wastes from the Nuclear Sampling System can be an input to the Solid Radwaste System. The activity of this waste is conservatively assumed to be that of degassed design basis reactor coolant; therefore, the isotopic inventory is the same as that presented in Table 11-2, with noble gases included.

Miscellaneous solid waste consisting of contaminated trash bags is received by the Solid Radwaste System at designated storage areas appropriately posted and controlled for the radilological hazards present; when a sufficient quantity has accumulated, the waste is packaged for shipment for disposal or processing by off-site company prior to disposal. Radioactivity of the bags containing rags, paper, clothing, glass, etc. is monitored on a case basis so that proper handling, storage and disposal are assured.

11.4.2.1 Equipment

Design parameters for equipment in the Solid Radwaste System are given in Table 11-17.

Spent Resin Storage Tanks

Two stainless steel, 5000-gallon spent resin storage tanks store spent resins from radioactive or potentially radioactive plant demineralizers. These tanks also provide the necessary suction head for the spent resin sluice pump.

By recirculating sluice water or nitrogen through the sparger in the bottom of each tank, the resins are loosened up prior to transfer to the radwaste batching tank. At the time of transfer nitrogen is allowed to flow through the sparger to provide the necessary overpressure required to propel the resins out of the tank to the radwaste batching tank while simultaneously producing a mixing action which keeps the resin fluidized in the sluice water. Johnson screens prevent the flow of resins out of the tank through the sparger. This allows the sparger to be used for draining sluice water from the spent resin storage tank to the waste evaporator feed tank of the Liquid Radwaste System if necessary.

Johnson screens also prevent resins from entering the spent resin sluice pump suction line, the nitrogen vent line, and the sluice water level instrumentation lines. The spent resin sluice pump suction line connection on each spent resin storage tank is located above the maximum expected resin level to reduce the possibility of clogging the Johnson screens with resins when operating the resin sluice pump.

Level instrumentation detects sluice water level in the tank and provides a signal to shut off the spent resin sluice pump at low water level. Instrumentation is also provided to signal when the resins in the tank have reached a maximum operating level.

A 2 inch pipe extends vertically from the top of each tank to within 3 inches of the tank bottom and provides the flow path for forcing resins out of the tank to the radwaste batching tank using nitrogen overpressure.

A relief valve on each tank prevents overpressurization due to nitrogen pressure regulating valve failure. The tank is vented to the room exhaust duct which is handled by the Auxiliary Building Filtered Exhaust System.

Chemical Drain Tank

One 600-gallon chemical drain tank collects and stores liquid chemical wastes from the plant hot laboratory. Instrumentation is provided for level indication and to supply a low level cutoff signal to the chemical drain tank pump. A reactor makeup water connection provides the ability to flush the tank if necessary. A drain connection is provided to the waste evaporator feed tank sump of the Liquid Radwaste System. An overflow pipe which drains to the waste evaporator feed tank sump is also provided. A minimum flow line is provided through a pipe connecting the chemical drain tank pump discharge with the tank.

The tank is vented to the tank vent header in the Liquid Radwaste System. Material of construction is stainless steel.

Evaporator Concentrates Holdup Tank

One 3000-gallon evaporator concentrates holdup tank may be used to collect and store concentrates from the waste evaporator and the recycle evaporator. It is also used to receive inputs from dewatering activities in the WSF.

The tank contains immersion heaters to keep the concentrates above solubility temperature.

Instrumentation is provided for level indication and to supply a high level signal to close the inlet valve and a low level signal to close the outlet valve.

Material of construction is stainless steel. The tank vent is routed to an intake of the Auxiliary Building Filtered Exhaust System.

Evaporator Concentrates Batch Tank

One 2000-gallon evaporator concentrates batch tank may be used to receive concentrates from the evaporator concentrates holdup tank. This tank provides isolation of the batch from incoming evaporator concentrates, plus the means to sample and chemically adjust prior to solidification. It is also used to receive inputs from dewatering activities in the WSF.

The tank contains immersion heaters to keep the concentrates above solubility temperature.

Instrumentation is provided for level indication and controls as well as temperature controls.

Material of construction is stainless steel. The tank vent is routed to an intake of the Auxiliary Building Filtered Exhaust System.

Radwaste Batching Tank

One 800-gallon radwaste batching tank is provided for dewatering and preparing spent resins for solidification. The tank has two connections equipped with Johnson screens to be used in dewatering bead resins.

An overflow connection drains to the mixing and settling tank of the Liquid Radwaste System.

Instrumentation is provided for level indication. Operators will administratively close the inlet valve at a preset high level.

The material of construction is stainless steel. The tank vent is routed to an intake of the Auxiliary Building Filtered Exhaust System.

Waste Solidification Facility

This facility is a curbed concrete pad under cover, (see Figure 11-36). It is located adjacent to the Auxiliary Building and is used for processing and conversion of radioactive wastes to a form acceptable for shipment and burial. This processing may include dewatering, solidification or other approved methods. Space is provided for the contractor's mobile solidification unit, a cask on a tractor-trailer, and cask liners (disposable shipping containers). Connections to the vendor equipment supply radwaste, air, flush water, binder, and ventilation via the unit vent. Waste can be solidified with the liner in the cask on the trailer (shielded by cask) or in liners located on the pad or in the liner vault space located nearest the shield wall. A shield wall is provided to protect operating personnel from exposure during the solidification process. Disposal liners may be temporarily stored in a recessed vault area. Vault covers provide additional shielding, a small sump in the bottom of the vault collects pad washdown water and any spills. The binder storage tank and pump are located adjacent to this facility.

Binder Storage Tank

A buried 6000-gallon binder storage tank is provided for the storage of DOW waste solidification binder. The solidification contractor may use this binder as a radwaste solidification medium.

The tank is made of carbon steel with an interior coating of Wisconsin Plastite 3066.

The contents of the tank can be recirculated and aerated periodically which will retard polymerization prior to its use.

Disposable Shipping Containers

Evaporator concentrates, chemical drain tank contents, and spent resins may be processed and packaged in a cask liner in the Waste Solidification Facility. After packaging, the wastes are transported to a licensed, offsite disposal facility where the liner is buried using approved methods.

Spent Resin Sluice Pump

One spent resin sluice pump provides sluicing flow to flush spent resins from plant demineralizers into the spent resin storage tanks. This is a canned rotor centrifugal pump. Material of construction is stainless steel.

Chemical Drain Tank Pump

One chemical drain tank pump may be used to recirculate the chemical drain tank contents and pumps the contents to the radwaste batching tank. This is a canned rotor centrifugal pump. Material of construction is stainless steel.

Radwaste Transfer Pump

One radwaste transfer pump is supplied to accurately meter the flowrate of evaporator bottoms or chemical wastes during the solidification process. This type of pump is specified to meet the water to resin ratio needed for the "DOW" solidification process. This is a variable speed, progressing cavity pump. There is a flow indicator on the control panel in the waste shipping area which is driven by a motor shaft tachometer. The pump variable speed control is adjusted at the control panel to drive the pump at the correct speed to yield the desired flowrate. Material of construction is stainless steel with a Buna-N pump stator. This pump is on the radwaste transfer skid in a room adjacent to the radwaste batching tank. An alternate transfer pump is provided to transfer RBT contents to the WSF for transfer to a High Integrity Container (HIC) liner.

Binder Pump

One binder pump is provided to transfer binder from the binder storage tank to a liner in the Waste Solidification Facility. This is done prior to the addition and solidification of radwaste by the contractor.

This is a progressing cavity pump. The wetted materials are a Viton stator and a stainless steel rotor.

Pump discharge pressure instrumentation is provided.

The pump is located adjacent to the Waste Solidification Facility pad.

Heat tracing is employed to maintain the binder at a minimum temperature of 60°F for viscosity considerations.

Liner Vault Sump Pump

A small air-driven sump pump transfers water from the liner vault sump in the Waste Solidification Facility to the Liquid Radwaste System.

Level alarms are provided for the sump and vault areas since they will normally be covered. These alarm locally and on the waste solidification panel.

The sump is stainless steel lined.

Dewatering Pump

One dewatering pump is provided to pump excess water out of the radwaste batching tank and back to the pressurized spent resin storage tank during preparation of the resins prior to solidification.

The pump is controlled from the control panel in the waste shipping area and is constructed of stainless steel.

Spent Resin Sluice Filter

A 25 micron spent resin sluice filter is at the discharge of the spent resin sluice pump. It filters resin fines from the resin sluice water.

