11.2 LIQUID WASTE MANAGEMENT SYSTEMS

In general, the liquid radwaste system collects, monitors, and recycles or releases, with or without treatment where appropriate, all potentially radioactive liquid wastes produced by the station during normal operation and maintenance, as well as transient conditions. The only exception is that effluent from the treated water system (Byron only), the condensate polisher sump and the turbine building fire and oil sump, because of minimal activity levels, is normally discharged without being processed through the liquid radwaste system. Effluent from these sumps is monitored by radiation monitors that will automatically terminate sump discharge if unacceptable activity is present in the sump effluent. Corrective action can then be initiated to reroute the sump effluents to the appropriate treatment system prior to release.

11.2.1 Design Bases

11.2.1.1 Safety Design Basis

The liquid radwaste system is designed so that liquid radwaste discharged from the site will have radioactive nuclide concentrations well within the limits specified in 10 CFR 20 and 10 CFR 50, Appendix I.

Each liquid radwaste processing stream terminates in a monitor tank (see Drawing M-48A). Since the liquid radwaste system operates on a batch basis, this arrangement allows each treated batch to be sampled to assure that the treatment was sufficient. If the sample indicates that the waste needs further processing, it is recycled either through the same subsystem or through another subsystem providing a different form of treatment. If the treated waste water is not needed for reuse, the water is sent to either release tank (OWX01T or OWX26T) for discharge. Each batch is sampled prior to discharge from the release tank to verify that its activity level is within limits for discharge. The actual discharge to the circulating water blowdown line requires manually opening a remotely operated valve with a keylocked switch. The key for the valve lock is controlled by administrative procedures.

11.2.1.2 Power Generation Design Basis

The liquid radwaste system is sized to handle maximum expected liquid waste inputs on the basis of both volume and activity as a result of normal operation, including anticipated abnormal occurrences for Units 1 and 2.

The liquid radwaste system is composed of the following two subsystems:

a. the steam generator blowdown subsystem, and

b. the nonblowdown radwaste subsystem.

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These subsystems are extensively crosstied to provide a high degree of availability and reliability.

The purpose of the steam generator blowdown subsystem is to maintain the steam generator water chemistry within specified limits.

The liquid radwaste system is designed to permit recycling of plant water. The stations are designed to minimize noncontaminated inputs from leakage of service water, circulating water, and groundwater into the plant floor drain system.

A cost-benefit analysis is not required for the liquid radwaste system. This is because Commonwealth Edison has complied with the Guides on Design Objectives for Light-Water-Cooled Nuclear Power Reactors proposed in the concluding statement of the position of the regulatory staff in Docket RM-50-2 dated February 20, 1974, pp. 25-30.

11.2.1.3 Expected Radioactive Releases

Byron and Braidwood Nuclear stations have uprated the core power level to 3586.6 MWt. The original licensed power level was 3411 MWt. The original expected liquid radwaste effluent data presented in the UFSAR is based on a power level of 3565 MWt.

Expected annual average releases of radionuclides from the liquid radwaste system are shown in Table 11.2-1. These releases were determined by using the NUREG 0017/PWR-GALE computer program (References 1 and 2). Both the original as well as the uprated parameters describing the expected normal operation of one unit of the station are listed in Table 11.2-2. These values were used as input to the computer code for the original analyses. The impact of core uprate on the effluent releases was evaluated based on an assessment of the changes in input parameters.

Core uprate results in a maximum potential increase of 0.6% in the liquid effluent release concentrations previously reported. Taking into consideration the accuracy and error bounds of the operational data utilized in NUREG 00017, this mall percentage change is well within the uncertainty of the calculated results of the original NUREG 0017 based expected liquid effluent concentrations presented in Table 11.2-4 which remain valid for uprate.

11.2.1.4 10 CFR 50 Comparison

Conservatively estimated annual average doses to individuals exposed to radioactive liquid effluents are given in Table 11.2-3. As can be seen from the total dose rates from the various exposure pathways, the numerical guidelines set forth in Appendix I to 10 CFR 50 are satisfied. As discussed in Section 11.2.1.3, this assessment and Table 11.2-3 remain valid for uprate.

11.2.1.5 10 CFR 20 Comparison

Table 11.2-4 compares expected liquid effluent concentrations with 10 CFR 20 limits. It can be seen that the expected effluent concentrations are significantly below the specified limits. As discussed in Section 11.2.1.3, this assessment and Table 11.2-4 remain valid for uprate.

11.2.1.6 Component Specifications

Table 11.2-5 gives the design parameters of various radwaste system components.

11.2.1.7 Seismic Design and Quality Group

The structures housing the liquid radwaste system are Safety Category I for the auxiliary building, and Safety Category II for the turbine building and radwaste building. All components (including tanks, pumps, valves, and piping) of the liquid radwaste system containing radioactive wastes are classified as Quality Group D, with the exception of the containment penetration piping out to and including the second isolation valve from the containment sump pump discharge, which is Quality Group B piping and valves (refer to Section 3.2).

11.2.1.8 Facility and Equipment Design

The liquid radwaste system is designed to minimize radiation exposure to operating personnel. Normal operations, maintenance, and nonroutine operations are discussed in the following.

11.2.1.8.1 Maintenance Operations

Wherever practicable, components of the liquid radwaste systems are segregated to the maximum extent practical. To reduce radiation exposure to maintenance personnel, components are arranged so that access to a low activity component does not necessitate passing near a high activity component. Instruments are located in low dose rate areas wherever practical to minimize the radiation exposure to maintenance personnel.

Valves, where practicable, are located outside of compartments to minimize radiation exposure from tanks or components during valve maintenance. Most radwaste pumps are equipped with mechanical seals to minimize maintenance.

In general, components which may require maintenance are capable of being flushed prior to maintenance.

11.2.1.8.2 Floor, Wall, and Ceiling Coatings

In rooms containing radioactive wastes, the floors, and as necessary, the walls and ceilings, are coated with a two-coat water base epoxy paint for ease of decontamination.

11.2.1.9 Tank Level Control

Provisions are made to preclude uncontrolled spills due to tank overflows. The following criteria apply to tanks outside the containment building which may contain radioactive fluids:

a. Tank level instrumentation is provided on most radwaste tanks with readout devices in the radwaste control room. A high-level condition on these tanks will be annunciated.

b. Some radwaste tanks overflow to an adjacent sump, as described in Table 11.2-9. Sumps are provided with duplex or triplex (redundant) pumps as appropriate. Sumps are level controlled and logic is provided to start and stop pumps automatically.

c. Provisions for tank level indication, level annunciation, and overflows are given in Table 11.2-9 for all tanks outside the containment building containing potentially radioactive liquids.

11.2.1.10 Prevention of Uncontrolled Releases

Based on operating experience during normal operations, it is expected that it will be necessary to make controlled releases of contaminated steam and condensate leakage to the environment. During normal operations, these releases of radioactive liquids to the environment are from the release tank after processing, as needed, by the liquid radwaste system.

As a batch of waste is processed, the effluent is transferred to an appropriate monitor tank (e.g., blowdown monitor tanks, boric acid monitor tanks, and radwaste monitor tanks) for sampling prior to being transferred to the release tanks or being reprocessed. In the release tanks, the liquid is mixed and sampled for activity prior to discharge. The release tanks discharge must pass through either one of two remotely controlled keylocked valves (0WX353 and 0WX896 on Drawing M-48-1) to be released from the station. Limit switches supply status information on the valve position to the operator at the radwaste control panel. A radiation monitor is provided to automatically close the valves on a high radiation signal.

