9.0 AUXILIARY SYSTEMS
LIST OF FIGURES

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9.0 AUXILIARY SYSTEMS
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*The listed drawings are included as "General References" only; i.e., refer to the drawings to obtain additional detail or to obtain background information. These drawings are not part of the UFSAR. They are controlled by the Controlled Documents Program.

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DRAWING*	SUBJECT
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9.1.2.2 Facilities Description

The major components of the spent fuel storage system are the spent fuel pool, the reactor well, and the dryer/separator pit. These pools are located in the reactor building on elevation 613'-0". Refer to Section 1.2 for detailed drawings of the spent fuel storage system arrangement.

9.1.2.2.1 Dryer/Separator Pit

The dryer/separator pit provides a location for underwater transfer and storage of the reactor moisture separator and steam dryer assemblies during refueling operations.

A raised step is provided at the bottom of the pit to:

A. Prevent particulate material from entering the reactor well from the dryer/separator pit; and

B. Ensure at least a 6-inch water coverage over the reactor shroud head, which becomes very radioactive during plant operations.

The pit is lined with stainless steel. The space between the storage pit liner and the concrete walls and floor has a drain which may be used to detect liner leakage. The annulus drainage flows through "tell-tale" sightglasses to the reactor building floor drain sump.

9.1.2.2.2 Reactor Well

The purpose of the reactor well is to provide a space which can be flooded to permit the removal and underwater transfer of the steam dryer, moisture separators and fuel. Removable shield plugs are installed over the reactor well during normal operation unless removed for short durations while shutting down the unit for refueling (see reference 8). The plugs are provided to reduce the operating floor radiation during plant operation to insignificant levels. To flood the reactor well for refueling, the refueling bulkhead, in conjunction with a system of bellows seals, provides a watertight barrier to permit flooding above the reactor while preventing water from entering the drywell. As shown in Figure 9.1-1, the bulkhead is a flat, circumferential plate, which is fixed rigidly to the inside of the containment. The bulkhead contains ventilation duct hatches, which allow the drywell cooling system to cool the area above the bulkhead (within the drywell head) during normal plant operations.

The drywell-to-reactor-building bellows seal (see Figures 9.1-1 and 9.1-2) accommodates the differential expansion that occurs between the drywell and the reactor building concrete during plant heatup and cooldown. The seal is a cylindrical, one-piece, stainless steel bellows that seals the annulus between the drywell concrete wall and the drywell liner. To facilitate leak detection, flow through a drain line at the low point on the reactor building side of the seal is monitored.

The reactor-vessel-to-drywell seal accommodates the differential expansion that occurs between the reactor vessel and the drywell during reactor heatup and cooldown (Figure 9.1-2). The seal is a cylindrical, one-piece, stainless steel bellows. One end is welded to a special skirt on the reactor vessel, while the other end is welded to the refueling bulkhead. It seals the opening between the reactor vessel head flange and the drywell to allow flooding the reactor cavity above. To facilitate leak detection, a flow switch is provided to monitor leakage to a drain line located at the low point on the outside of the seal. The drain line is piped to the drywell equipment drain sump.

9.1.2.2.3 Spent Fuel Pool

The spent fuel pool has been designed to withstand the anticipated earthquake loadings as a Class I structure. Each unit has its own spent fuel pool measuring 33 ft x 41 ft. Each pool is a reinforced concrete structure, completely lined with seam-welded stainless steel plates welded to reinforcing members (channels, I beams, etc.) embedded in concrete. The stainless steel liner, minimum 3/16-inch thick, will prevent leakage even in the unlikely event that the concrete develops cracks. To avoid unintentional draining of the spent fuel pool, there are no penetrations that would permit the spent fuel pool to be drained below a safe storage level, and all lines extending below this level are equipped with suitable valving to prevent backflow. As shown in Drawings M-31 and M-362, the passage between the spent fuel pool and the refueling cavity above the reactor vessel is provided with two double-sealed gates with a monitored drain between the gates. This arrangement permits detection of leaks from the passage and repair of a gate in the event of such leakage. The normal depth of water in the spent fuel pool is 37 feet, 9 inches and the depth of water in the transfer canal during refueling is 22 feet, 9 inches. A reinforced area is provided in one corner of each spent fuel pool for loading the spent fuel shipping cask. The liner is 1-inch thick at this location to ensure liner integrity. The cask set down pad is sized to accommodate the 100-ton NL 10/24 spent fuel shipping cask. The pad is reinforced above the pool liner by stainless steel plates welded in place. The water in the spent fuel pool is continuously filtered and cooled by the spent fuel pool cooling and cleanup system described in Section 9.1.3.

In addition to the current capacity for fuel assemblies, the spent fuel pool holds discarded local power range monitors (LPRMs), control blades (also control blades to be reinserted in the core), small reactor vessel components, and miscellaneous tools and equipment as necessary. Additional storage for large components, e.g. steam dryer and separator, is provided in the dryer/separator pit (see Section 9.1.2.2.1) adjacent to the reactor cavity.

9.1.2.2.3.1 Spent Fuel Pool Liner and Sumps

The spent fuel pool system incorporates design features to compensate for damage to the spent fuel pool liner. In addition to the system design capabilities, there are procedural controls to prevent damage from occurring.

The system design provides for minor cracks in the stainless steel liner. Beneath each liner seam weld is a drainage trough which directs leakage to the spent fuel pool liner drain network. These drains lead from beneath the liner to the reactor

9.1.3.2 System Description

The spent fuel pool cooling and cleanup system consists of two circulating pumps; two heat exchangers; a filter; a deep-bed demineralizer; and the required piping, valves, and instrumentation.

The pumps, heat exchangers, and demineralizer are located in the reactor building near the spent fuel pool. The fuel pool filter, which may become radioactive as it collects corrosion products, is located in the radwaste building.

The spent fuel pool cooling and cleanup system is shown in Drawings M-31, M-50, M-362, and M-373). Water from the spent fuel pool overflows via scuppers and an adjustable weir into a pair of crosstied skimmer surge tanks. Foreign material entering the spent fuel pool will either sink to the bottom (where it may be removed by a portable vacuum cleaner) or float about in the pool and eventually enter the skimmers, surge tanks, and filtering loop. The pumps take suction from the skimmer surge tanks (located at the top of the spent fuel pool); continuously skim the water from the surface; and circulate the water to the heat exchanger, filter, and demineralizer before discharging the water through two lines back to the spent fuel pool. During refueling operations, the spent fuel pool cooling system may be aligned to discharge into the reactor refueling cavity via manual isolation valves.

The precoat-type filter in each unit uses stainless steel elements. The precoat material slurry is added to the filter and is circulated through the filter vessel until a uniform coating of precoat material covers the elements. The filter is then placed in service until differential pressure signals the need for backwashing. The backwashing process consists mainly of first valving off and draining the dome of the filter, then filling the filter with high-pressure air. All vents are closed during this filling, and air is trapped in the filter dome above the elements. When the pressure in the filter dome reaches approximately 100 psig, the drain valve is quickly opened, and the filter cake, together with trapped impurities, washes into the filter sludge tank. From the sludge tank, the suspension of impurities and water is processed through the radwaste system.

The deep-bed demineralizer consists of a mixture of cation and anion resins. When the resins are depleted they are either sluiced out and regenerated or disposed of as solid radioactive wastes.

Aside from its normal function of cooling and purifying the spent fuel pool water, the system can be used after reactor refueling to drain the dryer/separator storage pit and reactor cavity. Drain lines allow transport of the water to either the condensate storage tanks or to the radwaste disposal system for processing, depending upon water condition. Usually water from the dryer/separator storage pit and reactor cavity is drained to the torus via the shutdown cooling system.