Resin Batching Tank Mixer

One radwaste batching tank mixer is provided for mixing resins in the tank. The mixer is designed to produce a well mixed slurry of water and resins and to suspend the solid resins in the water. The mixer is a top entering type that mounts on the top of the tank. Controls for the mixer are located on a control panel in the waste shipping area.

Mechanical Compactor

A mechanical compactor can be used to compress low activity miscellaneous solids waste (rags, clothing, sweepings, etc.) into containers for storage and shipment to a licensed offsite disposal or processing facility. The compression process takes place within an enclosure provided with the compactor. The interior of the enclosure is vented via a blower to the Auxiliary Building Filtered Exhaust System.

11.4.2.2 Operating Procedures

To facilitate the description of the Solid Radwaste System, it has been divided into five functionally different areas which are treated separately in the following sections.

11.4.2.2.1 Evaporator Concentrates Storage and Processing

This process is applicable only if it is desired to solidify concentrate and if the "DOW" process is to be utilized.

Normally the 3,000 gallon evaporator concentrates holdup tank (ECHT) is aligned to receive evaporator concentrates for solidification. When sufficient volume is accumulated to warrant their preparation for shipment, they are transferred to the 2,000 gallon evaporator concentrates batch tank (ECBT) for sampling and chemical adjustment.

If the ECHT is not required to receive evaporator concentrates it can be isolated and serve as a batch tank. Also, concentrates can be stored in the ECBT if additional capacity is needed.

The concentrates are solidified in the liner by the contractor using an appropriate solidification medium. If DOW binder is used the contractor attaches the fill head to the liner. A prescribed volume of binder is pumped into the liner prior to addition of radwaste to yield a specific radwaste to binder ratio. Taking suction from either the ECBT or the ECHT, the variable speed radwaste transfer pump is placed in recirculation mode and a sample is taken. Chemistry is adjusted if necessary. When the batch is ready for solidification, valves are realigned and radwaste is routed to the liner at a flowrate sufficiently low to assure proper mixing. Level instrumentation in the fill head provides indication that the radwaste fill is complete. The radwaste transfer pump continues to run as valves are realigned to provide pump suction from a flush water supply. A predetermined volume of water is added to flush the remainder of the radwaste to the liner, thereby clearing the lines. Catalyst and prometer are added by the contractor as necessary to control the rate and quality of the final product.

When waste addition and mixing are completed the fill head is removed and the liner is capped. The waste is then shipped to a licensed, offsite disposal facility. If immediate transportation is not available the liner vault provides storage for up to three liners containing solidified concentrates.

To minimize the potential for problems, the radwaste transfer lines are as short as possible and 5-diameter bends are used in place of elbows where feasible.

11.4.2.2.2 Non-Recyclable Hot Lab Liquid Waste Storage and Processing

When a sufficient amount of hot lab waste has accumulated in the chemical drain tank the contents may be transferred to the radwaste batching tank to be processed. Compatible hot lab wastes are normally transferred to the WL System for filtration and ion exchange.

If a combination of spent resin and chemical waste is to be processed using the "DOW" process, the resin is transferred to the radwaste batching tank and dewatered before the chemical waste is added (see Section 11.4.2.2.3 for resin transfer to batching tank). After addition of chemical waste, the batching tank mixer is started and the resin and chemical waste are mixed. This mixture is then recirculated by the radwaste transfer pump and a sample is taken. The chemistry of the resin-chemical waste mixture is determined and adjusted if using the "DOW" process. From this point on the solidification operation proceeds as in Section 11.4.2.2.1.

11.4.2.2.3 Spent Resin Storage and Processing

The spent resin sluice pump provides sluice water flow to flush spent resins from plant demineralizers into the spent resin storage tanks. The spent resin sluice pump suction lines are connected to the 5000-gallon spent resin storage tanks above the maximum expected resin level to assure that the recirculated sluice water is relatively free of spent resins. Johnson screens fitted to the ends of the suction lines and a filter in the discharge piping of the spent resin sluice pump provide additional assurance that the recirculated sluice water is free of resins. In the sluicing process, sluice water is pumped through a demineralizer from the bottom to the top, thereby breaking up the resin bed. The demineralizer sluice valve is then opened which allows the resin and sluice water mixture to flow into the appropriate spent resin storage tank. Instrumentation is provided to indicate when stored resins in a spent resin storage tank have reached a maximum level. When this occurs, that tank is isolated and sluicing flow is directed to the alternate spent resin storage tank.

In preparation for transfer to the RBT, resins in the spent resin storage tank are fluidized by recirculating sluice water through the spargers in the bottom of the spent resin storage tank. The spent resin storage tank is pressurized using nitrogen overpressure through the spargers in the bottom of the tank. By means of this nitrogen overpressure, the resins are transferred to the radwaste batching tank. When the level in the tank reaches a preset high level, the inlet valve is automatically closed. The resins are then dewatered using the dewatering pump. When the level in the tank ceases to fall, the dewatering pump is shut off and another load of resins is transferred to the tank. This process of transferring and dewatering is continued until the tank is full to the high level of dewatered resins. Once the tank is full of dewatered resins, sufficient water is added to produce the proper water-resin ratio, if using the "DOW" process. The resins are processed to meet DOT, NRC and Disposal site criteria.

11.4.2.2.4 Spent Filter Storage and Handling

Most potentially radioactive filters are accessible through a hatch in the Auxiliary Building 577' floor level. When a filter needs to be replaced it is first valved out of service. If the fluid in the housing potentially contains dissolved fission product gases, the contents are normally drained to the waste drain tank (Liquid Radwaste System). The filter housing is then vented and permitted to drain. An overhead hoist is used to remove any concrete hatch above the filter. The filter is removed from its housing into a container/shield. After its removal, the filter is placed in a storage area until it can be transferred in an appropriate package to a licensed waste processor or disposal facility.

11.4.2.2.5 Miscellaneous Solid Wastes

Miscellaneous solid wastes such as rags, sweepings, contaminated clothing, ventilation filters, and other equipment are stored until they can be transferred in an appropriate package to a licensed waste processor or disposal facility.

11.4.3 Expected and Maximum Volumes

Solid radioactive waste disposal volumes, isotopic content, and curie content are reported annually in the Annual Radioactive Effluent Release Report pursuant to Technical Specifications and Selected Licensee Commitments. Generated radioactive waste volumes vary from year to year based on the number of outages and work performed. Disposal volumes are typically less than generated volumes and do not exceed the maximum allocated volume set by licensed waste processors or disposal facilities. Volume reduction processes are utilized when supported by economic analysis.

11.4.4 Packaging

Evaporator concentrates, sludges, chemical wastes and resins are processed and converted to a form acceptable for transfer in an appropriate package to a licensed waste processor or disposal facility.

Spent radioactive filters are stored until they can be transferred in an appropriate package to a licensed waste processor or disposal facility.

All solid waste material which is shipped from the station is packaged in accordance with the applicable requirements of 10CFR 71 and Department of Transportation Regulations. External dose rates from containers of low level waste are within allowable limits. Containers which handle evaporator concentrates, sludges, spent resins, and filters are designed to meet all applicable regulations.

11.4.5 Storage Facilities

11.4.5.1 Evaporator Concentrates, Chemical Wastes and Spent Resins

These wastes are not permanently stored on site once they have been transferred to the cask liners. After they have been pumped from their respective hold up tanks and are processed, they are transferred in an appropriate package to a licensed waste processor or disposal facility.

11.4.5.2 Spent Filter Cartridges

Spent filter cartridges are stored until they can be transferred in an appropriate package to a licensed waste processor or disposal facility.

11.4.5.3 Dry Active Wastes (DAW – trash)

A shielded storage area for containers of low level wastes is provided in the waste shipping area located on the Auxiliary Building 594' level between column lines 59 and 60, and between column lines TT and VV. A mechanical compactor may be located adjacent to this storage area. Adequate shielding is provided so that, outside the building, the area in the vicinity of this storage room is not a Radiation Area except during movement of wastes under appropriate radiological controls. Containers can be moved by forklift from the storage area when ready for shipment.

Solid wastes can also be stored in the waste shipping area, filter bunker room, container and drum storage room, waste solidification area, Waste Monitor Tank Building, Radwaste Processing Facility (Figure 11-45) or other radiologically controlled areas in accordance with procedures. Access to the filter bunker room is via doors, which can be locked if necessary based on radiological conditions, and through a hatch to the waste shipping bay. The filter bunker room is shielded by a minimum of two foot concrete walls. It could be used for both high level (> 100 mrem /hr) or low level radwaste. High level radwaste can be stored in the container and drum storage room surrounded by 3 feet of concrete with a volume capacity of 6400 ft^3 If this is insufficient storage capacity, the filter bunker room can be used to store an additional 4000 ft^3 of high or low level radwaste. Expected annual dry active waste volumes are approximately 20,000 ft^3 of processed waste. The maximum annual dry active waste volume shipped offsite does not exceed the maximum allocated volume set by licensed waste processors or disposal facilities. The solidification area has storage space for 3 liners as shown on Figure 11-36. All radioactive wastes are stored until they can be transferred in an appropriate package to a licensed waste processor or disposal facility.