In addition, effluents from the treated water system, the condensate polisher sump and the turbine building fire and oil sump are released to the environment. While normally considered non-radioactive, these effluents can potentially become contaminated, and the sump effluents are monitored by radiation monitors which will halt sump pump operation if unacceptable activity levels are present in sump effluent.

11.2.1.11 ETSB-BTP 11-1 Comparison

The liquid radwaste system is designed to meet the design criteria of the former Effluent Treatment Systems Branch (ETSB), Branch Technical Position BTP 11-1, Revision 1, and meets the criteria of Regulatory Guide 1.143, as described in Appendix A.

11.2.2 System Description

The liquid radwaste system is shared by both units. Unit 1 and Unit 2, however, have separate equipment and floor drain collection sump systems. Process flow diagrams are shown in Drawing M-48A. The systems are depicted in Drawings M-48-1 through M-48-40.

Inputs to the system are separated according to origin and/or concentrations of radioactivity and chemical impurity. Separate collection tanks are provided for each input stream. The waste is routed from the collection tanks to the appropriate processing paths. The system processes the radioactive liquid waste by various combinations of filtration, evaporation (Braidwood only), and/or demineralization.

Provisions are made to bypass any processing device. The release tanks cannot be bypassed.

After being processed through the various equipment items, the purified effluent can be reused as secondary cycle makeup, or released to the environment via the circulating water blowdown line.

The liquid radwaste system is designed to handle wastes generated during design-basis operational occurrences. This is accomplished by providing sufficient process capacity within the subsystems and collection and monitor tanks of adequate size.

The liquid radwaste system consists of two crosstied subsystems:

a. steam generator blowdown subsystem, and

b. non-blowdown radwaste subsystem which treats the following waste streams:

   1. auxiliary building equipment drains,

   2. auxiliary building floor drains,

   3. chemical waste drains,

   4. regeneration waste drains,

   5. laundry (detergent) drains,

   6. turbine building equipment and floor drains when contaminated, and

   7. condensate polisher sump when unacceptably contaminated.

Expected concentrations of radioactive nuclides in the various input waste streams to the radwaste subsystems are listed in Table 11.1-6. Expected inventories of radioactive nuclides in major components of the liquid waste system are tabulated in Tables 11.1-7 through 11.1-12. Table 11.2-6 lists the annual average and maximum expected daily flows of each waste stream. The expected activities in Table 11.1-1 correspond to the annual average daily flows. The activities for the maximum daily flows vary significantly. Actual release data are available in the effluent release reports, which are prepared in accordance with the ODCM.

Table 11.2-7 lists the design-basis decontamination factors for the processing components used in the analysis of the systems.

The original steam generator blowdown prefilters were replaced with larger prefilter units. However, the expected average and maximum waste stream flows and the design basis decontamination factors for the steam generator blowdown prefilters were not revised to account for the larger prefilter volume. |

11.2.2.1 <u>Steam Generator Blowdown Subsystem</u>

The function of the steam generator blowdown subsystem is to maintain steam generator shell side water chemistry within the specified limits. Continuous blowdown constantly removes impurities from the steam generator. The flow rate is varied as required to maintain the steam generator water chemistry within the required limits.

At Byron, steam generator blowdown may be sent to the condensate polisher sump to improve secondary chemistry when excessive impurities are present that would quickly exhaust steam generator blowdown demineralizers.

For a further description of the steam generator blowdown subsystem, see Subsections 10.4.8 and 10.4.9.3.1.

The components of the steam generator blowdown treatment subsystem include four blowdown prefilters; four blowdown mixed bed demineralizers; four blowdown demineralizer after filters; three blowdown monitor tanks; and associated pumps, valves, and instrumentation.

11.2.2.1.1 Normal Operation

Steam generator blowdown is operated in a normal range of 15 to 90 gpm per steam generator, depending on steam generator chemistry requirements. During normal operation, blowdown is pumped from the steam generator blowdown condenser hotwells through the blowdown prefilters, the blowdown mixed-bed demineralizers, and the blowdown after filters to the condensate storage tanks or respective unit hotwell. In the event of high radioactive material in the purified effluent leaving the blowdown mixed-bed demineralizers, the effluent is diverted to the monitoring tanks. Unit 1 and Unit 2 blowdown is normally segregated, as the Unit 1 and Unit 2 condensate storage tanks are normally segregated.

Blowdown from each steam generator is sampled and analyzed at periodic intervals to determine:

a. If the blowdown flow rate requires adjustment to maintain the steam generator water chemistry limits.

b. If leakage condition exists, either at the main condenser or primary to secondary leakage within one or more steam generators so that remedial action can be taken.

c. If the method of processing the blowdown should be changed.

The time interval between samples of the blowdown from each steam generator depends upon operating experience.

The effluent from each blowdown mixed bed demineralizer is directed through a blowdown afterfilter to a header which is valved so that Unit 1 effluent is normally separated from Unit 2 effluent. Conductivity of each effluent stream from the blowdown mixed bed demineralizers is monitored. The processed liquid can be routed to either Unit 1 or Unit 2 condensate storage tanks as described above or to a monitor tank. The water in the blowdown monitor tanks is normally drained to the turbine building floor drain system. The water may also be used to sluice blowdown demineralizers or to backwash blowdown demineralizer strainers.

In addition to processing steam generator blowdown, the blowdown mixed bed demineralizers can be used for processing turbine building equipment drains, turbine building floor drains, and for the further processing of the purified effluent from the radwaste subsystems via the radwaste and blowdown monitor tanks. This practice is not recommended for normal operation.

Effluent from the blowdown prefilters of each unit can be diverted to each of the three radwaste evaporators (Braidwood only).

11.2.2.1.2 Circulating Water to Secondary System Leakage

In the event of condenser tube or tube sheet leakage, the blowdown rate may be increased to 360 gpm (180,000 lbs/hr) total per unit to keep the steam generator shell side chemistry within operating limits. The blowdown rate from the four steam generators would be approximately 90 gpm for each steam generator.

11.2.2.1.3 Primary-to-Secondary-Leakage Concurrent with Failed Fuel

The radioisotope concentration in the steam generator blowdown is given in Table 12.2-30 and Table 11.1-6. If primary to secondary leakage occurs in only one steam generator, the blowdown rate from nonleaking steam generators remains high enough to maintain chemistry specifications while the blowdown rate from the leaking steam generator may be increased to the design rate of 90 gpm.

11.2.2.1.4 Primary-to-Secondary Leakage Not Concurrent with Failed Fuel

The steam generator blowdown during primary-to-secondary leakage not concurrent with failed fuel will be processed as discussed in Subsection 11.2.2.1.3 during transient operating conditions.

11.2.2.1.5 Transient Operating Conditions

Increased blowdown may be used to keep the steam generator water chemistry within specifications.

11.2.2.2 Nonblowdown Liquid Radwaste Subsystem

This processing train collects and treats liquid radwastes from sources other than steam generator blowdown. The mode of operation is batchwise. The nonblowdown liquid radwaste subsystem includes the following input sources:

a. auxiliary building equipment drain,

b. auxiliary building floor drain,

c. chemical waste drain,

d. regeneration waste drain,

e. laundry (detergent) drain,

f. turbine building equipment and floor drain (when contaminated),

g. turbine building fire and oil sump (when contaminated) (Byron only),

h. condensate polisher sump when unacceptably contaminated, and

i. waste treatment system (when contaminated) (Byron only).

Each drain system except the chemical waste, regeneration waste, and laundry drains, has two drain collection tanks. The chemical waste and regeneration waste drains utilize one tank each plus a shared dual purpose chemical/regeneration waste drain tank. Waste is usually collected in one of two drain tanks. The contents of the other tank may be sampled or processed. The sample is taken from the recirculation line. Chemical additions to adjust the wastewater pH or filter aids may be added to improve waste processing efficiency.