The system maximum heat load capacity is approximately 7.25×10^6 Btu/hr at a pool temperature of 125 °F. Each pump and heat exchanger is rated at 700 gal/min and will handle the heat load imposed on the system during normal spent fuel storage, which is approximately 3.65×10^6 Btu/hr. In the event that a pump or heat exchanger should become inoperative, the cooling load can be handled by the remaining pump and/or heat exchanger until such time as the failed equipment can be repaired. Either one or both loops may be used, dependent upon the spent fuel heat load in the pool, for a total design flowrate of 1400 gal/min.

The shutdown cooling system may be connected in parallel with the spent fuel pool cooling system to assist in cooling the pool during periods of extremely high heat loads, such as immediately after refueling or a full core discharge. The shutdown cooling system consists of three pumps and heat exchangers. Each heat exchanger is rated at 27×10^6 Btu/hr. Refer to Section 5.4.7 for a description of the shutdown cooling system.

The two spent fuel pool heat exchangers, with one shutdown cooling heat exchanger, are capable of handling the decay heat load of a full core discharge plus the two most recently discharged batches of fuel. The cross connection is designed for 1500 gal/min flow from the spent fuel pool to the shutdown cooling system. This provides approximately 12.7×10^6 BTU/hr of decay heat removal at a pool temperature of 145 °F.

failure of any single hoist component. Redundancy has also been designed into the main hoist and trolley brakes, the spent fuel cask lifting devices, and crane control components. The system will prevent all postulated credible single component failures over the entire supporting load path.

Both the bridge and trolley meet the CMAA fatigue loading requirements. These requirements are stated in Table 3.3.3.1.3-1 of CMAA Specification No. 70. The service classification for the reactor building overhead crane is Class A1 which is designed for 100,000 loading cycles. The weldments fall into categories B and C which permit a stress range of 28,000 - 33,000 psi.

The reactor building overhead crane is classified as Safety Class II equipment and is not seismically qualified.

The main and auxiliary hoists have power control braking as well as two holding brakes. There are two brakes provided which are de-magnet-operated, electornic-shoe-type with a maximum torque rating of 100% of motor torque each. The brakes are applied whenever the dc solenoids are deenergized. One dc brake is provided to stop the bridge when deenergized. A manually operated hydraulic brake is also capable of stopping the bridge.

Spring bumpers effective for both directions of travel are provided on the outboard ends of the bridge truck. Crane runway stops with four spring-type trolley bumpers are mounted on runway girders at the ends of the runway rails. The reactor building overhead crane has stops which hook under both the bridge and trolley rails to prevent derailment. The stops also would prevent the reactor building overhead crane trolley from falling into the spent fuel pool.

The reactor building overhead crane is provided with three emergency shutdown switches located on the reactor building walls (elevation 613'-0").

A cable train equalizer feature guards against lifting loads that are not positioned directly beneath the main hook or when the load is off balance. If, during crane operation, the respective lengths of the redundant cable trains become excessively different, the equalizer circuit will disable all crane functions and activate a rotating red light. Following such a trip, all crane functions except raising and lowering may be restored by operating the EQUALIZER BYPASS keyswitch located in the cab.

The main hoist and auxiliary hoist each have two upper limit switches for the lifting circuit and one limit switch for the lowering circuit which inhibit the operation of the hoist in either direction when the upper or lower limit is reached. One set of the main hoist limit switch contacts is used for the main hoist motor control and a second set is used for the main hoist slow speed motor control. These switches are used to restrict lifting to a predetermined limit in the crane's restricted mode.

A digital-type weight indicator for the main hoist is provided. High- and low-load limits can be set manually on the unit with contact closures available for the set weight limits. The contacts operate the slow speed motor for the main hoist. When the weight to be lifted is above the setpoint on the weight indicator, the control circuit for the slow speed motor will prevent its operation and the main hoist brakes will set. As an alternative to the digital load limiter, station procedures require supervising personnel to ensure load hangups do not occur during reactor building crane operation.

lowered by the reactor building overhead crane to a truck or railway car in the equipment access area.

9.1.4.3 Safety Evaluation

This section discusses the safety aspects of the refueling platform, reactor building overhead crane, and associated equipment design. The analyses of the radiological consequences for fuel handling accidents and spent fuel cask drop accidents are discussed in Section 15.7.

9.1.4.3.1 Refueling Platform

Protective interlocks prevent handling of fuel over the reactor when a control rod is withdrawn, and another set of interlocks prevents control rod withdrawal when fuel is being handled over the reactor. Optional boundary zones generated by the PLC prevent moving the bridge outside of the fuel pool area or reactor cavity without additional operator action. The telescoping fuel grapple in the normal up position cannot lift any load, including fuel assemblies, which would result in less than seven feet of water coverage at normal fuel pool water level. For a fuel assembly, the top of active fuel (pellets) is about 18 inches below the bale handle. This results in about 8.5 feet of water coverage over fuel in the normal up position.

Fuel stored in the spent fuel pool is covered with sufficient water for radiation shielding, and fuel being moved is at all times covered by a minimum depth of 8 feet of water. Spent fuel will not be handled with an inadequate depth of water shielding. However, the geometry of fuel transfer casks may require that less than 8 feet of water be above a spent fuel bundle during transfer to the cask.

An evaluation of the dose rates at the spent fuel pool surface as a function of fuel bundle age for a 5-foot water shield above a spent fuel assembly has been completed. For calculational purposes, zero age was taken to be reactor shutdown. The active fuel length is 12 feet. The plenum above the fuel was assumed to be filled with normal density water. The assembly was assumed to be 5 inches on a side and to have an average power of 3.54 MWt. This was based on an equilibrium exposure of a 2561 MWt core containing 724 assemblies. A peaking factor of 1.5 was used to consider dose rates associated with a highly activated assembly. The water shield was placed 5 feet above the assembly, not above the active fuel. The neutron activation contribution to the dose rate was based on 1000 grams of Zircaloy-2 (wt.%: 97.89 Zr, 0.06 Ni, 0.15 Cr, 0.20 Fe, and 1.7 Sn) located 5 feet below the surface of the fuel pool.

The self-shielding properties of UO_2 were not considered in calculating the dose rates given in Table 9.1-2 and shown in Figure 9.1-19. With self-shielding considered, the fuel geometry is such that the dose rate calculations would yield a lower dose rate along the axis of the assembly. However, some points on the fuel pool surface are essentially unaffected by the UO_2 self-shielding effect. The calculation assumed the fuel assembly was filled with fission products associated with a 3.54 MWt fuel bundle but with normal density water as the self-shielding material.

If operations dictate that the assemblies be moved in 90 days, the dose rates at the surface of the spent fuel pool for the average and the highly activated assembly would be approximately 14 and 21 mrem/hr respectively.

During actual fuel transfer to/from the cask, the actual water shield thickness is 5 feet, $10\frac{3}{8}$ inches. The expected radiation dose will then be decreased by approximately a factor of 10.

9.1.4.3.2 Reactor Building Overhead Crane

The 125-ton capacity reactor building overhead crane main hoist is single failure proof. Within the dual load path, the design criteria are such that all dual elements comply with the CMAA Specification No. 70 for allowable stresses, except for the hoisting rope which is governed by more stringent job specification criteria. With several approved exceptions, single element components within the load path (i.e. the crane hoisting system) have been designed to a minimum safety factor of 7.5, based on the ultimate strength of the material. Components critical to crane operation, other than the hoisting system, have been designed to a minimum safety factor of 4.5, based on the ultimate strength of the material. Table 9.1-3 lists the results of the crane component failure analysis.

The reactor building overhead crane and spent fuel cask yoke assemblies meet the intent of NUREG-0554.

All analyses for handling spent fuel shipping casks, performed relative to the overhead crane handling system loads have been based on the National Lead (NL) 10/24 spent fuel shipping cask which weighs 100 tons (Figure 9.1-18). If larger casks are used, additional analyses will be required to assure safety margins are maintained.