11.4.6 Shipment

All solid wastes are transported by truck to an NRC or Agreement State licensed offsite processing or disposal facility. There are no plans to keep vehicles on site for more than a brief period after loading. Locations in the station where solid wastes may be stored at some stage in the handling process include the waste shipping area, filter bunker room, container and drum storage room, solidification area, or other radiologically controlled areas in accordance with procedures. All shipments of solid wastes meet the applicable requirements of 10CFR 71, Department of Transportation Regulations, and applicable State regulations.

11.4.7 Process Control Program (PCP)

The PCP is utilized in the control of the solidification or dewatering of radioactive wastes in order to meet disposal site requirements when received at a 10CFR61 disposal site.

Written procedures have been established and implemented and are maintained concerning the PCP. The PCP are initially approved by the Nuclear Regulatory Commission (NRC) prior to its implementation. Changes to the PCP are submitted to the NRC in the Radioactive Effluent Release Report for the period in which the change(s) was made.

The submittal shall contain:

1. Sufficiently detailed information to totally support the rationale for the change without the benefit of additional or supplemental information,
2. A determination that the change did not reduce the overall conformance of the solidified waste product to existing criteria for solid wastes, and
3. Documentation of the fact that the change has been reviewed and found acceptable by the Station Manager or the Chemistry Manager.

The change shall become effective upon review and acceptance by a qualified individual/organization.

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11.5 Process and Effluent Radiological Monitoring and Sampling Systems

11.5.1 Process and Effluent Radiological Monitoring System

11.5.1.1 Design Bases

The Process and Effluent Radiological Monitoring System is designed to:

1. Provide early warning to station personnel of potential radiological health hazards.
2. Assure that radiation exposures and releases of radioactive materials in effluent to unrestricted areas are as low as reasonably achievable.
3. Monitor airborne and liquid activity in selected locations and effluent discharge paths during normal operation, anticipated operational occurrences, and postulated accidents.
4. Automatically terminate discharge from waste systems at preset activity levels.

11.5.1.2 System Description

The Process and Effluent Radiological Monitoring System monitors primary and secondary systems during normal operation, including anticipated operational occurrences. Additionally, some of the monitors perform control functions during postulated accident conditions. The system sensors are strategically located to provide indication (and control functions where applicable) of the levels of radioactive fission products and activated corrosion products present in process and effluent streams. The following sections describe the liquid, airborne, and adjacent-to-line radiation monitors that compose the Process and Effluent Radiological Monitoring System.

11.5.1.2.1 Liquid Monitoring

Liquid Monitors are provided for normally radioactive systems and for plant piping systems that may become contaminated as a result of component failure (e.g., steam generator or heat exchanger tube leak). These monitors provide indication of the radioactivity concentrations in the monitored systems and provide alarms in the control room when the activity level reaches a preset value.

Table 11-19 identifies each liquid monitor including its range, sensitivity, setpoint, and detector type.

The following sections describe the process and effluent liquid monitors.

11.5.1.2.1.1 Turbine Building Sump Monitor

The turbine building sump monitor is an off-line gamma detector that continuously monitors the liquids collected in the turbine building sump. During normal operation, the contents of the sump are pumped to the Conventional Waste Water Treatment System; however, if a level of radioactivity in excess of a preset limit is detected in the sump, the turbine building sump monitor initiates an alarm in the control room and trips the turbine building sump pumps thus terminating sump discharge. With a sump radioactivity level higher than the preset limit, TBS liquid may either be pumped to WL System for processing or the sump discharge may be manually re-initiated to continue being discharged via WC System with administrative controls implemented to assure release limits are not exceeded.

The expected normal radioactivity concentration in the turbine building sump is 3E-8 µCi/ml based on the historical steam concentrations of Table 11-4 (historical Primary and Secondary Activity During Normal Operation) diluted by a factor of ten. Current information is available from Chemistry. The basis for the monitor setpoint is in Offsite Dose Calculation Manual (ODCM) methodology and assures that radioactive liquids collected in the turbine building sump are monitored to determine if processing by the Liquid Radwaste System is required.

11.5.1.2.1.2 Steam Generator Water Sample Monitor

The steam generator water sample monitor is normally isolated from steam generator sample flow. This monitor has been administratively removed from service (e.g. procedures for operation and maintenance of this monitor have been deleted). This monitor is no longer used to support plant operation.

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11.5.1.2.1.3 Containment Ventilation Unit Condensate Drain Tank (CVUCDT) Monitor

The CVUDT discharge is aligned to the Liquid Radwaste System. Discharge flow from the CVUCDT is monitored via the Liquid Radwaste Monitor.

11.5.1.2.1.4 Nuclear Service Water (NSW) Monitors

The nuclear service water monitors consist of two off-line gamma detectors (high range and low range) for each NSW train that continuously monitor the NSW return flow from the containment spray heat exchangers. Radioactivity in excess of a preset level in the NSW return flow from a containment spray heat exchanger is indicative of a heat exchanger tube leak (e.g., during post-LOCA recirculation of the containment sump). High NSW activity is alarmed in the control room to alert the operator to isolate the affected heat exchanger.

The normal radioactivity concentration in the NSW system is expected to be undetectable. A typical radioactivity setpoint for the NSW monitors is 1E-6 µCi/ml, the minimum practical setpoint considering dynamic range output capability of readout module. The basis for this setpoint is to limit the activity released to the environment from the NSW system to a value as low as reasonably achievable.

11.5.1.2.1.5 Component Cooling Water Monitors

The component cooling water monitors are off-line gamma detectors that continuously monitor the component cooling water at the downstream side of the two component cooling water heat exchangers. Radioactivity in the component cooling water is indicative of primary coolant in-leakage through a heat exchanger served by the Component Cooling Water System. In the event radioactivity in excess of a preset limit is detected in a train of the Component Cooling Water System, the associated component cooling water monitor actuates an alarm in the control room. The radioactivity alarm alerts the operator to locate and isolate the faulty heat exchanger.

The normal concentration of activity in the Component Cooling Water System varies with the amount of activated Na-24. The radioactivity setpoint for the component cooling water monitor is 1E-3 µCi/ml. The basis for this setpoint is to respond to inleakage of radioactivity. The Component Cooling Water System is a closed system. This setpoint may be higher to allow for fluctuation in the concentrations of activated Na-24.

11.5.1.2.1.6 Boron Recycle Evaporator Condensate Monitor

The boron recycle evaporator condensate monitor is an off-line gamma detector that continuously monitors the recycle evaporator condensate demineralizer outlet flow. The recycle evaporator effluent normally flows to the reactor makeup water storage tank; however, if radioactivity in excess of a preset limit is detected (i.e., the effluent activity is not within the Technical Specification limits for reactor makeup water), the boron recycle evaporator condensate monitor actuates an alarm in the control room and initiates automatic realignment of the flow to the recycle evaporator feed demineralizer.

The normal concentration of radioactivity in the recycle evaporator condensate demineralizer effluent is expected to be 1E-5 μCi/ml (refer to Section 11.2). A typical high radioactivity setpoint for the boron recycle evaporator condensate monitor is 1E-3 μCi/ml. The basis for this setpoint is to maintain the reactor coolant makeup water within Technical Specification limits.

11.5.1.2.1.7 Reactor Coolant Monitor

This monitor has been changed to an Adjacent-To-Line Monitor. See Section 11.5.1.2.3.

11.5.1.2.1.8 Waste Liquid Discharge Monitor (EMF 49)

The waste liquid discharge monitor consists of two off-line gamma detectors (high range and low range) to monitor the flow of low level radioactive liquid waste to the low pressure service water discharge. Liquid wastes are released at the low pressure service water discharge where they are diluted by an average flow of 54,000 gpm from the Low Pressure Service Water System. In the event that radioactivity in excess of a preset limit is detected in the liquid waste discharge flow, the waste liquid discharge monitor will actuate an alarm in the control room and terminate the discharge.

The radioactivity setpoint for the waste liquid discharge monitor is based on the most limiting nuclide and 10 times EC of 10CFR 20 Appendix B limit for the release. The setpoint methodology is based on ODCM. The liquid waste discharge flow rate is adjusted to assure that the low pressure service water flow dilutes the liquid waste concentrations to values within the limits of the Selected Licensee Commitments.