Oil separators are provided in those sumps that could potentially have oil in the water. A filter is installed downstream of each drain tank pump discharge header, or drain tank effluent is sent to vendor-installed equipment for filtration as needed.

The radwaste evaporator inlet header receives liquid wastes from the previously mentioned drain tanks. The liquid wastes entering the radwaste evaporator inlet header normally bypass the evaporators and are processed by the radwaste demineralizers or by the vendor demineralizers.

At Byron, nonessential service water to the radwaste evaporator skids has been isolated permanently. Blank plates have also been installed in the inlets to the evaporators to prevent liquid wastes from entering.

The radwaste monitor tanks collect radwaste demineralizer effluent. The tanks' contents will be mixed and sampled prior to being transferred to the release tank.

Wastewater may be routed from the radwaste monitor tanks to vendor taps in the radwaste building for additional processing, as needed, and returned to the installed radwaste system for monitored discharge.

Based on this sample and station water balance considerations, the water may be reprocessed or discharged via the release tanks.

See Table 11.2-6 for the design-basis average and maximum waste stream flows for the various inputs that are discussed in the following. Also refer to Table 11.1-6 for the realistic source terms for these inputs.

At Byron, effluent from the condensate polisher sump, from the turbine building floor and equipment drains (collected in the turbine building fire and oil sump) and from the waste treatment system is processed by the radwaste system if the contamination exceeds effluent limits for the sumps. The sump effluent is monitored by radiation monitors to ensure that ODCM limits are maintained.

At Braidwood, effluent from the condensate polisher sump and from the turbine building floor and equipment drains is processed by the radwaste system if contamination levels exceed effluent limits. The turbine building fire and oil sump effluent is monitored by a radiation monitor to ensure that ODCM limits are maintained.

11.2.2.2.1 Auxiliary Building Equipment Drain

Input sources to the auxiliary building equipment drain tanks include the following:

a. auxiliary building equipment drain collection sumps,

b. reactor coolant drain tank, and

c. spent resin tank drains (Braidwood only).

The waste is normally processed through demineralizers.

11.2.2.2.2 Auxiliary Building Floor Drain

Input sources to the floor drain tanks include leakage from pump seals and stuffing boxes, valve stem packing, equipment overflows, and spills. Oil separators are provided in the subsystem's sumps.

Input sources to the auxiliary building floor drain tanks include the following:

a. reactor cavity sumps,

b. containment floor drain sumps,

c. auxiliary building floor drain sumps,

d. fuel handling building floor drain sumps, and

e. radwaste building sump.

The two tanks are sized to accommodate the maximum accumulation of wastes expected in 1 day. The processing flow paths are the same as in the auxiliary building equipment drain.

11.2.2.2.3 Chemical Waste Drain

Input sources to the chemical drain tank and the dual purpose chemical/regeneration drain tank include the following:

a. laboratory drains,

b. fuel handling building decontamination sump,

c. samples containing tritiated water and chemicals required for analysis,

d. drumming station sumps,

e. boric acid processing system,

f. primary water storage tank, and

g. any other high-conductivity radioactive drains.

One tank is provided solely for the chemical drains. A second tank is used as a dual purpose chemical/regeneration waste drain tank. These wastes are processed through a demineralizer.

11.2.2.2.4 Regeneration Waste Drain

Input sources to the regeneration waste drain tank and the dual purpose chemical/regeneration waste drain tank include the following:

a. spent resin sluicing drain header,

b. drumming station decanting tank overflows (Byron only),

c. release tanks (regeneration waste drain tank only), and

d. tendon tunnel sumps (when determined to be a source of radiation contamination into the fire and oil sump).

The blowdown and radwaste mixed bed demineralizers are replaced as often as is required to maintain the demineralizers effluent water quality.

11.2.2.2.5 Laundry Drain

The laundry drain tank collects detergent wastes from the radioactive laundry (Braidwood only), personnel decontamination shower and the TSC drains and showers. These waste streams are sent to the release tanks for release or a radwaste demineralizer for further treatment.

11.2.2.2.6 Turbine Building Equipment Drain

Secondary system drains are divided into turbine building equipment drain and turbine building floor drain. The turbine building equipment drain system can recover a large amount of condensate grade water for station reuse.

Two turbine building equipment drain tanks receive water from the turbine building equipment drain sumps. Since this drain water is from the secondary system, the water in the turbine building equipment drains are normally uncontaminated or only very slightly contaminated. The water is normally treated in the wastewater treatment plant for discharge. There are also flowpaths from the turbine building equipment drain system to the radwaste demineralizers and to the liquid release tank.

At Byron, in the event of excessive leakage of the primary coolant into the secondary system, the water may be processed in the waste treatment plant and returned to the release tank for discharge. At Braidwood, in the event of excessive leakage of the primary coolant into the secondary system, the contaminated water may be processed through the coalescer/carbon filters and through additional filtration as needed and discharged via the release tanks.

11.2.2.2.7 Turbine Building Floor Drain

The two turbine building floor drain tanks collect water from the turbine building floor drain sumps, condensate pit sumps, and essential service water sumps. These wastes are normally nonradioactive, except for tritium, and are released to the environment after filtration via the wastewater treatment (TR) system.

11.2.2.2.8 Turbine Building Fire and Oil Sump

Turbine building waste water collected in the fire and oil sump, including equipment and floor drain water, is monitored by a radiation monitor. Water from this sump is normally discharged to the waste treatment system for removal of oil and solids and then released to the environment via the circulating water system and blowdown line. However, if unacceptable radioactive contamination is detected, the sump pumps are automatically stopped and the water may be sent to the liquid radwaste treatment system, via the waste treatment system (Byron only). If the source of radioactive contamination is determined to be one of the tendon tunnel sumps, either tendon tunnel pump discharge can be sent to the regeneration waste drain tank for processing in the radwaste system. The water may be processed by the waste treatment plant and returned to the release tanks for discharge (Byron only).

11.2.2.2.9 Condensate Polisher Sump

Water in the condensate polisher sump is monitored by a radiation monitor on the sump discharge. Water from this sump discharge is normally directed to the circulating water system, and then released to the environment via the blowdown line. If a high radiation signal is detected, pump operation is automatically stopped and major condensate polisher inputs into the sump are automatically isolated. If samples confirm that the water is contaminated, the operator may manually change the valve lineup to send the water to the release tank for a monitored discharge.

11.2.2.2.10 Waste Treatment System

The input to the waste treatment system is the Turbine Building Fire and Oil Sump (see 11.2.2.2.8). Water processed by the waste treatment system is normally released to the environment via the circulating water system and blowdown line. If the radiation monitor on the Turbine Building Fire and Oil Sump should fail, an alarm will be annunciated in the radwaste control room, and the contents of the treated water system would be sampled. If the sample contains radioactive contamination, the system's contents would be pumped to the liquid radwaste system.

11.2.2.3 Operating Procedures

If the contents of a monitor tank are to be released, the required radioactivity analysis is performed prior to transferring the material to the release tank. The liquid is then pumped to a release tank where a sample is again taken and the required analysis is performed. Based on this analysis, the discharge rate is determined so that, when mixed with cooling water blowdown discharges, the water leaving the plant has a radioactivity level less than the applicable effluent concentration as stated in the Technical Specifications. A remotely operated valve with a keylocked switch may then be manually opened so that water can be discharged. The key for the valve lock is controlled by administrative procedures. As a further backup, a radiation detector monitors the liquid in the discharge line prior to the point where the liquid is mixed with the cooling water blowdown to the river. Upon detecting an abnormal level of radiation, a valve on the release tank line immediately upstream of the mixing point closes and an alarm signal is relayed to the control room. A composite sample of the cooling water blowdown is analyzed to verify that radioactive releases conform with the requirements of the Technical Specifications. Records are maintained of radioactive wastes discharged to the environment.