Administrative controls and installed limit switches restrict the path of travel of the crane to a specific controlled area when moving the spent fuel cask. The controls are intended to assure that a controlled path is followed in moving a cask between the shipping area and the spent fuel pool. Administrative controls also ensure movement of other heavy loads such as the drywell head, reactor vessel head, and dryer separator assembly is over preapproved pathways.

Technical Specification 3.10/4.10 states refueling requirements. Station procedures prohibit movement of heavy loads over the spent fuel pools or open reactor cavity except under Special Procedures.

The crane reeving system does not meet the recommended criteria of Branch Technical Position APCSB 9-1 (now incorporated into NUREG-0554) for wire rope safety factors and fleet angles. The purpose of these criteria is to assure a design which minimizes wire rope stress wear and thereby provides maximum assurance of crane safety under all operating and maintenance conditions. Because the crane reeving system does not meet these recommended criteria, there is a possibility of an accelerated rate of wire rope wear occurring. Accordingly, to compensate in these design areas, a specific program of wire rope inspection and replacement is in place.

The inspection and replacement program assures that the entire length of the wire rope will be maintained as close as practical to original design safety factors at all times. This inspection and replacement program provides an equivalent level of protection to the methods suggested in wire rope safety and crane fleet angle criteria and will assure that accelerated wire rope wear will be detected before crane use.

"Two blocking" is an inadvertently continued hoist which brings the load and head block assemblies into physical contact, thereby preventing further movement of the load block and creating shock loads to the rope and reeving system. A mechanically operated power limit switch in the main hoist motor power circuit on the load side of all hoist motor power circuit controls provides adequate protection

9.1.5 References

1. Exxon Nuclear Criticality Analysis for 9x9 Fuel, XN-NF-84-115, Revision 1.
2. Quadrex Corporation, Qualification Report, QUAD-3-83-002, Revision 1.
3. EMF-94-098(P) Revision 1, "Criticality Safety Analysis for ATRIUM-9B Fuel: Dresden Units 2 and 3 Spent Fuel Storage Pool,"NFS NDIT #960095, dated January 1996.
4. EMF-96-148(P) Revision 1, "Criticality Safety Analysis for ATRIUM-9B Fuel: Dresden and Quad Cities New Fuel Storage Vaults,"NFS NDIT #960127, dated September 1996.
5. Letter, J. A. Zwolinski (NRC) to D. L. Farrar (ComEd), "Technical Specifications Relating to Storage of New and Spent Fuel in the High Density Fuel Storage Racks," dated December 12, 1985. Transmitted Amendment No. 91 to DPR-19 and Amendment No. 85. to DPR-25.
6. GE SIL No. 152, "Criticality Margins For Storage Of New Fuel," dated March 31, 1976.
7. Fuel Pool Cooling Heat Removal Capability, DRE 97-0096, Revision 0.
8. Safety Evaluation Tracking No. 1998-04-247.

diagrams of the CCSW systems for Units 2 and 3 are shown in Drawings M-29, Sheet 2 and M-360, Sheet 2, respectively.

The CCSW system provides cooling water for the containment cooling heat exchangers during both accident and nonaccident conditions, as described in Section 6.2.2. System piping is arranged to form two separate, two pump, flow networks (loops) until the piping downstream of the differential pressure control valve on the discharge of the heat exchanger. At this point, the piping from both loops merge into a common discharge line to the service water 48" header. Each pair of CCSW pumps takes a suction from the crib house via separate supply piping. Two CCSW pumps discharge into a common header which routes the cooling water to that loop's associated heat exchanger. At the heat exchanger, heat is transferred from the low pressure coolant injection (LPCI) subsystem to the CCSW system, and subsequently to the river.

During normal plant operation, the CCSW system is not operating. Following an accident or other plant evolution which requires containment heat removal, the CCSW system is manually started. Each CCSW pump is rated at 500 hp with a service factor of 1.15. The CCSW pumps are powered by normal ac or diesel generator ac power. Additional CCSW pump information is provided in Table 9.2-1.

The CCSW pumps develop sufficient head to maintain the cooling water heat exchanger tube side outlet pressure 20 psi greater than the LPCI subsystem pressure on the shell side. The ΔP is maintained by the manual operation of a differential pressure control valve in the CCSW outlet piping from the LPCI heat exchanger. Maintaining this pressure differential prevents reactor water leakage into the service water and thereby into the river. A minimum of 5000 gpm is necessary to maintain containment cooling.

The four CCSW pumps are located in the turbine building. Two of the four CCSW pumps (pumps B and C) are located in a single, common watertight vault for flood protection. To prevent the CCSW pump motors from overheating, the vault has two vault coolers. The cooling water for each cooler is provided from its respective CCSW pump discharge line through a four-way valve. This valve also permits flow reversal of the cooling water through these coolers to help clean the tubes. Refer to Section 3.4 for a discussion of the flood protection features at Dresden.

A continuous fill of the CCSW system is provided by the service water system or, in the case of a loss of power to the service water pumps, the diesel generator cooling water system may be aligned to provide the continuous fill. This eliminates the potential for water hammer upon CCSW system startup. The diesel generator cooling water system is discussed in Section 9.5.5.

The Unit 2 CCSW loops also provide a safety-related source of service water to the control room air conditioning condensers. Refer to Sections 6.4 and 9.4.1 for a description of the control room ventilation system.

The CCSW system also supplies a safety related source of river water to the LPCI and HPCI room coolers as a backup ot the service water system

9.2.1.3 Safety Evaluation

Containment cooling is not immediately required following a design basis loss-of-coolant accident (LOCA). The required timing of the initiation of containment cooling functions by CCSW is described in Section 6.2.1.3.2. One of the two heat exchangers, two CCSW pumps, and one LPCI pump all in the same loop are the minimum requirements for containment cooling.

9.2.2 Service Water System

9.2.2.1 Design Bases

The design objective of the service water system is to provide strained river water of suitable quantity and quality for plant equipment cooling requirements. To achieve this objective, the service water system was designed to:

A. Cool the RBCCW system under all operating conditions;

B. Meet cooling water requirements during the reactor shutdown mode, which represents the most severe condition and is used as the design basis;

C. Operate at a higher pressure than any of the loads which it serves; and

D. Provide an inexhaustible supply of water to the condenser hotwell, via the standby coolant supply valves, so that feedwater flow can be maintained to the reactor in the event of a LOCA. A description of the standby coolant supply system is provided in Section 9.2.8.

9.2.2.2 System Description

The service water system is shared by Units 2 and 3. The purpose of the system is to provide strained river water for various plant equipment. The components and systems which are cooled by or receive water from the service water system are listed in Table 9.2-2. The service water systems for Units 2 and 3 are shown in Drawings M-22 and M-355, respectively. As shown in these drawings, the system consists of five pumps, three strainers, and a common distribution header. Two service water pumps are provided per unit and the fifth shared pump is used as a backup. A chemical treatment system and the necessary control and support equipment are also provided.

Normally two pumps and one strainer for each unit are in operation while the fifth pump and one strainer are in standby. The system is cross-tied between Units 2 and 3. The pumps take their suction from a flooded pit in the common intake structure (crib house) for Units 2 and 3. The water supply from the river and/or lake is described in detail in Section 2.4. The service water pumps from both units discharge into a common header serving both units. From this common header, service water is routed through the strainers to a common distribution header which routes the service water to the plant equipment listed in Table 9.2-2.

The system is a once-through flow network. Each heat exchanger discharges into one of two standpipes which connect to the plant discharge flume. The larger of the two standpipes is monitored for radioactive contamination.

In the event of a failure of the service water pumps to maintain header pressure, motor-operated isolation valves may be closed to isolate nonessential loads (TBCCW heat exchangers, reactor recirculation pump motor-generator (M-G) sets oil coolers, main generator stator cooling water heat exchangers, and hydrogen coolers) from the service water system.

The service water pumps are mounted vertically and are driven by 1000-hp electric motors. Each has a capacity of approximately 15,000 gal/min at 91 psig.