11.5.1.2.1.9 Clean Area Floor Drains Discharge Monitor (EMF 52)

The clean area floor drains discharge monitor is an off-line gamma detector that continuously monitors the combined discharge of the clean area floor drain sump pumps and the auxiliary feedwater sump pumps. The contents of these sumps are normally pumped to the turbine building sump; however, should a preset level of radioactivity be detected in the sump discharge, the clean area floor drains discharge monitor actuates an alarm in the control room and diverts the discharge flow from the turbine building sump to the floor drain tank of the Liquid Radwaste System. The discharge flow may be selected to continue to TBS and control of effluent release takes place via TBS monitor.

The normal radioactivity concentration in the clean area floor drains discharge is expected to be undetectable. The monitor setpoint is based on ODCM methodology and is set at a response level to allow positive control of effluent releases.

11.5.1.2.1.10 Waste Monitor Tank Building Liquid Discharge Monitor (EMF 57)

The waste monitor tank building liquid discharge monitor is an off-line gamma detector that monitors the flow of low level radioactive liquid waste from the waste monitor tanks in the Waste

Monitor Tank Building to the low pressure service water discharge. In the event that radioactivity in excess of a preset limit is detected in the liquid waste discharge flow, the waste monitor tank building liquid discharge monitor will actuate alarms in the Waste Monitor Tank Building control room, the remote monitor tank building control panel located in the Auxiliary Building, and the main control room. It will also terminate the discharge.

The radioactivity setpoint for the waste monitor tank building liquid discharge monitor is based on the most limiting nuclide and 10 times EC of 10CFR 20 Appendix B limit for the release. The setpoint methodology is based in ODCM. The liquid waste discharge flow rate is adjusted to assure that the low pressure service water flow dilutes the liquid waste concentrations to values within the limits of the Selected Licensee Commitments.

11.5.1.2.1.11 Auxiliary Building Cooling Water (YN) Monitor (EMF89)

The Auxiliary Building Cooling Water Monitor is an off-line gamma detector that continuously monitors the Auxiliary Building Cooling Water (YN) system. The monitor can monitor the YN supply and return headers of either Unit 1 or Unit 2. It is normally aligned to the Unit 1 YN headers with the Unit 2 supply and return lines isolated. The normal radioactivity concentration in the YN System is expected to be minimal. In January 2011, a tube leak was confirmed in the 1B Reactor Coolant Hot Leg Sample Heat Exchanger. This leak allowed Reactor Coolant to enter the YN system. In spite of efforts to decontaminate the YN system, low levels of contamination remain. Therefore, the YN system is being operated as a contaminated system. Should a preset level of radioactivity be detected, the Auxiliary Building Cooling Water monitor actuates an alarm in the control room.

11.5.1.2.2 Airborne Monitoring

Airborne monitors are provided to monitor ventilation systems that remove air from plant areas that are potential sources of airborne radioactivity. These monitors provide indication of the airborne radioactivity in the areas monitored and provide alarms in the control room when the activity level exceeds a preset value.

Catawba Nuclear Station uses continuous air samplers to monitor particulates contained in the plant gaseous effluent. The particulate sample media is 0.3 micron filter paper. All appropriate precautions have also been taken to insure that radiation exposures to personnel will be ALARA and not exceed the limits prescribed in General Design Criteria 19.

The sample nozzles used for isokinetic sampling of the unit vent stack for radiation monitoring were provided by General Atomic Co., the supplier of the monitor. General Atomic has stated that the maximum error due to anisokinetic sampling of the nonlinear stack velocity profile is five percent or less. This conclusion was drawn from test data taken in accordance with ANSI N13.1-1969, Appendix A. The isokinetic sampling system at Catawba is similiar to the system used at McGuire Nuclear Station.

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Table 11-20 identifies each airborne monitor including its range, sensitivity, setpoint, and detector type.

The following sections describe the process and effluent airborne monitors.

11.5.1.2.2.1 Unit Vent Airborne Monitor

The unit vent airborne monitor continuously monitors the gaseous, and particulate activity levels of the Containment Purge System, Annulus Ventilation System, Auxiliary Building Ventilation

System, Fuel Pool Ventilation System Containment Air Release and Addition System, condenser air ejectors, and other potentially radioactive sources that are released to the atmosphere through the unit vent.

The unit vent airborne monitor consists of a sample pump that draws a minimum 3 SCFM sample from the unit vent through an airborne monitor equipped with a particulate filter, and a gas monitoring chamber. The particulate monitor is a plastic beta scintillator and reads out in cpm/min. The sample piping length is minimized, and its bends are limited to long radii to prevent plateout of particulates while sampling. An isokinetic sample probe is employed in the unit vent to provide isokinetic sampling of the particulate activity release.

The normal particulate activity in the unit vent is expected to be undetectable. Unit vent air particulate activity in excess of a preset limit is alarmed in the control room. The particulate activity setpoint for the unit vent particulate monitor is based on methodology and dose parameters in SLCs and ODCM using a unit vent flow plus containment purge flow of 160,000 CFM. The setpoint for the air particulate monitor ensures that the alarm/trip will occur prior to exceeding the limits of 10CFR Part 20.

Regulatory Guide 1.21 provides guidance on how to develop an effluent monitoring program acceptable to the NRC for measuring, reporting, and evaluating releases of radioactive materials in liquid and gaseous effluents. Reg. Guide 1.21 states that the licensee may use the guidelines put forth in ANSI N13.1-1969 in meeting the Reg. Guide guidelines when designing an airborne effluent monitoring system. ANSI N13.1-1969 provides at least two means for accounting for particulate measurement (representative sampling). For the Unit Vent Airborne Particulate Monitor, representative sampling can be achieved by either drawing a sample of the same velocity as the unit vent stack, or by applying correction factors to the setpoint to ensure that the limits of 10 CFR Part 20 are not exceeded. Therefore, there are two means that can be utilized to ensure that the Unit Vent Airborne Particulate Monitor does not exceed 10 CFR Part 20 limits. These means are to either periodically adjust sample flow velocity to be equivalent to unit vent stack velocity, or to apply a correction factor to the Unit Vent Airborne Particulate Monitor alarm/trip setpoint. In the case of the sample velocity being less than the vent velocity, the error results in a conservative collection of particles. In the case of the sample velocity being greater than the vent velocity, the error results in a non-conservative collection of particles. Correction factors are required when the non-conservative situation exists. Errors due to anisokinetic conditions have been determined based on ANSI N13.1-1969 Appendix C and have been incorporated into station procedures for determining the Unit Vent Airborne Particulate Monitor setpoint. These correction factors can be applied if the Unit Vent Airborne Particulate Monitor is operated at a fixed sample velocity where the sample velocity is not equivalent to the unit vent stack velocity.

The normal expected concentration of gaseous activity in the unit vent is 8E-7 µCi/ml, based on the historical releases in Table 11-14. Current information on releases is available in CNS Annual Radiological Effluent Release Report. Unit vent gaseous activity in excess of a preset limit is alarmed in the control room. The gaseous activity setpoint for the unit vent gaseous activity monitor is based on methodology and dose parameters in SLCs and the ODCM using a unit vent flow plus containment purge flow of 160,000 CFM. The setpoint for the gaseous monitor will be calculated to ensure that the alarm/trip will occur prior to exceeding the limits of 10CFR Part 20.

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In addition to the off-line monitors, a unit vent high range monitor employing an ion chamber for gross gamma detection is attached to the unit vent. The detector is sensitive to the 80 Kev energy range of noble gases and is shielded to minimize the count rate contribution of extraneous sources. Unit vent high range gross gamma activity in excess of a preset limit is alarmed in the control room.

11.5.1.2.2.2 Containment Atmosphere Monitor

The containment atmosphere monitor continuously monitors the gaseous and air particulate activity levels in the containment atmosphere.

Leakage to the containment volume from the Reactor Coolant System (RCS) results in airborne activity that may be released to the environment during purge operations. The containment atmosphere particulate monitor monitors for the presence of and to the extent possible, the magnitude of reactor coolant leakage and quantitatively analyzes atmosphere activity released to the environment by the Containment Purge and Containment Air Release and Addition Systems. The containment atmosphere particulate monitor is used to monitor for and alarm on Reactor Coolant System pressure boundary leakage. The particulate channel and OAC will detect a 1 gpm leak within 12 hours based on actual particulate activity in the reactor coolant system. The alarm is set as low as practicable to facilitate the earliest indication of a leak and the response time will normally be less than the required 12 hours.