11.2.2.4 Performance Tests

Liquid wastes may be monitored before and after each processing step on a batch basis. The equipment is therefore subjected to continuous performance testing.

Data on specific isotope decontamination factors are not conclusive. This system was designed using conservative overall decontamination factors. These decontamination factors are based on guidelines from References 2, 4, and 5.

Through system cross-ties, redundancy of equipment, and excess storage capacity, ample provision has been made for equipment maintenance and for reprocessing treated effluents if required.

11.2.2.5 Control and Instrumentation

A large portion of the liquid radwaste system is controlled and monitored from the liquid radwaste control panel (LRCP) located in the radwaste control room. Radwaste and blowdown demineralizers and radwaste evaporator control panels and the liquid/solid radwaste interface are also located in the radwaste control room. The solid radwaste handling system control panel is located in the radwaste building.

Some subsystem operations are controlled by automatic sequencers. Instrumentation on radwaste system tanks includes, as a minimum, a high level detector for LRCP annunciation, a low level detector for pump cutoff, and LRCP level recording. The system instrumentation is shown in detail on Drawings M-48-1 through M-48-40.

11.2.3 Radioactive Releases

11.2.3.1 Release Points

All liquid radwaste system effluent paths for radioactive nuclides to the environment are suitably processed, monitored, and recycled or discharged via the release tanks in accordance with procedures outlined in Subsection 11.2.2.3. The radioactive waste release line joins the circulating water blowdown line. Water from the turbine building fire and oil sump, the condensate polisher sump and the treated water system (Subsections 11.2.2.2.8, 11.2.2.2.9 and 11.2.2.2.10), if not unacceptably contaminated, is discharged after suitable treatment into the circulating water flume, and released via the blowdown line.

11.2.3.2 Dilution Factors

At 100% capacity factor and design-basis ambient air conditions, blowdown from the circulating water system serving the two units is approximately 23,000 gpm. On an average annual basis, the circulating water blowdown is expected to be approximately 13,000 gpm, or 2.6×10^{13} cm^3 per year. The annual radionuclide release and the concentration in the cooling tower blowdown line are given in Table 11.2-4.

Circulating water blowdown enters the Rock River approximately 50 yards downstream of the intake structure, so releases do not become entrained in makeup water. The circulating water blowdown warming line to the river screen house is isolated during releases to prevent entraining radionuclides in the circulating water and essential service water makeup lines.

11.2.3.3 Estimated Annual Average Doses

The estimated total annual release of radionuclides in liquid effluents is given in Table 11.2-1. Using an annual dilution volume of 2.6×10^{13} cm^3, the concentration of each nuclide in the cooling tower blowdown line can be determined. This is shown in Table 11.2-4.

Estimated annual average doses to individuals exposed to radioactive liquid effluents were calculated using the methodology of Regulatory Guide 1.109 (Reference 3). Fish consumption, drinking water, and recreational exposure pathways were considered. Annual use factors for these pathways are given in Table 11.2-8.

In order to obtain a conservative estimate of the radiation doses, no radioactive decay or dilution by river water was taken into consideration.

Estimates of doses to the whole body and to different organs are summarized in Table 11.2-3. As explained in Subsection 11.2.1.4, these estimated doses are all within Appendix I to 10 CFR 50 guidelines. Actual release data are available in the effluent release reports, which are prepared in accordance with the ODCM.

11.2.3 Radioactive Releases

11.2.3.1 Release Points

All controlled liquid radwaste system effluent releases of radioactive nuclides to the environment are suitably processed, monitored, and recycled or discharged via the release tanks in accordance with procedures outlined in Subsection 11.2.2.3. The radioactive waste release line joins the cooling pond blowdown line as indicated in Drawing M-48-1. Water from the fire and oil sump, and condensate polisher sump (Subsections 11.2.2.2.8 and 11.2.2.2.9), if not unacceptably contaminated, is discharged, after suitable treatment, into the cooling pond at the circulating water discharge canal, where it mixes with circulating water prior to release via the blowdown line.

11.2.3.2 Dilution Factors

At 100% capacity factor, blowdown from the cooling lake is expected to be 25,000 gpm on an annual average basis, or 4.98×10^{13} cm^3 per year. The annual radionuclide release and the concentration in the cooling pond blowdown line are given in Table 11.2-4. Blowdown isotope concentrations were calculated using cooling pond blowdown flow of 12,000 gpm, which is the normally expected blowdown flow rate without the use of blowdown booster pumps.

Cooling pond blowdown enters the Kankakee River approximately 50 yards downstream of the intake structure, so that releases do not become entrained in makeup water.

11.2.3.3 Estimated Annual Average Doses

The estimated total annual release of radionuclides in liquid effluents is given in Table 11.2-1. Using an annual dilution volume of 2.4×10^{13} cm^3, the concentration of each nuclide in the discharge canal can be determined. This is shown in Table 11.2-4.

Estimated annual average doses to individuals exposed to radioactive liquid effluents were calculated using the methodology of Regulatory Guide 1.109 (Reference 3). Fish consumption, drinking water, and recreational exposure pathways were considered. Annual use factors for these pathways are given in Table 11.2-8.

In order to obtain a conservative estimate of the radiation doses, no radioactive decay or dilution by river water was taken into consideration.

Estimates of doses to the whole body and to different organs are submitted in Table 11.2-3. As explained in Subsection 11.2.1.4, these estimated doses are all within Appendix I to 10 CFR 50 guidelines. Actual release data are available in the effluent release reports, which are prepared in accordance with the ODCM.

11.2.4 References

1. Regulatory Guide 1.112, "Calculation of Releases of Radioactive Materials in Gaseous and Liquid Effluents from Light Water-Cooled Power Reactors," U.S. Nuclear Regulatory Commission, April 1976.

2. NUREG-0017, "Calculation of Releases of Radioactive Materials in Gaseous and Liquid Effluent from Pressurized Water Reactors (PWR-GALE Code)," Office of Standards Development, U.S. Nuclear Regulatory Commission, April 1976.

3. Regulatory Guide 1.109, "Calculation of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10 CFR Part 50, Appendix I," U.S. Nuclear Regulatory Commission, Revision 1, October 1977.

4. ANSI Standard N199, "Liquid Radioactive Waste Processing System for Pressurized Water Reactor Plants," American National Standards Institute, Inc., 1976.

5. WASH-1258, "Numerical Guides for Design Objectives and Limiting Conditions for Operation to Meet the Criteria 'Low as Practicable' for Radioactive Material in Light-Water-Cooled Nuclear Power Reactor Effluents," U.S. Atomic Energy Commission, 1973.