The pumps are powered by 4-kV buses 23(33) and 24(34). The 2/3 service water pump can be powered by either Unit 2 or Unit 3. In the event of loss of power to any of these buses, the associated service water pumps will trip on undervoltage. Once power is restored to the bus, the pump can be manually restarted. There are no automatic start features for the service water pumps.

The service water strainers consist of wire mesh elements which undergo automatic self-cleaning when strainer differential pressure reaches a preset limit. The strainers can also be backwashed manually.

The chemical injection system is used to inject a biocide to control clam growth and remove slime-causing bacteria. The chemical injection system inhibits growth of algae which would reduce heat transfer capability of the heat exchanger tubes.

The service water system keeps the station fire protection system header pressurized when the fire water system is not in use. One or more of the following pumps will be used to maintain fire water header pressure if the service water pumps fail to do so. Manually operated Unit 1 screen wash pump, automatically operated Unit 1 diesel-driven fire pump or automatically operated Unit 2/3 diesel-driven fire pump.

If the diesel-driven fire pump fails, the service water system may be used to provide required fire water flow through a normally closed isolation valve. Refer to Section 9.5.1 for details of the fire protection system.

The service water system supplies water to the standby coolant supply system, which in turn provides an inexhaustible supply of water to the hotwell (under accident conditions). Standby coolant supply system information is provided in Section 9.2.8.

Service water provides a backup supply of cooling water to the CRD pumps in the event TBCCW is unavailable for normal cooling.

Under normal operating conditions, the service water system provides cooling water to the ECCS room coolers and pressurizes the CCSW pump keep fill line.

The CCSW system provides a safety related backup source of cooling water to the ECCS room coolers if service water is lost.

The HPCI and X-area coolers have been provided with four-way valves to allow reversing the service water flow through the coolers to keep the coolers and associated piping clean. This modification improved the efficiency of these room coolers.

The service water system is the primary source of cooling water for the RBCCW and TBCCW heat exchangers. Alternate cooling may be provided to the RBCCW and TBCCW heat exchangers and consequently the loads they cool. The fire header system or CCSW system can be used to provide cooling via temporary connections to the RBCCW and TBCCW heat exchangers to service equipment required to be operational.

Permanent tap connections on the TBCCW and RBCCW heat exchanger service water inlet lines facilitate connection of temporary cooling water sources during service water system outages. The taps are installed on the inlet lines for the 2B, 2/3 and 3B RBCCW heat exchangers and the 2A, 2B, 3A and 3B TBCCW heat exchangers. Each tap consists of a normally closed isolation valve and a flange. The RBCCW heat exchanger service water lines have 8-inch taps and the TBCCW heat exchanger inlets have 2½-inch taps. During normal heat exchanger operation, each flange is blind flanged and the corresponding isolation valve is closed.

9.2.2.3 Safety Evaluation

In the event of loss of auxiliary power on a unit, the standby service water pump will be manually started using power from the other unit. The standby pump and the two pumps on the remaining unit are sufficient to provide service water to both the tripped unit and the operating unit.

In the event of loss of auxiliary ac power to the 4kV safety-related electrical buses, the emergency diesel generators will automatically repower the safety-related electrical buses, and the operator will manually start a service water pump on emergency power after securing a safe shutdown of the units. (A LOCA or failure of either of the diesels to start concurrent with the loss of auxiliary ac power will affect the speed with which the operator can put discretionary loads onto the emergency power system.) Service water is not necessary for a safe shutdown of the units, but it is needed to attain a normal cold shutdown condition.

In the event of a LOCA and a loss of all power where the service water system is unavailable, the HPCI and LPCI room coolers will receive backup cooling water from the CCSW system. Once the CCSW pumps are loaded on the emergency diesel generators and started, cooling water is diverted from the main system header to the service water header that feeds all three room coolers. This ensures that heat can be removed from the HPCI and LPCI rooms almost continuously.

The thermal response of the HPCI room has been evaluated for a postulated LOCA and LOOP assuming continuous system operation for an extended period of time (four hours). The HPCI room temperature setpoint at which the system would isolate was never reached, and the system would be always available.

9.2.2.4 Testing and Inspection Requirements

The station service water system is normally in operation, and no functional tests are required.

The service water effluent gross activity monitor is required to be operable; otherwise, a grab sample must be taken and analyzed every 12 hours. This radiation monitor is verified operable once per 24 hours.

9.2.2.5 System Instrumentation

The service water pumps can be controlled either from the main control room or from a local panel in the crib house. Local control has been provided for safe shutdown concerns in the event the control room becomes inaccessible.

Pressure and temperature instrumentation is provided on selected heat exchangers cooled by the service water system.

Principal measurements such as service water header pressure, supply pressure, and pump motor current are indicated in the control room. Local pressure and temperature gauges are provided for flow balancing and equipment cooling control by manual valve adjustment. For that equipment which requires a controlled temperature, local automatic temperature controllers are provided to control service water flow through the equipment. As shown in Drawings M-22 and M-355, temperature control valves are included for the following:

A. The TBCCW heat exchanger common service water discharge;

B. Turbine oil coolers common service water discharge;

C. Main generator hydrogen coolers common service water discharge;

D. Reactor recirculation pump M-G set oil coolers common service water discharge;

E. The RBCCW individual heat exchanger service water discharge; and

F. Each control room air conditioner condenser service water discharge.

Abnormal conditions, such as low service water pressure, a service water pump trip, or an X-area cooler trip are annunciated in the main control room. This provides the operator with information to assess the abnormal condition and initiate corrective actions.

Instrumentation is provided for the operation of the automatic backflush of the service water strainers on high differential pressure.

Radiation monitoring instrumentation is provided at the outlet of the service water system to monitor the radioactive discharges to the environment. Process radiation monitoring information is provided in Section 11.5.

9.2.3.2 System Description

The RBCCW system is a closed loop system which consists of piping, pumps, heat exchangers, an expansion tank, a chemical feeder, and the necessary control and support equipment. Diagrams of the Unit 2 and 3 RBCCW systems are shown in Drawings M-20 and M-353, respectively.

The system's purpose is to provide cooling under various modes of operation and shutdown for the reactor auxiliaries listed in Table 9.2-3. The RBCCW system is available to cool all plant cooling loads in the reactor building under all operating conditions.

Five RBCCW pumps are provided: two for each unit and one extra, designated 2/3, which is shared by Units 2 and 3. The shared pump is located on the Unit 2 side. Each pump is a centrifugal pump with a capacity of 8800 gal/min at 80 psig (50% capacity) driven by a 300-hp electric motor. All three pumps on Unit 2 have a common suction header and a common discharge header; both pumps on Unit 3 also have a common suction header and common discharge header. From each unit's common discharge header, the cooling water is routed to the various plant equipment. The RBCCW systems for Units 2 and 3 are normally isolated from each other but may be crosstied at the suction and discharge of the 2/3 RBCCW pump.

The RBCCW system water returning from the loads is routed through the heat exchangers prior to returning to the pump suction. Similar to the RBCCW pump arrangement, five 50% capacity heat exchangers are provided: two for each unit and one extra, designated 2/3, which is shared between Units 2 and 3. The 2/3 heat exchanger is located on the Unit 2 side.

The RBCCW heat exchangers provide means for heat rejection from RBCCW to the service water (see Section 9.2.2). Each heat exchanger is a two pass, counterflow heat exchanger rated at 78×10^6 Btu/hr.

An expansion tank is provided for each unit, connected to the suction line of the associated unit pumps. The expansion tank allows for water expansion from temperature and pressure changes within the RBCCW system. The tank is located above the highest point in the system and provides adequate net positive suction head (NPSH) to the RBCCW pumps. The tank also provides a storage volume of water to replenish RBCCW from the clean demineralized water tank and provides a means for RBCCW to overflow to the reactor building floor drain sump. Leakage into or out of the RBCCW system can be detected by low and high tank level alarms. The tank is provided with a vent pipe to prevent pressure buildup.