Of the two channels (gaseous, and particulate), only the particulate channel is credited as one of the Reactor Coolant System Leakage Detection Instruments. Due to improved fuel integrity and resulting reduced RCS radioactivity levels, the gaseous channel has become less effective for RCS leakage detection and cannot meet the originally accepted basis for the equivalent of detecting one gallon per minute within one hour. Therefore, the gaseous channel is not required for the Technical Specifications. The gaseous channel, however, is available and maintains its function to provide operators qualitative information as an additional diverse method of detecting leakage. Refer to Section 5.2.5 for additional discussion of leakage detection instrumentation.

The containment atmosphere particulate channel is used to monitor for and alarm on Reactor Coolant Pressure boundary leakage. In conjunction with the Operator Aid Computer (OAC), the particulate monitor will alarm upon reaching a setpoint that is set as low as practicable to minimize spurious alarms, yet low enough to assure reasonable sensitivity for early detection of an RCS leak. The response time for the particulate channel to detect a 1 gpm leak ranges from 1 to 10 hours while operating between 100% power and hot zero power respectively. The particulate channel may not be able to meet the Regulatory Guide 1.45 leakage guidance during lower modes due to decreased coolant inventory activation products and decreased coolant enthalpy. Therefore, the particulate monitor is not required by the Technical Specifications in Modes 2, 3, and 4 but will be another diverse leakage detection method. In the event of a loss of the Operator Aid Computer, procedures are in place to manually acquire and analyze plant data to monitor for RCS leakage.

The containment atmosphere monitor consists of a sample pump that draws a sample stream through a airborne particulate filter, and a gas monitoring chamber, and then returns the air sample to the containment. The sample flow is delivered to the detector through a manifold of solenoid-operated sample valves operated from the control room. The sample valves provide the capability to monitor various locations within the containment with a minimum number of containment penetrations. The containment areas sampled include the upper containment, lower containment, and the incore instrumentation room. The incore tunnel area is indirectly monitored by means of forced ventilation through the area into lower containment.

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The normal gaseous activity concentrations expected in the containment are provided in Table 12-11. Containment gaseous activity in excess of a preset limit actuates an alarm in the control room and automatically terminates containment release. The noble gas activity setpoint for the containment gaseous activity monitor during containment purge is based on sample analysis. The typical flow rate is 25,000 ± 10% cfm for the Containment Purge (VP) System and 300 cfm for the Containment Air Release and Addition (VQ) System. The setpoint may be adjusted as necessary to accommodate sample activity and monitor background rate.

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As described in section 5.2.5.2.3.2, the containment airborne monitors are not required to meet seismic Category 1 design requirements.

11.5.1.2.2.3 Auxiliary Building Ventilation Monitor

The auxiliary building ventilation monitor sequentially monitors the gaseous activity of 12 areas in the auxiliary building which are potential sources of gaseous activity. The auxiliary building ventilation monitor sample pump draws a 1 SCFM air sample from each of the 12 monitored areas. A sampling manifold allows each area to be independently monitored once per hour.

The normal gaseous activity levels expected in the auxiliary building are provided in Table 12-9. Auxiliary Building gaseous activity in excess of a preset limit is alarmed in the control room. A typical gaseous activity setpoint for the auxiliary building ventilation monitor is 1.7E-4 μCi/ml, based on a 2mR/hr submersion dose in a semi-infinite Xe-133 cloud.

11.5.1.2.2.4 Fuel Building Ventilation Monitor

The fuel building ventilation monitor continuously monitors the gaseous activity released to the atmosphere by the spent fuel pool area ventilation fans. The spent fuel pool may release gaseous activity resulting from partial mixing of the fuel pool water with reactor coolant during refueling. A 1 SCFM air sample is taken from and returned to a common ventilation duct adjacent to the spent fuel pool.

The normal gaseous activity concentrations expected in the Fuel Building are provided in Table 12-9. Fuel Building gaseous activity in excess of a preset limit is alarmed in the control room. A typical gaseous activity setpoint for the fuel building ventilation monitor is 1.7E-4 μCi/ml, based on a 2mR/hr submersion dose in a semi-infinite Xe-133 cloud.

11.5.1.2.2.5 Control Room Air Intake Monitors

The control room air intake monitors continuously monitor the gaseous activity in each of the two control room air intake ducts. For each air intake, a 1 SCFM air sample is taken from the ventilation duct, monitored by the gaseous activity detector provided for that air intake, and returned to the ventilation duct.

The normal concentrations of gaseous activity expected for the control room air intakes are provided in Table 12-9. Gaseous activity in a control room air intake which exceeds a preset limit actuates an alarm in the control room. Operations can then isolate the affected intake if desired. A typical gaseous activity setpoint for the control room air intake monitors is 1.7E-4 μCi/ml, a 2 mR/hr submersion dose in a semi-infinite Xe-133 cloud.

11.5.1.2.2.6 Waste Gas Discharge Monitor

The waste gas discharge monitor continuously monitors the gaseous activity released to the environment from the waste gas decay tanks. The waste gas decay tanks contain radioactive noble gases that, after laboratory analysis, may be released through the unit vent on a controlled basis.

The setpoint for the waste gas discharge monitor is based on the concentration of the tank to be discharged, as determined by laboratory analysis. Waste gas discharge radioactivity in excess of a preset limit indicates an improper discharge valve line up or possible valve leakage from a source of high gaseous activity. The discharge is automatically terminated and an alarm is initiated in the control room when the preset level of gaseous activity is detected in the waste gas discharge flow.

11.5.1.2.2.7 Condenser Air Ejector Exhaust Monitor

The condenser air ejector exhaust monitor continuously monitors the gaseous activity released to the unit vent from the condenser air ejector exhaust. The condenser air ejector exhaust may contain airborne radioactivity in the event of a primary to secondary leak in the steam generator. In the event a level of radioactivity in excess of a preset limit is detected by the condenser air ejector exhaust monitor, the monitor will actuate a control room alarm and terminate steam generator sample and blowdown flow by initiating closure of the sample line isolation valves, blowdown flow control valves, atmospheric vent valves, and the Turbine Building sump valve. Termination of sample and blowdown flow prevents the release of radioactivity to the environment during analysis of steam generator water or during blowdown of the steam generators to the Turbine Building sump. Sampling may be continued by individually sampling each steam generator through the Nuclear Sampling System to determine the source of radioactivity. Blowdown may be continued by realigning the blowdown flow path to the Condensate System.

The normal concentration of gaseous activity expected from the condenser air ejector exhaust is 8E-5 µCi/ml, assuming the steam concentrations of Table 11-4. Gaseous activity in the condenser air ejector exhaust which exceeds a preset limit is alarmed in the control room. A typical gaseous activity setpoint for the condenser air ejector exhaust monitor is "… assuming no identified leakage, is 200 cpm or approximately 30 GPD."

11.5.1.2.2.8 Containment High Range Monitors

The containment high range monitors consists of two physically and electrically separated ion chambers located inside the Reactor Containment to measure high range gamma radiation. In the event high gamma activity is detected inside the containment, the containment high range monitors will automatically terminate discharge flow from the containment sump pumps and containment ventilation unit drain header, and will actuate an alarm in the control room.

A typical setpoint for the containment high range monitors is 100R/hr, selected as being low in the LOCA range but high enough to avoid spurrious trips.

Seismic and environmental qualification of these monitors are discussed in Section 3.10 and 3.11, respectively.

11.5.1.2.2.9 Technical Support Center Air Intake Monitors

The technical support center air intake monitors continuously monitor the gaseous activity in each of the two technical support center air intake ducts. For each air intake, a 1SCFM air sample is taken from the ventilation duct, monitored by the gaseous activity detector provided for that air intake, and returned to the ventilation duct.

The normal concentrations of gaseous activity expected for the technical support center air intakes are provided in Table 12-9. Gaseous activity in a technical support center air intake which exceeds a preset limit actuates an alarm in the center and automatically initiates isolation of the affected air intake. A typical gaseous activity setpoint for the technical support center air intake monitors is 1.7E-4 µCi/ml, based on a 2mR/hr submersion dose in a semi-infinite Xe-133 cloud.

11.5.1.2.2.10 Waste Monitor Tank Building Ventilation Monitor

The Waste Monitor Tank Building Ventilation Monitor continuously monitors the gaseous activity level of the Monitor Tank Building Ventilation System exhaust to the environment. In the event that radioactivity in excess of a preset limit is detected in the exhaust stream, the Waste Monitor Tank Building Ventilation Monitor will actuate alarms in the main control room, the Waste Monitor Tank Building control room and the remote monitor tank building control panel located in the Auxiliary Building.