TABLE 11.2-1

EXPECTED_ANNUAL_AVERAGE_RELEASES_OF_RADIONUCLIDES_IN_LIQUID_EFFLUENTS

NUCLIDE	HALF-LIFE (DAYS)	COOLANT CONCENTRATIONS PRIMARY (MICRO CI/ML)	SECONDARY (MICRO CI/ML)	ANNUAL RELEASES TO DISCHARGE CANAL BORON RS (CURIES)	MISC. WASTES (CURIES)	SECONDARY (CURIES)	TURB BLDG (CURIES)	TOTAL LWS (CURIES)	ADJUSTED TOTAL (CI/YR)	DETERGENT WASTES (CI/YR)	TOTAL (CI/YR)
CORROSION AND ACTIVATION PRODUCTS											
CR 51	2.78+01	1.90-03	2.51-07	5.36-06	6.13-09	0.00	2.48-06	7.85-06	6.16-05	0.00	6.16-05
MN 54	3.03+02	3.10-04	6.08-08	9.21-07	1.05-09	0.00	6.05-07	1.53-06	1.20-05	1.00-03	1.01-03
FE 55	9.50+02	1.60-03	2.12-07	4.77-06	5.44-09	0.00	2.11-06	6.89-06	5.40-05	0.00	5.40-05
FE 59	4.50+01	1.00-03	1.55-07	2.88-06	3.29-09	0.00	1.54-06	4.42-06	3.47-05	0.00	3.47-05
CO 58	7.13+01	1.60-02	2.15-06	4.67-05	5.34-08	0.00	2.14-05	6.81-05	5.35-04	4.00-03	4.53-03
CO 60	1.92+03	2.00-03	2.73-07	5.97-06	6.81-09	0.00	2.72-06	8.69-06	6.82-05	8.70-03	8.77-03
ZR 95	6.50+01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.40-03	1.40-03
NB 95	3.50+01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00-03	2.00-03
NP239	2.35+00	1.20-03	1.23-07	1.82-06	2.32-09	0.00	1.14-06	2.95-06	2.32-05	0.00	2.32-05
FISSION PRODUCTS											
BR 83	1.00-01	4.80-03	1.26-07	2.11-09	2.69-09	0.00	2.24-06	2.24-06	1.76-05	0.00	1.76-05
RB 86	1.87+01	8.50-05	1.40-08	5.83-06	1.34-08	0.00	1.38-07	5.98-06	4.69-05	0.00	4.69-05
SR 89	5.20+01	3.50-04	6.17-08	1.01-06	1.16-09	0.00	6.13-07	1.63-06	1.28-05	0.00	1.28-05
MO 99	2.79+00	8.40-02	1.19-05	1.42-04	1.76-07	0.00	1.11-04	2.53-04	1.98-03	0.00	1.98-03
TC 99M	2.50-01	4.80-02	2.18-05	1.35-04	1.65-07	0.00	1.58-04	2.94-04	2.31-03	0.00	2.31-03
RU103	3.96+01	4.50-05	6.21-09	1.29-07	1.48-10	0.00	6.16-08	1.91-07	1.50-06	1.40-04	1.41-04
RU106	3.67+02	1.00-05	1.52-09	2.97-08	3.39-11	0.00	1.51-08	4.49-08	3.52-07	2.40-03	2.40-03
AG110M	2.53+02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.40-04	4.40-04
TE127	3.92-01	8.50-04	1.31-07	8.46-07	1.24-09	0.00	9.37-07	1.78-06	1.40-05	0.00	1.40-05
TE129M	3.40+01	1.40-03	1.87-07	3.99-06	4.56-09	0.00	1.85-06	5.85-06	4.59-05	0.00	4.59-05
TE129	4.79-02	1.60-03	5.39-07	2.56-06	2.94-09	0.00	1.30-06	3.86-06	3.03-05	0.00	3.03-05
I130	5.17-01	2.10-03	1.53-07	2.95-06	1.18-08	0.00	1.09-05	1.38-05	1.09-04	0.00	1.09-04
TE131M	1.25+00	2.50-03	2.39-07	2.10-06	3.24-09	0.00	2.07-06	4.17-06	3.27-05	0.00	3.27-05
I131	8.05+00	2.70-01	3.72-05	6.62-03	7.69-05	0.00	3.63-03	1.03-02	8.04-02	6.20-05	8.05-02
TE132	3.25+00	2.70-02	3.07-06	4.94-05	6.02-08	0.00	2.90-05	7.85-05	6.16-04	0.00	6.16-04
I132	9.58-02	1.00-01	9.32-06	5.11-05	3.47-07	0.00	1.77-04	2.28-04	1.79-03	0.00	1.79-03
I133	8.75-01	3.80-01	3.43-05	1.85-03	3.65-06	0.00	2.80-03	4.66-03	3.66-02	0.00	3.66-02
CS134	7.49+02	2.50-02	4.01-06	1.86-03	4.25-06	0.00	3.99-05	1.91-03	1.50-02	1.30-02	2.80-02
I135	2.79-01	1.90-01	9.96-06	2.10-05	5.10-07	0.00	5.33-04	5.54-04	4.35-03	0.00	4.35-03
CS136	1.30+01	1.30-02	1.78-06	8.59-04	1.98-06	0.00	1.75-05	8.79-04	6.89-03	0.00	6.89-03
CS137	1.10+04	1.80-02	2.67-06	1.34-03	3.06-06	0.00	2.65-05	1.37-03	1.08-02	2.40-02	3.48-02
BA137M	1.77-03	1.60-02	7.67-06	1.26-03	2.87-06	0.00	2.48-05	1.29-03	1.01-02	0.00	1.01-02
CE144	2.84+02	3.30-05	6.08-09	9.80-08	1.12-10	0.00	6.05-08	1.59-07	1.24-06	5.20-03	5.20-03
ALL OTHERS		2.53-01	2.02-06	3.69-06	7.27-09	0.00	2.84-06	6.54-06	5.13-05	0.0	5.13-05
TOTAL (EXCEPT TRITIUM)		1.46+00	1.50-04	1.43-02	2.49-05	0.00	7.60-03	2.19-02	1.72-01	6.23-02	2.34-01

TRITIUM RELEASE 300 CURIES PER YEAR

TABLE 11.2-2

PARAMETERS USED IN THE GALE-PWR COMPUTER PROGRAM
(ORIGINAL & UPRATED) - NOTE 1

1)	Reactor type	PWR
2)	Thermal power level (MWt)	3565.0 (3586.6)
3)	Mass of coolant in the primary system (10^6 gms)	242 (247.7)
4)	Primary system letdown rate (gpm)	75.0
5)	Letdown cation demineralizer flow (gpm)	7.5
6)	Number of steam generators	4.0
7)	Total steam flow (10^6 lb/hr)	15.0 (16.04)
8)	Mass of steam in each steam generator (10^3 lb)	9.1 (6.039)
9)	Mass of liquid in each steam generator (10^3 lb)	117.0 (114.465)
10)	Total mass of secondary coolant (10^3 lb)	2023.0
11)	Steam generator blowdown rate (10^3 lb/hr)	30.0
	The steam generator blowdown is recycled to the condensate system after treatment in the blowdown system. Condensate demineralizers are not used.	
12)	Condensate demineralizer regeneration time (days)	0.0
13)	Fraction of feedwater through the condensate demineralizers	0.0
14)	Annual average liquid radwaste dilution flow (10^3 gpm)	
	Cooling tower blowdown, Byron	13.0
	Cooling lake blowdown, Braidwood	12.0*
15)	Shim bleed rate (gpd)	2160.0
16)	Decontamination Factors for the shim bleed system:	
	Iodine - 10^3, Cesium - 2 x 10^3, Others - 10^4	

TABLE 11.2-2 (Cont'd)

17)	Shim bleed system - Collection time (days)	0.60
	Processing time (days)	2.00
	Fraction discharged	0.10
18)	Equipment drains input (gpd)	2800.0
	Fraction of primary coolant activity	0.005
19)	Decontamination Factors for Equipment Drains Processing:	
	Iodine - 10^5, Cesium - 2 x 10^4, Others - 10^6	
20)	Equipment drains - Collection time (days)	2.30
	Processing time (days)	0.15
	Fraction discharged	0.10
21)	Clean waste input (gpd)	2800.0
	Fraction of primary coolant activity	0.002
22)	Decontamination Factors for Clean Waste Processing:	
	Iodine - 10^5, Cesium - 2 x 10^4, Others - 10^6	
23)	Clean waste - Collection time (days)	2.30
	Processing time (days)	0.15
	Fraction discharged	0.10
24)	Dirty wastes input (gpd)	2800.0
	Fraction of primary coolant activity	0.0068
25)	Decontamination Factors for Dirty Waste Processing:	
	Iodine - 10^5, Cesium - 2 x 10^4, Others - 10^6	
26)	Dirty wastes - Collection time (days)	4.60
	Processing time (days)	0.11
	Fraction discharged	0.10
27)	Blowdown fraction processed	1.00
28)	Decontamination Factors for Blowdown Processing:	
	Iodine - 10^2, Cesium - 10, Others - 10^2	
29)	Blowdown - Collection time (days)	0.03
	Processing time (days)	0.03
	Fraction discharged	0.10