The RBCCW piping and loads are divided into three loops by isolation valves which can control the flow through the associated loop. Table 9.2-3 lists the loads associated with the individual loops.

A. Loop I - Primary containment critical loads. Loss of RBCCW to the primary containment may require immediate reactor shutdown.

B. Loop II - Shutdown cooling system heat exchangers.

C. Loop III - Reactor building auxiliary equipment.

Motor-operated valves are provided for loop isolation. The containment isolation valves do not receive containment isolation signals and, therefore, remain open unless closure is manually initiated. The motor-operated valve located on the outlet of the shutdown cooling heat exchangers may be throttled to control the temperature of the water injected to the reactor vessel by the shutdown cooling system.

The RBCCW pumps are not provided with a pump minimum flow valve. Prior to pump operation, a minimum flow path of 900 gal/min is required.

The RBCCW system is used to cool several reactor auxiliary systems and related equipment. With the exception of the Drywell Equipment Drain Sump Heat Exchanger, the Reactor Building Equipment Drain Tank Heat Exchanger, the Reactor Recirculation Pump Motor Oil Coolers, and the Reactor Recirculation Pump Seal Coolers, the RBCCW system operating pressure is lower than the processes served. The RBCCW system operating pressure is lower than the service water system operating pressure in the RBCCW heat exchangers. Except for the components listed above, any leakage will be into the RBCCW loop from both the equipment being cooled, and from the service water system. In all cases, however, the design prevents the accidental discharge of potentially radioactive water into the service water system, and thereby into the river.

A radiation monitor that records and alarms in the control room is located on the inlet piping to the heat exchangers to detect the leakage of any radioactive process water into the RBCCW system. Another method to evaluate leakage from equipment to the closed loop is via the grab sampling station located near the outlet of each major component of the cooling water system. A high-level alarm in the expansion tank would also detect leakage into the system.

RBCCW provides cooling under various modes of plant operation and shutdown. Pump and heat exchanger requirements for each mode of service will depend on plant conditions of operation or shutdown.

A chemical feeder provides a means for inhibiting rust development and controlling pH. Sodium nitrite ($NaNO_2$) is used to prevent rust development.

9.2.3.3 Safety Evaluation

The pumps and heat exchangers should be used in equal numbers. If two pumps and one heat exchanger are used, the design capacity of the heat exchanger is exceeded and causes excessive vibration. With two heat exchangers and one pump, the load limits for the pump can be exceeded as the pump approaches runout conditions.

Loss of RBCCW cooling flow to the primary containment loads (Loop I) requires immediate plant shutdown if flow cannot be reestablished within 1 or 2 minutes. Damage to electrical equipment and reactor recirculation pump seals and bearings may result.

Loss of RBCCW to the drywell coolers results in drywell atmosphere heatup and subsequent drywell pressure increase. The RBCCW pump logic provides for operation in all circumstances except when an accident signal is received concurrent with a loss of auxiliary power (see Section 8.3). The continuous supply of water to the drywell coolers will support the reduction of drywell pressure following a scram. The cooling water will also continue to be supplied to the reactor recirculation pumps and motors during a pump coastdown (loss of RBCCW could possibly cause seizure of a recirculation pump).

Loss of RBCCW to the drywell equipment drain sump heat exchangers may result in an increase in airborne activity in the primary containment.

In the event of an ac power failure, one RBCCW pump (obtaining power from the emergency diesel) and one heat exchanger will provide cooling for the reactor recirculation pump, drywell sump, and the drywell coolers (these are considered to be critical loads). The RBCCW system (one pump) is considered in the diesel generator support of a nonaccident safe shutdown (refer to Section 8.3). The RBCCW is not required to perform any post-accident heat removal functions. In the case of a coincident loss of offsite power and a LOCA, power is not automatically provided to the RBCCW pump motors.

The heatup of the drywell during a postulated loss of coolant accident could, in turn, heatup the volume of liquid trapped between the RBCCW drywell return line containment isolation valves. Heatup of this trapped volume could overpressurize and fail the associated piping, creating a bypass path for the primary containment. To prevent the potential overpressurization of this piping, a relief valve has been installed between the containment isolation valves to protect against the consequences of thermal expansion of the trapped fluid. Another relief valve has been installed on the non-safety related loop to prevent the pressure buildup that could affect the inboard isolation valves.

9.2.3.4 Testing and Inspection Requirements

Since the system is operating at all times, no testing is required except for periodic operation of the spare pump.

9.2.3.5 System Instrumentation

Major components serviced by the cooling water system are provided with high-temperature alarms and/or temperature transmitters to aid in regulating cooling water flow.

As shown in Drawings M-20, M-22, M-353, and M-355, RBCCW temperature is automatically controlled by local temperature controllers which regulate service water flow through the RBCCW heat exchangers. The RBCCW pump discharge header temperature and pressure are indicated in the main control room. Low RBCCW system pressure is detected by a pressure switch which monitors the RBCCW pump discharge header pressure and annunciates in the main control room. High temperature at the RBCCW heat exchanger outlet is annunciated in the main control room. Local pressure and temperature gauges are provided for balancing flow through equipment by manual valve adjustment.

Instrumentation located in the main control room provides information allowing the operator to assess annunciated abnormal conditions and initiate corrective measures. Temperature of the cooling water to equipment located in the drywell is recorded in the control room along with cooling water outlet temperature from each drywell cooler. Low RBCCW flow from the reactor recirculation pumps is annunciated in the control room. Cooling water outlet temperatures from recirculation pump motor cooling coils and pump seals are recorded, and abnormally high temperature is annunciated.

Water level in each RBCCW expansion tank is indicated locally. Water level is sensed by tank-mounted level switches. One level switch controls the automatic level control valve for filling the expansion tank. A second level switch monitors abnormally high and low water level conditions and annunciates in the control

9.2.4 Demineralized Water Makeup System

The demineralized water makeup system consists of all equipment required to transfer water from the well water storage tank, through the makeup demineralizers, and into the various water storage tanks onsite.

9.2.4.1 Design Bases

The design objective of the demineralized water makeup system is to provide the desired quantity of reactor quality water for pre-operation and normal operation of the power plant. The system provides makeup water to the clean demineralized water storage tanks and the contaminated condensate storage tanks.

9.2.4.2 System Description

The demineralized water makeup system is common to both Units 2 and 3 and consists of pumps, storage tanks, demineralizers, and the necessary control and support equipment. The system pumps are of adequate size to provide the maximum expected flowrates. Drawings M-35, Sheet 1and M-423, Sheets 1 through 5, depict the demineralized water makeup system.

The system takes well water from the existing 200,000-gallon Unit 1 well water storage tank. This tank is filled from two deep wells. Well water is pumped from the well water storage tank, by any of the three well water transfer pumps, to the makeup demineralizer system. As shown in Drawing M-423, Sheets 1 through 5, the makeup demineralizer system consists of three 33⅓% capacity dual media filters whose combined effluent is routed to either of two parallel cation demineralizer beds which discharge to a decarbonator. Two decarbonator booster pumps are provided to transfer the water from the decarbonator through either of two parallel anion demineralizers. From the anion beds the effluent is routed through either of two mixed bed demineralizers. The combined demineralizer effluent is routed through a direct acting pressure control valve to the 200,000-gallon clean demineralized water storage tank. Water may also be routed to any of the contaminated condensate storage tanks.

As shown in Drawing M-423, Sheets 6 through 8, the demineralizer system is provided with necessary storage tanks and pumps to regenerate the demineralizer resin beds in place.

The demineralized water makeup system operates on demand at infrequent intervals to replenish demineralized water in the storage tanks.

9.2.4.3 Safety Evaluation

The demineralized water makeup system has been evaluated by the NRC under Systematic Evaluation Program (SEP) Topic VI-10.B, Shared Systems. This evaluation determined that this system is not required to function for any safety-related purpose.