The setpoint for this monitor is based on methodology and dose parameters in SLCs and ODCM, and a waste monitor tank building flow rate of 11,000 CFM. This action level is set at approximately 2% of the site boundary limit in order to prevent exceeding administrative limits at the site boundary while releasing simultaneously from a single unit vent and the waste monitor tank building vent.

11.5.1.2.2.11 Annulus Monitor

The annulus monitor continuously monitors gaseous activity in the annulus. The monitor normally draws a sample simultaneously from four different locations within the annulus, allowing evaluation of airborne radioactivity levels prior to entry into the annulus. In addition, elevated levels of radioactivity in the annulus indicate a breach of the containment vessel. The sample is returned to the annulus. In the event that radioactivity in excess of a preset limit is detected, the annulus monitor actuates an alarm in the control room. The monitor will also isolate the inlet line and purge the sample line with air from the Auxiliary Building. The purge air will be exhausted to the annulus to avoid the concern of high radiation exposure to equipment in the area of the monitor and the Auxiliary Building portion of the sample line.

A typical setpoint for the annulus monitor is (7E-6 µCi/ml *correlation factor) plus existing reading (in cpm).

11.5.1.2.3 Adjacent-to-Line Monitoring

Adjacent-to-line monitors are provided to monitor liquid or gaseous systems that are difficult to monitor by conventional liquid or airborne monitors using sampling equipment. These monitors are located adjacent to process piping to monitor radioactivity contained in the process stream. The radioactive concentrations in the systems flowing through the piping can be inferred from this information. The monitors also provide alarms in the control room when the levels of radioactivity reach a preset value, indicating an undesirable condition.

Table 11-22 identifies each adjacent-to-line monitor including its range and location.

The following section describes the process and effluent adjacent- to-line monitors.

11.5.1.2.3.1 Reactor Coolant Monitor

The Reactor Coolant monitor is an adjacent-to-line monitor utilizing a GM gamma detector that continuously monitors the radioactivity levels in a sample stream of reactor coolant. Low flow in the sample line is annunicated in the control room. Reactor coolant radioactivity in excess of a preset limit, as detected by this monitor, actuates a control room alarm to alert the operator to a possible failure in the fuel cladding. A correlation curve is used to convert the detector readings to percent failed fuel.

11.5.1.2.3.2 Steam Generator Leakage Monitors

The Steam Generator Leakage monitors are adjacent-to-line monitors utilizing scintillation detectors to continuously monitor the presence of the Nitrogen-16 isotope in the main steam lines. There is one monitor adjacent to each of the four steam lines. Radioactivity in excess of a preset limit, as detected by these monitors, actuates a control room alarm to alert the operator to a possible steam generator tube leak.

11.5.1.2.4 Alarms and Indication

Alarms and indicators for the Process and Effluent Radiological Monitoring System are located in the control room, with the exception of those associated with the Technical Support Center. Alarms and indicators for the Technical Support Center are provided locally.

Alarms are provided to alert the operator when the liquid or airborne radioactivity levels in process or effluent streams exceed their preset limits; alarms are also provided to alert the operator to abnormal monitoring system operation (e.g., low sample flow to off-line detectors). For each monitor an alarm condition is annunciated in the control room by a flashing light and an audible warning signal.

Control room indication of the radioactivity levels in the monitored process and effluent streams is provided by level meters. Trend recorders are also provided in the control room to record the output of radioactivity monitors as selected.

11.5.1.2.5 Calibration and Testing

One of each different type of radioactivity monitor is factory calibrated utilizing isotopic primary calibration sources that are traceable to the National Institute of Standards and Technology (NIST) with the exception of the steam generator leakage monitors. Based on this primary standards calibration, a secondary calibration source is prepared for each of the different types of monitor. All remaining monitors of a given type are calibrated with the secondary calibration source. The secondary calibration sources, along with the initial calibration data for each monitor, are forwarded to the station with the monitoring equipment to allow periodic calibration and calibration checks.

Each of the low range process and effluent radiological monitors is provided with an installed check source located at the detector. Remote control of each check source is provided in the control room to allow for periodic functional testing of the monitoring system.

The steam generator leakage monitors are calibrated using a reference source to ensure the N-16 gamma is registered by the detector. These monitors do not have a checksource.

Primary calibrations are sometimes performed on site. NIST traceable isotopic sources (such as Ba-133 and Cs-137 for liquid monitors) are used. Each detector's high voltage and discriminator voltage are adjusted to optimal values. Secondary transfer sources are then applied to the detector and the response is recorded. The responses and source activity are used to determine a correlation value for the monitor, and a reference count rate to be used in the periodic channel calibration. If calibrations are performed on a representative sample of detectors, the responses can be used to determine a reference count rate for all detectors of that type.

11.5.1.2.6 Maintenance

The liquid and airborne Process and Effluent Radiological Monitoring System detectors are housed in detector wells that protrude into removable sample chambers. Process and Effluent Radiological Monitoring System detectors are not in direct contact with the process or effluent streams and, therefore, are not subject to contamination. The use of detector wells allows for detector replacement without requiring that the process system be opened.

Removable sample chambers are employed to allow for isolation and replacement of chambers which become contaminated.

11.5.1.2.7 Power Supplies

The majority of the Process and Effluent Radiological Monitoring System is powered from the battery-backed 120VAC Auxiliary Control Power System as described in Section 8.3.2. The system sample pump motors are powered from the 4160V Blackout Auxiliary Power System as described in Section 8.3.1.

Each of the two containment high range monitors are powered from separate trains of the 120VAC Vital Instrumentation and Control Power System as described in Section 8.3.2.

The technical support center air intake monitors are powered from the 120VAC Technical Support Center Power System. This power system can be supplied from the blackout bus of either Catawba unit.

11.5.2 Effluent Radiological Sampling

Periodic sampling is performed to supplement the effluent radiological monitoring systems described above. The sampling programs meet Regulatory Guide 1.21. All stored wastes are sampled and samples analyzed before release of wastes to the environment. All continuous effluents that are potentially radioactive are periodically sampled and analyzed. Comparisons will be made between gross radioactivity measurements of continuous monitors and analyses of specific radionuclides as required by Regulatory Guide 1.21.

11.5.2.1 Bases for Selecting the Location

The waste monitor tanks, recycle monitor tanks (when tank contents are discharged to the environment), containment, and waste gas decay tanks are sampled prior to release to the environment, and analysis will be performed to determine the constituent radionuclides and the concentrations, in order to set the proper release rates in accordance with the Selected Licensee Commitments and 10CFR 20. Steam generator blowdown and upper shell, condenser air ejector exhaust, and steam generator feed water samples are taken periodically to determine if there is leakage of reactor coolant into the secondary side. These samples supplement the continuous monitors for detection of leakage into the secondary side described above.

A periodic sample is taken of the unit vent to quantify specific radionuclides that are being discharged from the station from various gas discharges. This sample supplements the continuous unit vent monitor described in Section 11.5.1.2.2.1.

11.5.2.2 Expected Composition and Concentrations

The specific radionuclides compositions will vary for each release from the waste monitor tanks, recycle monitor tanks, containment, or waste gas decay tanks. The estimated radioactive releases in liquid effluents are discussed in Section 11.2.3. The estimated radioactive releases in gaseous effluents are discussed in Section 11.3.3.

11.5.2.3 Quantity Measured

Gamma spectral analyses are made to determine constituent radionuclides (such as I-131 and Cs-137) and quantities (hence concentrations). Measurements are also made to determine gross alpha, strontium-89, strontium–90, and tritium concentrations in the liquid samples and gaseous samples.

11.5.2.4 Sampling Frequency, Type, and Procedure

The frequency of sampling is in accordance with the Selected Licensee Commitments and Regulatory Guide 1.21. Samples are collected by radiation protection and chemistry personnel and analyzed and measured in the Counting Room as well as other accredited offsite laboratories in accordance with station operation procedures concerning the release of radioactive waste.

The waste monitor tanks, waste gas decay tanks, containment, and condenser air ejector exhaust are sampled from local sample points and connections. The recycle monitor tank is sampled in the nuclear sampling room. The steam generator feedwater is sampled in the conventional sampling room, and the steam generator blowdown is sampled from either the conventional or nuclear sampling rooms, or local points.

The liquid contents of the tank being sampled are recirculated prior to taking the sample to ensure mixing of the tank contents. All sample connections are located in a free flowing stream or in a location that a representative sample may be taken. The sample lines are purged for an adequate period of time before the sample is taken to ensure that the sample is representative. A sample vessel is provided with quick disconnects for collecting a gas sample of the waste gas decay tanks.