TABLE 11.2-2 (Cont'd)

30)	Condensate demineralizer regenerant flow (gpd)	0.00
31)	Decontamination Factors for Regenerant Processing: Iodine - 1.0, Cesium - 1.0, Others - 1.0	
32)	Regenerant - Collection time (days)	0.00
	Processing time (days)	0.00
	Fraction discharged	0.00
33)	There is not continuous stripping of full letdown flow.	
34)	Holdup time for xenon (days)	45.0
35)	Holdup time for krypton (days)	45.0
36)	Fill time for gas decay tanks (days)	43.0
37)	The waste gas system does not have a HEPA filter.	
38)	The auxiliary building vent system does have a HEPA filter, but it does not have a charcoal filter.	
39)	Containment volume (10^6 ft^3)	2.9
40)	Containment atmosphere cleanup rate (10^3 cfm)	16.0
41)	The containment shutdown purge line has a HEPA filter, but it does not have a charcoal filter.	
42)	There is no continuous low volume purge of the containment.	
43)	There is no blowdown tank vent.	
44)	Fraction of iodine released from the main condenser air ejector **	0.10**
45)	Reciprocal of the detergent waste processing decontamination factor	1.00

TABLE 11.2-3

PATHWAYS DOSES FROM LIQUID EFFLUENTS

(BYRON)

EXPOSURE PATHWAY	ORGAN	DOSE (mrem/yr/unit)*
Drinking Water		
	Whole Body	7.36×10^{-1}
	GI-LLI	6.87×10^{-1}
	Thyroid	$3.49 \times 10^{+0}$
	Bone	7.03×10^{-2}
Fish Consumption		
	Whole Body	4.54×10^{-1}
	GI-LLI	7.43×10^{-2}
	Thyroid	1.03×10^{-1}
	Bone	3.4×10^{-1}
Shoreline Recreation		
	Skin	9.15×10^{-3}
	Whole Body	7.83×10^{-3}
Swimming & Boating		
	Skin	3.38×10^{-4}
	Whole Body	2.56×10^{-4}

*All activities are assumed to take place in the discharge canal. No credit is taken for dilution of effluents in the Rock River.

TABLE 11.2-3

PATHWAYS DOSES FROM LIQUID EFFLUENTS

(BRAIDWOOD)

EXPOSURE PATHWAY	ORGAN	DOSE (mrem/yr/unit)*
Drinking Water		
	Whole Body	9.88×10^{-1}
	GI-LLI	9.22×10^{-1}
	Thyroid	$4.69 \times 10^{+0}$
	Bone	9.44×10^{-2}
Fish Consumption		
	Whole Body	6.09×10^{-1}
	GI-LLI	9.97×10^{-2}
	Thyroid	1.38×10^{-1}
	Bone	4.67×10^{-1}
Shoreline Recreation		
	Skin	1.23×10^{-2}
	Whole Body	1.05×10^{-2}
Swimming and Boating		
	Skin	4.53×10^{-4}
	Whole Body	3.42×10^{-4}

*All activities are assumed to take place in the discharge canal. No credit is taken for dilution of effluents in the Kankakee River.

TABLE 11.2-4

COMPARISON OF EXPECTED LIQUID EFFLUENT CONCENTRATIONS TO 10 CFR 20 LIMITS

ISOTOPE	EXPECTED* RELEASE (Ci/yr/unit)	BLOWDOWN** CONCENTRATION (µci/ml)	10 CFR 20 LIMIT*** (µCi/ml)
H 3	3.00+02	1.16-05	3.00-03
Cr 51	6.20-05	2.39-12	2.00-03
Mn 54	1.00-03	3.86-11	1.00-04
Fe 55	5.40-05	2.08-12	8.00-04
Fe 59	3.50-05	1.35-12	5.00-05
Co 58	4.50-03	1.74-10	9.00-05
Co 60	8.80-03	3.40-10	3.00-05
Br 83	1.80-05	6.59-13	3.00-06
Rb 86	4.70-05	1.81-12	2.00-05
Sr 89	1.30-05	5.02-13	3.00-06
Zr 95	1.40-03	5.40-11	6.00-05
Nb 95	2.00-03	7.72-11	1.00-04
Mo 99	2.00-03	7.72-11	4.00-05
Tc 99m	2.30-03	8.88-11	3.00-03
Ru 103	1.40-04	5.40-12	8.00-05
Ru 106	2.40-03	9.26-11	1.00-05
Ag 110m	4.40-04	1.70-11	3.00-05
Te 127	1.40-05	5.40-13	2.00-04
Te 129m	4.60-05	1.78-12	2.00-05
Te 129	3.00-05	1.16-12	8.00-04
Te 131m	3.30-05	1.27-12	4.00-05
Te 132	6.20-04	2.39-11	2.00-05
I 130	1.10-04	4.24-12	3.00-06
I 131	8.00-02	3.09-09	3.00-07
I 132	1.80-03	6.95-11	8.00-06
I 133	3.70-02	1.43-09	1.00-06
I 135	4.30-03	1.66-10	4.00-06
Cs 134	2.80-02	1.08-09	9.00-06
Cs 136	6.90-03	2.66-10	9.00-05
Cs 137	3.50-02	1.35-09	2.00-05
Ce 144	5.20-03	2.01-10	1.00-05
Np 239	2.30-05	8.88-13	1.00-04

* Calculated using the PWR-GALE computer program described in NUREG-0017. The actual data are available in the effluent release reports, which are prepared in accordance with the ODCM.

** Annual average cooling tower blowdown = 29.0 cfs.

***Limits used in the comparison are those that were in effect at the time of the analysis.

TABLE 11.2-4

COMPARISON OF EXPECTED LIQUID EFFLUENT CONCENTRATIONS TO 10 CFR 20 LIMITS

ISOTOPE	EXPECTED* RELEASE (Ci/yr/unit)	BLOWDOWN** CONCENTRATION (μCi/ml)	10 CFR 20 LIMIT*** (μCi/ml)
H 3	3.00+02	1.55-05	3.00-03
Cr 51	6.20-05	3.21-12	2.00-03
Mn 54	1.00-03	5.18-11	1.00-04
Fe 55	5.40-05	2.80-12	8.00-04
Fe 59	3.50-05	1.81-12	5.00-05
Co 58	4.50-03	2.33-10	9.00-05
Co 60	8.80-03	4.56-10	3.00-05
Br 83	1.80-05	9.33-13	3.00-06
Rb 86	4.70-05	2.44-12	2.00-05
Sr 89	1.30-05	6.74-13	3.00-06
Zr 95	1.40-03	7.25-11	6.00-05
Nb 95	2.00-03	1.04-10	1.00-04
Mo 99	2.00-03	1.04-10	4.00-05
Tc 99m	2.30-03	1.19-10	3.00-03
Ru 103	1.40-04	7.25-12	8.00-05
Ru 106	2.40-03	1.24-10	1.00-05
Ag 110m	4.40-04	2.28-11	3.00-05
Te 127	1.40-05	7.25-13	2.00-04
Te 129m	4.60-05	2.38-12	2.00-05
Te 129	3.00-05	1.55-12	8.00-04
Te 131m	3.30-05	1.71-12	4.00-05
Te 132	6.20-04	3.21-11	2.00-05
I 130	1.10-04	5.70-12	3.00-06
I 131	8.00-02	4.14-09	3.00-07
I 132	1.80-03	9.33-11	8.00-06
I 133	3.70-02	1.92-09	1.00-06
I 135	4.30-03	2.23-10	4.00-06
Cs 134	2.80-02	1.45-09	9.00-06
Cs 136	6.90-03	3.57-10	9.00-05
Cs 137	3.50-02	1.81-09	2.00-05
Ce 144	5.20-03	2.69-10	1.00-05
Np 239	2.30-05	1.19-12	1.00-04

1.55E-5 μCi/ml × 1×10^6 pCi/μCi × 1000 ml/1 L = 15,500 pCi/l

* Calculated using the PWR-GALE computer program described in NUREG-0017. The actual data are available in the effluent release reports, which are prepared in accordance with the ODCM.