The heatup of the drywell during a postulated loss of coolant accident could, in turn, heatup the volume of water trapped between the demineralized water drywell supply line containment isolation valves. Heatup of this trapped volume could overpressurize and fail the associated piping, creating a bypass path for the primary containment. To prevent the potential overpressurization of this piping, a relief valve has been installed between the containment isolation valve to protect against the consequences of thermal expansion of the trapped fluid.

9.2.4.4 Testing and Inspection Requirements

The makeup water system operates intermittently during operation of the plant and no testing of the system is required.

9.2.4.5 System Instrumentation

As shown in Drawings M-35, Sheet 1, and M-423, Sheets 1 through 8, the clean demineralized water storage tank levels are indicated locally. Pumps and valves for the demineralized water makeup system are controlled from the makeup demineralizer building. The demineralizer trains are fully instrumented with flow, level, pressure, temperature, conductivity, and pH indicators located as necessary throughout the process.

During this sequence of events, the operator is required to trip the circulating and service water pumps to prevent pump damage. Other equipment, which either adds heat to the primary system or which is cooled directly or indirectly by river water, would be removed from service.

Following the reactor scram on Units 2 and 3, the relief valves from the primary system to the suppression chamber would open to prevent overpressurizing the reactor vessel. Level in the reactor would be maintained by reactor feed pumps; control rod drive pumps; or, in the case of loss of auxiliary power, the HPCI system. With the initiation of the isolation condenser, depressurization of the primary system would start.

Each of the reactors could be depressurized at a controlled rate using the isolation condensers. The primary system temperature could be reduced to 212°F in 8 - 12 hours and be maintained at this condition with the isolation condensers. Generally, the temperature could not be reduced below this point since the system depends on steam flow to remove the core decay heat.

Preferred makeup water to the isolation condenser is from the clean demineralized water storage tank via two diesel driven makeup pumps or the clean demineralized water pumps, the latter of which are discussed in Section 9.2.6. With this water source unavailable, river water would be pumped to the isolation condensers by diesel-driven fire pumps or by portable engine-driven pumps pumping into the fire system. Contaminated condensate water is also available to provide makeup water to the isolation condensers; however, the use of this water source is less desirable than the other sources. It is also possible to obtain portable pumps which would draw suction from the intake canal and discharge to the fire protection system.

The fire protection system is considered a Class II system; however, parts of this system can meet the requirements of a Class I system. Using existing valves, it is possible to sectionalize the system to isolate the failed parts.

Operation of the diesel generators is assured since the diesel generator cooling water pumps' suction lines are at elevation 487'-8". The diesel fire pump of Units 2 and 3 has its suction above elevation 495'-0". Therefore, the compartment that contains the suction of the fire pump and the CCSW intakes must be reflooded using the travelling screen refuse pumps. This is further explained in Section 9.2.5.3.2.

Analysis has shown that the amount of water required by each unit to remove decay heat through the isolation condenser over a 30-day period is 2.5 million gallons. This water would not be returned to the intake structure since it will be boiled off. This analysis assumed the cooling water entering the isolation condenser is at 100°F.

An additional small amount of cooling water for diesel generator cooling is also required but could be recirculated to the intake structure after dissipating its heat to the environment.

Loss of impounded river water, due to evaporation, could be made up by a portable, low-head, high-volume, engine-driven pump. Dresden Station can obtain several suitable pumps from many sources in the Northern Illinois area, such as other company-owned facilities and pump rental companies.

9.2.5.3.2 Dam Failure Coincident with a LOCA

If, at the time of the catastrophic failure of the dam, either Unit 2 or Unit 3 were to have a LOCA, it would still be possible to handle the LOCA and safely shut down the unaffected unit. Safe shutdown is still possible with coincident failure of offsite electrical power and Class II systems.

For a postulated LOCA on Unit 2, Unit 3 would be forced to shut down and depressurize due to the loss of circulating water, as previously described in Section 9.2.5.3.1. For Unit 2, depressurization would be to its suppression chamber. None of the core cooling systems would be affected by the loss of river water except the LPCI containment cooling mode. The LPCI containment cooling mode would be affected because the CCSW pumps take suction from the Unit 2 and 3 intake structure via two lines which have a centerline elevation of 500'-0". However, a short radius elbow at the end of each of the intake lines draws water at an elevation of 498'-0" (see Section 9.2.1.). As indicated in Figure 2.4-1, a dam failure places the CCSW suction piping above the water level in the intake canal, which would be at elevation 495'-0".

In order to operate a CCSW pump to reduce containment pressure and cool the water in the suppression chamber, it would be necessary to raise the water level in the area of these suction pipes. The drywell pressure and temperature would rise due to the transfer of core decay energy to the containment system. In about ½ hour, containment system pressure would start to increase and, after a period of 2 hours, cooling of the suppression chamber would be needed. During this period of time, measures would be undertaken in the intake structure to restore suction to the CCSW pumps.

Reference should be made to Drawing M-10. The suction lines for the CCSW pumps take suction from a compartment between column row B and C with its center line on column line 4. The diesel fire pump also takes suction from this compartment. River water enters this compartment through two screened openings to the left and right of column line 4. The floor of this compartment is at elevation 493'-8" and the ceiling is at elevation 509'-6". The two openings extend between these two elevations. The wire mesh screens from each of these openings would be lifted out of place and replaced with stop logs. The stop logs are stored in the crib house at a location which would minimize the time required for their installation by station operators should a dam failure occur.

Dewatering valves, located at elevation 480'-0", would be opened to permit river water to flow from the compartments under the circulating water pumps and intake piping to the trash rake refuse pit located between column row C and D and column line 7 and 8. The floor of this pit is at elevation 477'-0". Thus, the water in this pit would rise to elevation 495'-0", the level in the intake canal.

Two refuse pumps take suction from this pit. The pumps are located in a compartment adjacent to the pit with their suction at elevation 479'-0". Each pump has a discharge capacity of 2400 gal/min. A permanent pipe line is installed between the discharge line of these pumps and the compartment with the CCSW pumps. By proper electrical switching, the refuse pumps can be operated off the diesel generator.

A CCSW pump would be placed in service discharging to the containment cooling heat exchanger of Unit 2 and then to the discharge canal. River water in the discharge canal would be recirculated by way of the deicing line back to the crib house forebay. In this manner, containment pressure would be reduced and the suppression chamber water cooled.

If necessary, the Unit 2 containment may be completely flooded by using the alternate injection systems as defined in emergency operating procedures or by the circulating water system. Containment flooding via the circulating water system can be accomplished by removing bolted access plates at the bottom of the condenser hotwell, opening an access cover on the circulating water piping, opening a circulating water pump discharge valve, and gravity draining through the circulating water system. These actions will flood the condenser pit area to a level above the bottom of the hotwell. Condensate and/or feedwater pumps can then inject this water into the reactor pressure vessel where it will flow through the break into containment.

In discussions with the Army Corps of Engineers, they indicated that a number of measures would be undertaken if damage were to occur to the dam. The use of increased diversion from Lake Michigan (with approval of the U.S. Supreme Court) would be one method if the dam were partially damaged. This method would be used to maintain pool level. Another method would be the sinking of stone-loaded barges directly above the dam as a base for a temporary rock-filled dam. Both of these methods would help to hold levels in the Dresden flumes to permit maintaining the Dresden units in a safe condition.

9.2.5.4 Testing and Inspection Requirements

A surveillance is performed every third refueling outage to verify the ability of the system to accomplish its intended purpose of providing a source of water for post-LOCA containment cooling and also verify that the required manual operations described in Section 9.2.5.3.2 can be performed in a reasonable time.

9.2.6.1 Design Bases

The design objective of the condensate storage facilities is to provide water of a quality and quantity required for preoperation and operation of the power plant.