11.5.2.5 Analytical Procedure and Sensitivity

Analyses and sensitivities are in accordance with the Selected Licensee Commitments and Regulatory Guide 1.21 using Counting Room instruments described in Section 12.5. Analytical procedures are those utilized in general practice in the nuclear industry or in applicable standards. The accuracy and precision of the results are standardized with central or outside laboratories using radioactivity standards traceable to the National Institute of Standards and Technology (NIST).

11.5.3 Effluent Monitoring and Sampling

General Design Criterion 64 requires monitoring of effluent discharge paths. As described in Section 11.5.1, continuous monitoring is provided for all gaseous and liquid effluent paths by which detectable quantities of radioactivity could be released from the station during normal operations including anticipated operational occurrences. In addition, as described in Section 11.5.2, samples of processed gases and liquids are analyzed before release of these fluids is begun.

11.5.4 Process Monitoring and Sampling

Means are provided to control the releases of radioactivity to the environment in accordance with the requirements of General Design Criterion 60. Sufficient holding capacity is provided for processed wastes to allow in-plant decay of the short-lived radionuclides and to allow release of the remaining radioactivity to the environment under favorable conditions. Samples of the wastes are analyzed before any release to the environment is permitted. During actual releases, continuous detection of gross radioactivity is employed as described in Sections 11.5.1.2.1.9 and 11.5.1.2.2.6. Also, as described in these sections, if the detected radioactivity level exceeds the monitor setpoint, the release is automatically terminated.

General Design Criterion 63 requires the provision of instrumentation to detect excessive radiation levels in radioactive waste systems and associated handling areas.

The area radiation and airborne radioactivity monitoring instrumentation described in Section 12.3.4 detects levels that are excessive in areas surrounding waste systems. The process and effluent radiological monitors described in Section 11.5.1 detect levels that are excessive within their respective system.

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11.6 Monitor Tank System

This section describes the design and operating features of the Monitor Tank System. The purpose of the Monitor Tank System is to provide additional processing capability to the existing Liquid Waste (WL) Systems and the Steam Generator Drain Tanks. It also provides condensate powdex processing capability and additional monitor tank capacity.

11.6.1 Design Bases

The Monitor Tank System is designed to increase WL System process rates and ensure segregation for the various liquid waste streams. The Monitor Tank System is also designed to accommodate portable modular equipment to provide surge capacity and processing flexibility for load cycling, condenser ice melt and volume reduction requirements. The equipment and components associated with the Monitor Tank System are designed as part of the Liquid Radwaste Treatment System (WL).

Annual quantities released from the WL system, listed by radionuclide and the resulting doses to individuals at or beyond the site boundary are discussed in Section 11.2.3. Release points for the WL System and the Monitor Tank System are indicated in Figure 2-4.

Monitor Tank System component parameters are shown in Table 11-21. Component design objectives, criteria and processing routes are discussed in Section 11.6.2.2. The WL System and the Monitor Tank System provide sufficient surge capacity to handle the worst case maintenance - that of shutting down a unit, draining and flushing the radioactive water from a steam generator contaminated by a tube leak, and holding that water for decay and/or treatment prior to release to the environment.

All Monitor Tank System equipment is housed in the Monitor Tank Building (MTB) which is located north of the Unit 2 Turbine Building. The Monitor Tank Building and its components are designed in accordance with the guidance provided in Duke Nuclear Guide 1.143. Thus, the foundations and walls of the building are designed to the appropriate seismic criteria to a height which is sufficient to contain the maximum liquid inventory expected to be in the building. A non-seismic trench design for transporting piping between the MTB and the plant was adopted and provisions were made for routing collected liquids to the liquid radwaste treatment system. Sumps are provided in the trenches, the discharges from which are routed to either the MTB sump or a sump in the Auxiliary Building.

The equipment and components, including piping, associated with the Monitor Tank Building are designed as part of the liquid radwaste treatment system (WL). Since the impact of this system on safety is limited, the design is governed by the specifications of Duke Class E (Nuclear Guide 1.26), which is both non-seismic and non-safety. All supporting systems, including air, water and power, are also non-seismic and non-safety.

Five "trains" of processing capability serving each of two Steam Generator Drain Tanks, along with three identical monitor tanks and pumps, provide both processing flexibility and some measure of redundancy. However, no part of the system is required to be operated under emergency conditions.

Due to the nature of material and chemical storage in the Monitor Tank Building and the similarities with comparable areas of the Auxiliary Building, fire detection and automatic sprinkler systems are not required. Fire extinguishers are provided at various locations in the building and a fire escape is provided for personnel safety.

The Monitor Tank Building and associated trenches do not house any equipment which is important to safety and being a remote facility, cannot adversely affect any equipment which is important to safety. An accident or malfunction within the facility can, however, result in a radioactive release to the environment. The most severe consequences would follow a tank failure, but this does not represent an accident of a different type than that which is already analyzed in Section 15.7.

The accident which is already analyzed is the failure of the refueling water storage tank (RWST) which results in the release of 395,000 gallons of contaminated water directly to Lake Wylie. Since the total volume of all MTB tankage is much less than that of the RWST and since the radionuclide concentrations of liquids within the MTB will be less than those assumed in the RWST analysis, the consequences of the MTB accident will be much less severe than the RWST accident. The releases resulting from the postulated RWST failure were determined to be within the limits of 10CFR 20, Appendix B.

Therefore, accidents and malfunctions within the Monitor Tank Building will not affect the safe operation or shutdown of the plant and will not adversely affect the health and safety of the public.

11.6.2 System Description and Functions

11.6.2.1 General Description

The Monitor Tank System is shown on Figure 11-37 thru Figure 11-39. The Monitor Tank System consists of several major components and areas contained in the Monitor Tank Building. The Monitor Tank System includes the Monitor Tank Process Train, the Powdex Tank Process Train and Support Areas.

11.6.2.1.1 Monitor Tank Process Trains

The monitor tank sub-system provides capability for the processing of liquid wastes from the WEFT, FDT and SGDTs via the semi-permanent modular equipment located in the Process Room. Such equipment may include demineralizers, filters and other purification equipment deemed necessary. Water passes through the process equipment, to the monitor tanks for monitoring and sampling prior to release to the RL System discharge.

11.6.2.1.2 Powdex Tank Process

The powdex tank provides storage capacity for radioactive condensate powdex transferred from the Turbine Building. In addition, capability is provided for dewatering and subsequent transfer to a truck mounted shipping liner for burial at an appropriately licensed burial site.

11.6.2.1.3 Support Areas

Support areas include the Truck Bay, Sample Room, Lab, Control Room and Change Areas. Other appropriate areas are also included.

11.6.2.2 Design Bases

11.6.2.2.1 Tanks

11.6.2.2.1.1 Auxiliary Monitor Tanks (AMT)

The auxiliary monitor tanks are 3 - 20,000 gallon tanks which receive waste which has been processed in the Process Room. The tanks are located in the Monitor Tank Room and are constructed as a stainless steel right cylinder. A flash mixer, which is controlled from the control panel, is located on each tank to provide 50 gpm throughput operability for low-activity/high-volume waste and to remove gasses in high-activity/low-volume waste. Ladder access and a catwalk are provided to each tank for mixer access and maintenance.

11.6.2.2.1.2 Powdex Storage Tank (PST)

The powdex storage tank is a 30,000 gallon tank which may receive radioactive powdex from the condensate demineralizers, or spent resins from MTB ion exchange vessels for dewatering prior to transfer for shipping. The tank is a stainless steel right cylinder with a conical bottom and mixer. The mixer is controlled from the control panel. Multiple connections are provided for tank dewatering. Sight glasses on the side of the tank serve to check tank powdex level. Ladder access is provided to the tank for mixer access and maintenance.

11.6.2.2.2 Pumps

11.6.2.2.2.1 Monitor Tank Pumps

These pumps are capable of transferring water from the monitor tanks to the RL system. They also have tank recirculation and transfer capability within the Monitor Tank Building. The design basis for these centrifugal pumps is based on a 200 gpm discharge to the RL system, with system pressure drop requirements as calculated. Material of construction is stainless steel. Controls are located on the MTB control panel and on the Auxiliary Building control panel. These pumps are also protected by a Lo tank level alarm and trip.

11.6.2.2.2.2 Powdex Dewatering Pump

This pump is capable of transferring water from the powdex storage tank via dewatering connections, through filtration and other processing equipment in the Process Room and back to the monitor tanks. Material of construction is stainless steel. Pump controls are located on the MTB control panel and on the Auxiliary Building control panel.