** Annual average cooling lake blowdown = 13.4 cfs per unit. Original design and without the use of CW blowdown booster pumps installed at Braidwood.

*** Limits used in the comparison are those that were in effect at the time of the analysis.

TABLE 11.2-5

LIQUID RADWASTE SYSTEM COMPONENTS AND DESIGN PARAMETERS PER STATION

EQUIPMENT	DESIGN PRESSURE (psig)	DESIGN TEMP (°F)	CAPACITY	NUMBER	MATERIALS OF CONSTRUCTION
I. Blowdown mixed bed demineralizers	150	110	180 gpm	4	316-SS
II. Radwaste mixed bed demineralizers	150	110	45 gpm	3	316-SS
III. Cartridge filters:					
1. Chemical drain	150	140	130 gpm	1	316-SS
2. Regeneration waste drain	150	140	130 gpm	1	316-SS

TABLE 11.2-5 (Cont'd)

	EQUIPMENT	DESIGN PRESSURE (psig)	DESIGN TEMP (°F)	CAPACITY	NUMBER	MATERIALS OF CONSTRUCTION
3.	Blowdown prefilters (Byron)	250	120	360 gpm	4	Housing shell - 304-SS internal components - 316-SS
	Blowdown prefilters (Braidwood)	150	250	250 gpm	4	Housing shell - carbon steel internal components - 304-SS
4.	Blowdown after-filters	150	140	250 gpm	4	304-SS
5.	Auxiliary Bldg. floor drains	150	180	250 gpm	1	304-SS
6.	Auxiliary Bldg. equipment drain	150	180	250 gpm	1	304-SS
7.	Turbine Bldg. floor drains	150	140	130 gpm	1	304-SS
8.	Turbine Bldg. equipment drains	150	180	130 gpm	1	304-SS
9.	Laundry drain	150	180	130 gpm	1	304-SS
10.	Radwaste demineralizer afterfilter	150	180	250 gpm	3	304-SS

TABLE 11.2-5 (Cont'd)

EQUIPMENT	DESIGN PRESSURE (psig)	DESIGN TEMP (°F)	CAPACITY	NUMBER	MATERIALS OF CONSTRUCTION
VI. Tanks:					
1. Chemical drain	Atmos.	200	6,000 gal	1	304-SS
2. Dual Purpose Chemical/Regeneration waste Drain	Atmos.	200	10,000 gal	1	304-SS

TABLE 11.2-5 (Cont'd)

	EQUIPMENT	DESIGN PRESSURE (psig)	DESIGN TEMP (°F)	CAPACITY	NUMBER	MATERIALS OF CONSTRUCTION
3.	Regeneration waste Drain	Atmos.	200	30,000 gal (Byron) 20,000 gal (Braidwood)	1	304-SS
4.	Auxiliary Bldg. equipment drain	50	200	8,000 gal	2	304-SS
5.	Auxiliary Bldg. floor drain	Atmos.	150	8,000 gal	2	304-SS
6.	Turbine Bldg. equipment drain	Atmos.	130	12,000 gal	2	C.S.
7.	Turbine Bldg. floor drain	Atmos.	150	12,000 gal	2	C.S.
8.	Laundry drain	Atmos.	200	4,000 gal	1	C.S.
9.	Laundry drain storage	Atmos.	130	2,000 gal	2	C.S.
10.	Blowdown monitor	Atmos.	150	20,000 gal	3	304-SS
11.	Radwaste monitor	Atmos.	150	20,000 gal	2	304-SS
12.	Release	Atmos.	150	30,000 gal	2	304-SS

TABLE 11.2-5 (Cont'd)

	EQUIPMENT	DESIGN PRESSURE (psig)	DESIGN TEMP (°F)	CAPACITY	NUMBER	MATERIALS OF CONSTRUCTION
13.	Concentrates (Byron) holding	Atmos.	250	6,400 gal	1	316L-SS
14.	Spent Resin (Byron)	125	120	5,000 gal	1	304-SS
15.	Low Activity Spent Resin (Braidwood)	15	120	6,400 gal	1	316L-SS
16.	High Activity Spent Resin (Braidwood)	125	120	5,000 gal	1	304-SS

TABLE 11.2-5 (Cont'd)

	EQUIPMENT	CAPACITY	DISCHARGE HEAD (ft)	NUMBER	MATERIALS OF CONSTRUCTION
VII.	Pumps:				
	1. Chemical drain tank	60 gpm	235	2	316-SS
	2. Dual purpose chemical/ Regeneration waste drain tank	60 gpm	235	2	316-SS
	3. Regeneration waste drain tank	60 gpm	235	2	316-SS
	4. Auxiliary Bldg. equip. drain tank	60 gpm	235	2	304-SS
	5. Auxiliary Bldg. floor drain tank	60 gpm	235	2	304-SS
	6. Turbine Bldg. equip. drain tank	90 gpm	235	2	304-SS
	7. Turbine Bldg. floor drain tank	90 gpm	235	2	304-SS
	8. Laundry drain tank	30 gpm	200	1	C.S.
	9. Laundry drain storage tank	25 gpm	150	2	C.S.
	10. Blowdown monitor tank	350 gpm	175	3	304-SS
	11. Radwaste monitor tank	350 gpm	175	2	304-SS

TABLE 11.2-5 (Cont'd)

EQUIPMENT	CAPACITY	DISCHARGE HEAD (ft)	NUMBER	MATERIALS OF CONSTRUCTION
12. Release tank	500 gpm	100	2	304-SS
13. Blowdown condenser	180 gpm	1050	4	304-SS
14. Spent resin (Byron)	120 gpm	115	2	ACI CD4MCu-SS
15. Spent resin (Braidwood)	65 gpm	175	2	BUNA N, 316-SS

NOTE: Radwaste Evaporator Components have been intentionally deleted from this table. Braidwood and Byron stations do not intend to use this equipment.

TABLE 11.2-6

DESIGN-BASIS ANNUAL AVERAGE AND MAXIMUM WASTE STREAM FLOWS

(Two Units)

WASTE INPUT SOURCES	AVERAGE DAILY FLOW (gpd)	MAXIMUM DAILY FLOW (gpd)
Steam generator blowdown	259,200*	604,800**
Auxiliary building equipment drain	5,600	16,000
Auxiliary building floor drain	5,600	16,000
Chemical waste drain	2,100	6,000
Laundry drain	1,400	4,000
Turbine building equipment drain	4,200	12,000
Turbine building floor drain	4,200	12,000
Condensate polisher	25,300	90,700
Turbine building fire and oil sump	62,000	150,000
Waste treatment system	36,300	56,900

* Based on average of 28 days primary to secondary leakage (1956 gpm/two units), 28 days condenser to secondary leakage (420 gpm/two units) and 309 days of normal operation (120 gpm/two units).