The system is designed to ensure a minimum of 90,000 gallons of water is available from each contaminated condensate storage tank (CCST) for use by HPCI.

9.2.6.2 System Description

As shown in Drawings M-35, Sheet 1 and M-366, the condensate storage facilities consist of two 250,000-gallon capacity CCSTs (CCST 2/3A and 2/3B), one 200,000-gallon capacity contaminated demineralized water storage tank (T-105A), and two clean demineralized water pumps shared between Units 2 and 3. Two of the tanks, CCST 2/3A and 2/3B, are each normally maintained at levels which make 90,000 gallons available to each HPCI system that is required to be operable. 90,000 gallons satisfies the HPCI system makeup water assumptions in an NRC Systematic Evaluation Program analysis regarding safe shutdown using only Class I systems. A minimum combined water volume in CCST 1, CCST 2/3A, and CCST 2/3 B of 130,000 gallons (single plant operation) and 260,000 gallons (dual plant operation) is required to meet Appendix R safe shutdown requirements. Refer to Section 6.3 for a discussion of the HPCI system. Each unit has two condensate makeup pumps, two condensate transfer pumps, and one condensate transfer jockey pump with associated piping and valving to transfer condensate throughout the plant.

Two clean demineralized water pumps, each rated at 250 gal/min, take suction from the clean demineralized water storage tank and discharge into a common header. The clean demineralized water transfer system provides water for multiple uses including the following:

A. Decontamination;

B. Floor washdown in areas containing radioactive drain systems;

C. Laboratories;

D. Filling of cooling water systems;

E. Purposes requiring demineralized water where radioactive contamination is not desired;

F. Makeup water to the isolation condenser.

The potential for the ECCS condensate supply lines to freeze has been evaluated. The majority of the CCST piping to ECCS is buried 5 to 6 feet below surface grade. To prevent freezing, the ECCS lines entering the CCSTs above ground are well insulated, heat traced, and contained in an insulated permanent enclosure. All other safety-related process instrument and sampling lines are indoors and not exposed to subfreezing temperatures.

9.2.6.4 Testing and Inspection Requirements

Water quality in the clean and contaminated condensate storage tanks is periodically analyzed in accordance with station chemistry procedures.

9.2.6.5 System Instrumentation

As shown in Drawing M-35, Sheet 1, each CCST level is indicated in the control room and low-level alarms alert the operator to excessive use of condensate or when normal makeup is required. High-level alarms are provided for each tank to indicate the filled condition. Each storage tank is electrically heated and thermostatically controlled locally.

The condensate makeup pumps, condensate transfer pumps, and the condensate transfer jockey pumps are remotely operated from the control room. Each is provided with circuitry to annunciate a tripped condition in the control room. The condensate makeup pumps will automatically start due to a low hotwell level.

Condensate transfer pump discharge header pressure and demineralized water pump discharge header pressure are indicated in the control room. Low condensate transfer header pressure and low demineralized water header pressure signals actuate alarms in the control room.

9.2.7 Turbine Building Closed Cooling Water System

9.2.7.1 Design Bases

The purpose of the TBCCW system is to provide a means of heat rejection from systems located in the turbine building and crib house.

9.2.7.2 System Description

The TBCCW is a closed loop system which consists of pumps, heat exchangers, an expansion tank, a chemical feeder, and associated control and support equipment. Separate, independent systems are provided for Units 2 and 3. The TBCCW system is shown in Drawings M-21 and M-354, Sheets 1 and 2.

The TBCCW system consists of two pumps which circulate the cooling water throughout the unit. An expansion tank piped to the TBCCW pump suction line is located on the turbine building ventilation fan floor (elevation 549'-0"). Its elevation above the TBCCW pumps ensures adequate NPSH for the pumps. It also provides a surge volume for the system as the cooling water density varies. Expansion tank level is maintained by an automatic level control valve which supplies demineralized water to the tank as level decreases. An internal overflow for the tank is routed to the 48-inch service water discharge header.

The TBCCW pumps discharge to a common header which supplies cooling water to the various equipment listed in Table 9.2-4.

The electrohydraulic control (EHC) fluid coolers have a temperature control valve on the common cooling water outlet of the heat exchangers which automatically controls the cooling water flow in response to EHC fluid effluent temperature.

The sparging air compressor aftercoolers, the instrument air compressors, the Unit 2 service air compressor, and reactor feedwater pump oil coolers have temperature control valves on the cooling water inlet lines which control the cooling water flow through these components, maintaining proper temperatures. The Unit 3 service air compressor has a solenoid valve which opens automatically when the compressor is started. The cooling water flow is adjusted with a manual valve on the cooling water outlet line, for component temperature control.

Other loads have no automatic temperature control, but flow through them may be manually throttled.

Return flow from the various loads enters a common header which is routed to one of two TBCCW heat exchangers. The cooling water flows through the shell side of the selected heat exchanger and the effluent is routed to the TBCCW pump suction. Service water provides the cooling medium on the tube side of the heat exchanger. An air-operated temperature control valve, common to both heat exchangers, throttles the service water in response to the temperature of the cooling water effluent. Refer to Section 9.2.2 for a description of the service water system. A chemical feeder at the suction to the pumps provides a mechanism to add a corrosion inhibitor to the system.

9.2.7.3 Safety Evaluation

The equipment cooled by the TBCCW system is not considered essential. It is important to note that loss of TBCCW cooling to the control rod drive pumps does not affect the function of the control rod scram function. Service water backs up the TBCCW supply to the CRD pumps.

9.2.7.4 Testing and Inspection Requirements

The TBCCW system operates continually and requires no operability checks. The cooling water is sampled periodically in accordance with station chemistry procedures. A corrosion-inhibitor is added via the chemical feeder when required, as determined by the sample analysis.

9.2.7.5 System Instrumentation

As shown in Drawings M-21 and M-354, Sheets 1 and 2, a level switch is provided to automatically open the demineralized water makeup valve to fill the TBCCW expansion tank. A second level switch actuates a common high or low expansion tank level annunciator in the control room.

The TBCCW pumps are remotely controlled from the main control room. Discharge header pressure is indicated and low header pressure is annunciated in the control room. Discharge header temperature is also indicated and high temperature is annunciated in the control room.

The TBCCW pumps are powered by normal ac power supplies (480-V MCCs) and are protected by thermal overload trips. A trip of a TBCCW pump annunciates in the control room. There are no automatic start features for the pumps; thus, if only one TBCCW pump is operating, the idle TBCCW pump will not automatically start if the originally operating pump trips.

Local temperature and pressure indicators are provided throughout the system to allow for flow balancing and determination of individual heat exchanger performance.

9.2.8 Standby Coolant Supply System

9.2.8.1 Design Bases

The purpose of the standby coolant supply system is to provide an inexhaustible supply of water to the condenser hotwell so that feedwater flow to the reactor can be maintained in the event it is needed for core flooding and/or containment flooding following a postulated LOCA.

9.2.8.2 System Description

The system consists of piping between the service water system and the condenser hotwell (see Drawings M-22 and M-355), as well as associated valves, and instrumentation. The service water system is described in detail in Section 9.2.2. This equipment supplies approximately 15,000 gal/min of screened and strained river water to the hotwell. Two motor-operated isolation valves are used in the interconnected piping to provide the capability for testing the valves and to prevent leakage of river water to the condenser. The volume between the valves is provided with a tell-tale drain with a flow sightglass.

A hydrostop flange has been added upstream of standby coolant supply isolation valves, MO-2-3901 and MO-3-3901, to permit valve maintenance. The hydrostop plug that remains in the system is in the tee out of the main flow stream. The line water pressure acts on the plug to force it into the tee. This ensures the plug will not enter the main flow stream.