11.6.2.2.2.3 Powdex Transfer Pump

This pump is capable of transferring process media from the powdex storage tank to a liner. This is a peristaltic type hose pump. Material of construction is stainless steel. Main controls are located on the MTB control panel and on the Auxiliary Building control panel.

An emergency pump cut off is located in the Truck Bay Area for use during resin transfer to a truck mounted cask liner.

11.6.2.2.2.4 Monitor Tank Building Sump Pumps

Floor drains and equipment drains are routed to the monitor tank building sump. Sump pumps are provided to transfer water which is collected in the sumps to the SGDT. In addition to automatic controls supplied by sump level switches, manual control is provided on the MTB control panel and on the Auxiliary Building control panel. Sump pump motor run time counters are also provided to track waste collection and leakage.

11.6.2.2.3 Structures

The Monitor Tank Building is designed with seismic floor and curb walls (seismic "bathtub" concept, OBE per Duke Nuclear Guide 1.143) with the exception of the sample, lab, control room, truck bay and change areas. Since these areas are not involved in waste processing or storage, seismic requirements do not apply. The general construction of the seismic portion of the building is seismic curb walls (approx. 3.5') with a conventional building superstructure, shield walls are provided where required. Roof height is approximately 45' from grade.

11.6.2.2.4 HVAC

Monitor Tank Building HVAC requirements are divided into three areas:

Area 1. This includes the portions of building which require ventilation due to the presence of process equipment. The entire seismic portion of the building is included in the area, plus the Truck Bay. This consists of the Powdex Tank, Powdex Pump, Monitor Tank and Process Rooms and the Inlet Valve Gallery, Corridor and Truck Bay. Climate control in Area 1 is sufficient for general equipment protection, habitability for work and freeze protection. The Monitor Tanks are vented through carbon filters and HEPA filters prior to monitored release.

Areas 2 and 3. These areas occupy the non-seismic portion of the building. Area 2 includes the Change Area, the Sample Room and the Control Room. Area 3 consists of only the Lab. These rooms have climate control for general protection of equipment, inhabitability for work and freeze protection. The Sample Room also has exhaust provisions for the 2 sample hoods. Area 3 has climate control to meet instrumentation requirements, which are similar to Auxiliary Building Hot Lab requirements. Exhaust is also provided for the lab hoods and trunks for portable equipment.

11.6.2.2.5 Valves

All remotely operated valves will be operated from the Monitor Tank Building control panel and from the Auxiliary Building radwaste area control panel, unless otherwise specified. Indicating lights will be provided on each panel to verify position.

11.6.2.2.6 Mixers

A flash mixer is provided in each AMT and in the Powdex Storage Tank. Each mixer will be operated from the MTB control panel or the Auxiliary Building control panel.

11.6.2.3 Electrical Power Requirements

All electrically powered equipment in this system is supplied from non-vital buses, as it is not required to be operated under emergency conditions. A single 575VAC motor control center with normal and alternate incoming power connections from the main plant are provided in the Monitor Tank Building. 208/120VAC power is available for low voltage loads. 125VDC power is not available. Operation of all valves and equipment is primarily from the Monitor Tank Building control panel although a redundant panel is located on the Auxiliary Building in the radwaste processing work area.

11.6.2.4 Water Chemistry

See Section 11.2.2.4 for WL System chemistry.

11.6.2.5 Thermal Insulation and Heat Tracing

Thermal insulation and heat tracing are not required for this system.

11.6.2.6 System Instrumentation and Control

Instrumentation consists of both local and remote indication. Remote indication is located both on the control panel in the Monitor Tank Building and in the waste control area of the Auxiliary Building, unless otherwise specified.

11.6.2.6.1 System Operation

The Monitor Tank System is operated manually except for the sump pump operation and automatic shutoff of certain pumps on low tank level. High tank level alarms are provided at the Auxiliary Building waste processing area to insure proper system operation.

11.6.2.6.1.1 Monitor Tank Process Train Operation

The monitor tank process train is divided into two waste cleanup trains. The loops are called Train A and Train B respectively. Train A is primarily intended for processing of the SGDT waste feed via the SGDT pumps located in the Auxiliary Building. Train B is primarily intended for unusual waste process streams such as powdex decant, turbine room sump and other unusual process streams. The two train inlet headers run the length of the Inlet Valve Gallery and can feed any of the process equipment. Flow passes through the appropriate cleanup equipment and to either the outlet header or to the crossover connections (which will allow waste to pass through several pieces of process equipment in series).

All process equipment is connected via temporary piping or hoses to the permanent flanged connection located along the walls of the Process Room. From the process equipment, the clean water flows to any of the Auxiliary Monitor Tanks for holdup and monitoring prior to release. Once a monitor tank is full, flow is diverted to one of the remaining tanks while the full tank is sampled. Sampling is accomplished by putting the tank in recirc using the appropriate Auxiliary Monitor Tank Pump and initiating flash mixer operation. Once mixing of the tank is complete, a sample is drawn at the Sample Room for analysis prior to release. If the tank contents meet release requirements, the monitor tank is discharged to the RL System using the appropriate monitor tank pump. If the sample shows that further processing is required, the pump can be used to transfer the tank contents through the process equipment and back to one of the two other Auxiliary Monitor Tanks, and the sampling process is repeated prior to release. All releases are monitored by the process radiation monitor located in the Monitor Tank Room. A high radiation signal closes the discharge valve 1WLX28, located in the Turbine Building, to prevent release.

11.6.2.6.1.2 Powdex Tank Process Train Operation

The powdex tank process train may be used to collect, dewater and transfer spent radioactive powdex from the condensate demineralizers, or spent resins from MTB ion exchange vessels. Powdex is transferred from the Polishing Demineralizer Backwash Tanks by the Backwash Tank Pumps. MTB ion exchange media is transferred into the PST by a Skid mounted pump. The media is allowed to settle and the Powdex Dewatering Pump removes the decant and transfers this water to one of the Auxiliary Monitor Tanks. Temporary filtration located in the

Process Room removes resin and fines which may remain in the decant. The process is repeated until the backwash tank is empty. When the Powdex Storage Tank is ready to be emptied, the Powdex Transfer Pump is used to transfer the contents to a shipping container for transport and subsequent burial at an appropriately licensed facility.

11.6.3 Estimated Radioactive Releases

Section 11.6.3, and its associated figures and tables such as Tables 11-11 and 11-12, include the bases and results of an analysis of estimated radioactive releases in liquid effluents and estimated doses from such releases. Unless specifically indicated otherwise, this is a prospective analysis performed prior to initial system operation, based upon estimates, and yielding expected results. A corresponding retrospective analysis is performed annually, based upon routinely updated information contained in the Offsite Dose Calculation Manual (ODCM) and the Annual Radiological Environmental Operating Report, and yielding actual results which are reported in the annual Radioacitve Effluent Release Report. Both of these annual reports, and all changes to the ODCM, are submitted the NRC as required.

The estimated quantity of radioactivity released in liquid effluents from each unit during normal operation, including anticipated operational occurrences, is shown in Table 11-11.

The methodology of NUREG-0017 (Reference 1) was used in determining liquid radioactive releases. Additional assumptions used are indicated in Section 11.2.3.

11.6.3.1 Release Points

All routine liquid discharges of detectable radioactivity are through the WL System (through the Low Pressure Service Water System) into Lake Wylie. One gaseous release point is located at the Monitor Tank Building. The locations of the discharge can be seen on Figure 2-4. In addition, very low levels of radioactivity are released through WC System into Lake Wylie.

11.6.3.2 Dilution Factors

Low Pressure Service Water provides dilution for WL System liquid waste. Dilution factors are discussed in Section 11.2.3.2.

11.6.3.3 Estimated Doses

Doses received by individuals as a result of radioactive liquid releases from the WL System are presented in Table 11-12. WL System estimated doses are discussed in Section 11.2.3.3.

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11.7 Radiological Ground Water Protection Program

By 2006, industry experience had confirmed that spills, leaks, and equipment failures at several commercial U.S. nuclear sites had led to inadvertent ground water contamination. Details of these experiences were documented by the Nuclear Regulatory Commission in NRC Information Notice (IN) 2006-13, Ground Water Contamination Due To Undetected Leakage of Radioactive Water (July 10, 2006). Lessons learned from these experiences were captured through the development of a series of industry guidelines. Using the Nuclear Energy Institute (NEI) Groundwater Protection Final Guidance Document, NEI 07-07 (August 2007), Duke Energy has established a radiological ground water protection program at Catawba Nuclear Station.

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