** Based on condenser to secondary leakage of 420 gpm/two units.

TABLE 11.2-7

DESIGN-BASIS PROCESS DECONTAMINATION FACTORS

ELEMENT	FILTERS (A)	FILTERS (B)	CLEAN WASTE DEMINER-ALIZERS	BLOWDOWN DEMINER-ALIZERS	EVAPORATORS	EVAPORATORS DISTILLATE DEMINER-ALIZERS
H	1	1	1	1	1	1
Cr	10	1	100	100	10^4	10
Mn	10	1	100	100	10^4	10
Fe	10	1	100	100	10^4	10
Co	10	1	100	100	10^4	10
Br	1.0	1	100	100	10^4	10
Kr	1	1	1	1	1	1
Rb	1.0	1	2	10	10^4	10
Sr	1.0	1	100	100	10^4	10
Y	1.0	1	100	100	10^4	10
Zr	10	1	100	100	10^4	10
Nb	10	1	100	100	10^4	10
Mo*	10	1	100	100	10^4	10
Tc*	1.0	1	100	100	10^4	10
Ru	1.0	1	100	100	10^4	10
Rh	1.0	1	100	100	10^4	10
Te	1.0	1	100	100	10^4	10
I	1.0	1	100	100	10^3	10
Xe	1	1	1	1	1	1
Cs	1.0	1	2	10	10^4	10
Ba	1.0	1	100	100	10^4	10

TABLE 11.2-7 (Cont'd)

ELEMENT	FILTERS (A)	FILTERS (B)	CLEAN WASTE DEMINER-ALIZERS	BLOWDOWN DEMINER-ALIZERS	EVAPORATORS	EVAPORATORS DISTILLATE DEMINER-ALIZERS
La	1.0	1	100	100	10^4	10
Ce	1.0	1	100	100	10^4	10
Pr	1.0	1	100	100	10^4	10
Np	1.0	1	100	100	10^4	10

Basis for Decontamination Factors:

1. Filters:
   (A) Is used for filter source term calculations only.
   (B) Is used for other calculations. (Table 1-3, NUREG-0017, PWR GALE)
2. (A) Radwaste Demineralizers:
   (Table 1-3, NUREG-0017, PWR GALE and Table 1 ANSI N199-1976)
   (B) Blowdown Demineralizers
   (Table 1-3, NUREG-0017, PWR GALE)
3. Evaporators:
   (Table 1-3, NUREG-0017, PWR GALE and Table 1 ANSI N199-1976)
4. Evaporator Distillate Demineralizers:
   (Table 1-3, NUREG-0017, PWR GALE)

TABLE 11.2-8

CONSUMPTION FACTORS FOR THE MAXIMUM EXPOSED INDIVIDUAL

PATHWAY	CHILD	TEEN	ADULT	UNITS
Fruits, vegetables and grains*	520.0	630.0	520.0	kg/yr
Leafy vegetables**	26	42	64	kg/yr
Milk**	330	400	310	l/yr
Meat and poultry**	41	65	110	kg/yr
Sport fish**	6.9	15.8	21	kg/yr
Drinking water**	508	508	728	l/yr
Shoreline activities***	-	-	15.0	hr/yr
Boating/swimming***	-	-	29.0/6.0	hr/yr
Inhalation*,**	3700.0	8000.0	8000.0	m^3/yr
	1400.0	(Infant)		

* From Regulatory Guide 1.109, Table E-5 (Reference 3).

** From Offsite Dose Calculation Manual, Revision 1.2, Table D-10.

*** From HERMES as used in Zion Station annual and semiannual reports on station radioactive waste, environmental monitoring, and occupational personnel radiation exposure.

TABLE 11.2-9

SUMMARY OF TANK LEVEL INDICATION, ANNUNCIATORS, AND OVERFLOWS FOR TANKS OUTSIDE OF CONTAINMENT POTENTIALLY CONTAINING RADIOACTIVE LIQUIDS

TANK	LEVEL INDICATOR AND/OR RECORDER LOCATION	ANNUNCIATOR	OVERFLOW TO
Primary Water Storage	Main Control Room* Radwaste Control Panel	AL, AH, AHH None	Turbine Building Equipment Drains Sump
Condensate Storage	Main Control Room* Radwaste Control Panel Makeup Demineralizer Panel	AL, AH None AL, AH	Turbine Building Equipment Drains Sump
Turbine Building Equipment Drain	Radwaste Control Panel	AL, AH	None
Turbine Building Floor Drain	Radwaste Control Panel	AL, AH	None
Chemical Drain	Radwaste Control Panel	AL, AH	None
Chemical/Regeneration Waste Drain	Radwaste Control Panel	AL, AH	None
Regeneration Waste Drain	Radwaste Control Panel	AL, AH	Auxiliary Building Floor Drain System*
Auxiliary Building Equipment Drain	Radwaste Control Panel	AL, AH	None
Auxiliary Building Floor Drain	Radwaste Control Panel	AL, AH	None

TABLE 11.2-9 (Cont'd)

TANK	LEVEL INDICATOR AND/OR RECORDER LOCATION	ANNUNCIATOR	OVERFLOW TO
Laundry Drain	Radwaste Control Panel	AL, AH	None
Laundry Waste Storage	Radwaste Control Panel	AL, AH	Auxiliary Building Equipment Drains Sump
Blowdown Monitor	Radwaste Control Panel	AL, AH	Turbine Building Equipment Drains Sump
Radwaste Monitor	Radwaste Control Panel	AL, AH	Auxiliary Building Equipment Drains Sump
Release	Radwaste Control Panel	AL, AH	Regeneration Waste Drain Tank or Auxiliary Building Floor Drain System*
Concentrates Holding (Byron)	Radwaste Control Panel	AL, AH	None
Spent Resin (Byron)	Radwaste Control Panel	AL, AH	None
Decant (Byron)	Solid Radwaste Panel	AL, AH	Regeneration Waste Drain Tank
Vacuum Deaerator Catch	Radwaste Control Panel	AL, AH	None
High Activity Spent Resin (Braidwood)	Radwaste Control Panel	AHH	None

TABLE 11.2-9 (Cont'd)

TANK	LEVEL INDICATOR AND/OR RECORDER LOCATION	ANNUNCIATOR	OVERFLOW TO
Low Activity Spent Resin (Braidwood)	Radwaste Control Panel	AHH	None
Auxiliary Building Borated Equipment Drain	Radwaste Control Panel	AL, AH	None
Auxiliary Building Waste Oil Collection	Local	AH (Radwaste Panel)	None
Refueling Water Storage	Main Control Room*	AH, AL, ALL, ALLL	Recycle Holdup Tank
Volume Control	Main Control Room* Local	AH, AL None	None
Recycle Holdup	Main Recycle Panel Local	AH, AL None	None
Boric Acid	Main Control Room* Local	AH, AL None	Auxiliary Building Equipment Drains
Boric Acid Batching	Local	AH, AL (Main Control Room)	Recycle Holdup Tank

TABLE 11.2-9 (Cont'd)

TANK	LEVEL INDICATOR AND/OR RECORDER LOCATION	ANNUNCIATOR	OVERFLOW TO
Boric Acid Monitor	Boron Recovery Panel Local	AH, AL None	Auxiliary Building Equipment Drains

NOTES:

AL - Alarm Low
ALL - Alarm Low Low
ALLL - Alarm Low Low Low

AH - Alarm High
AHH - Alarm High High
*General Services Panel

Figures 11.2-1 through 11.2-41 have been deleted intentionally.