Table 9.2-1

CONTAINMENT COOLING SERVICE WATER EQUIPMENT SPECIFICATIONS

Containment Cooling Service Water Pumps

Number	4 (2 needed to provide required cooling capacity)
Type	Horizontal, centrifugal
Power source	Auxiliary transformer or emergency diesel
Capacity	3,500 gal/min each
Head (approximately)	470 feet

9.3 PROCESS AUXILIARIES

This section includes descriptions of the following systems:

A. Compressed air systems (9.3.1);

B. Process sampling systems (9.3.2);

C. Equipment and floor drainage systems (9.3.3); and

D. Standby liquid control system (9.3.5).

9.3.1 Compressed Air Systems

The primary compressed air systems include the instrument air system (oil-free) and the service air system. Each of the units (2 and 3) has its own independent instrument and service air systems which, if needed, can be cross-connected with each other for reliability. Unit 1 has an independent service air system which supplies Unit 1 instrument air. The Unit 2 service air system will normally supply the Unit 1 service air system when the Unit 1 service air compressor is not operating.

Other compressed air systems include the pump-back and drywell pneumatic supply systems. The pump-back system and drywell pneumatic supply system supply primary containment gases (instead of air) to the drywell. The radwaste area has its own air sparging system.

9.3.1.1 Design Bases

The design objective of the compressed air systems is to ensure the availability of air (of suitable quality and pressure) for power plant operation. To achieve this objective, the compressed air systems are designed in accordance with the following specifications:

A. Design temperature of 105°F,

B. Design operating pressure of 110 psig, and

C. Design capacity of 500 ft^3/min per system.

9.3.1.2 Instrument Air System

9.3.1.2.1 System Description

The purpose of the instrument air system is to supply clean, dry, compressed air for air-operated control devices and instruments.

All major instrument air system components except those associated with the 3C compressor train are located at elevation 517'-6" in the turbine building. The 3C compressor train is located on the Unit 3 538'-0" elevation. Unit 2 has two compressor trains, 2A and 2B; Unit 3 has three, 3A, 3B, and 3C. Each train consists of a compressor, an aftercooler, air receiver tanks, dryers, prefilters, afterfilters and the necessary control and support equipment (see Drawings M-37, Sheets 7 and 9 and M-367, Sheets 1 and 4).

The instrument air system supplies air to:

A. Turbine building loads,

B. Reactor building loads,

C. Radwaste building loads,

D. Crib house loads, and

E. Off-gas filter building loads.

The 2A and 3A compressors are single-stage reciprocating air compressors powered by 60-hp electric motors. Each compressor is rated for 200 ft^3/min at 125-psig discharge pressure.

The 2B, 3B and 3C instrument air compressors are two-stage, water cooled, 100 Hp electric motor driven, rotary screw compressors, which deliver oil-free, pulsation-free air. Each compressor is rated at 460 CFM at 100 psig discharge pressure. These compressors will operate on the compressor's pressure switch to load and unload. The compressors have no interlock with the Unit 2(3) instrument air main receiver pressure switch.

Cooling for all compressors is provided by the turbine building closed cooling water (TBCCW) system.

The instrument air supply system is operable at all times during plant operations. With the compressor in NORMAL mode and set to RUN, the following sequence occurs:

A. The instrument air compressor starts and runs unloaded (magnetic unloader deenergized);

B. If after a predetermined time the main receiver pressure is less than a predetermined setpoint, the magnetic unloader energizes and loads the compressor;

C. The instrument air compressor runs loaded until the proper main receiver pressure is established. At that time the magnetic unloader deenergizes and the compressor unloads; and

9.3.1.2.3 Testing and Inspection Requirements

A periodic survey is performed to test the service-air-to-instrument-air backup valve.

Periodic air quality monitoring is performed to ensure that high-quality instrument air is supplied to the plant.

9.3.1.3 Service Air System

9.3.1.3.1 System Description

The purpose of the service air system is to:

A. Provide air to certain process equipment and breathing air manifolds;

B. Provide air for mixing and agitating functions at reduced pressure;

C. Provide an emergency backup supply of air to the plant instrument air system; and

D. Provide pneumatic pressure to control the operation of the service air compressors.

E. Provide operating air to Unit 1 air systems when the Unit 1 service air compressor is not operating.

The major service air system components are located at elevation 517'-6" in the turbine building. Units 2 and 3 each have one compressor train. Each train consists of a compressor, an aftercooler, a moisture separator, an air receiver tank, and necessary control and support equipment (see Figure 9.3-5).

The service air system supplies air to:

A. Turbine building loads,

B. Reactor building loads,

C. Radwaste building loads,

D. Crib house loads, and

E. Off-gas filter building loads.

F. Unit 1 air systems when the Unit 1 service air compressor is not operating.

The Unit 2 service air compressor is an oil-free, rotary screw, water cooled, two stage compressor powered by a 125 H.P. electric motor. The Unit 2 service air compressor is rated for 574 ft^3/min at 110 psig. Cooling is provided by the TBCCW system. An intercooler, after cooler, moisture separator and drain traps are contained within the compressor compartment.

Service air receivers are used as buffers between compressor discharge and the rest of the system. In this configuration, they dampen pressure pulses from the compressor and provide a smooth flow of air to the system. They also provide storage capacity to accommodate intervals when demand exceeds capacity of the compressor.

All relief valves in this system are set at 125 psig.

A pressure regulating valve supplies air to Unit 1 air systems when Unit 1 service air compressor is not operating.

The service air system also has a carbon monoxide monitor to protect workers using the breathing air feature of the system.

9.3.1.3.2 Testing and Inspection Requirements

A periodic survey is performed to test the service-air-to-instrument-air backup valve.

A periodic survey is performed to test the service-air to Unit 1 pressure regulating valve closing pressure.

9.3.1.4 Pump-Back System

The pump-back system maintains a 1-psi drywell-to-torus differential pressure in order to decrease the amount of hydro-shocking of the torus support structure during drywell pressurization.

The pump-back system includes two 100% capacity compressors and a receiver tank. The suction for the system is from the torus, via the nitrogen supply line. The discharge is to the drywell. All controls are in the control room.

The pump-back system is cross-connected with the drywell pneumatic supply system and supplies drywell gas (typically nitrogen) to the associated instruments and actuators. The reverse is not true; that is, the drywell pneumatic supply system cannot be used as a backup to the pump-back system.

9.3.1.5 Drywell Pneumatic Supply System

The drywell pneumatic supply system has a function similar to the instrument air system, but it supplies drywell gas (instead of air) to control devices and instruments in the drywell.

Suction to the drywell pneumatic supply system is from the drywell rather than from outside air, thereby reducing the need for venting the drywell due to continuous bleeding of air from pneumatic components (air which would otherwise lead to an increase in drywell pressure and excessive oxygen concentration in the inerted atmosphere). The drywell pneumatic compressors have been permanently removed from service. The crosstie to the pump back system supplies the pressurized drywell gas to this system. The nitrogen purge system can also supply the drywell pneumatic components.

level signal and the second pump starts on a sump high-high level signal. A high-high sump level alarm is provided in the main control room. Both pumps trip on sump low level. Run time indication is provided in the radwaste control room.

The Unit 2 and Unit 3 turbine building equipment drain sumps have a 2 inch normal pipe size transfer line which permits their contents to be pumped into the adjacent floor drain sump pit.

9.3.3.6 Turbine Building Floor Drains and Sumps

Each unit has one floor drain sump with two pumps located in the condensate pump pit. Sump pumps are started automatically by a mechanical alternator level switch. One pump starts on a high sump level signal and the second pump starts on a high-high sump level signal. A high-high sump level alarm is provided in the main control room. Both pumps trip on sump low level. Run time indication is provided in the radwaste control room.

9.3.3.7 Radwaste Floor Drains and Sumps

Two sumps, each with one pump, are located in the radwaste basement near the west wall. Each pump is started automatically by a level float switch on a high sump level signal and trips on a low sump level signal. Run time indication is provided in the radwaste control room. A high sump level alarm is also provided in the radwaste control room.

9.3.3.8 High-Pressure Coolant Injection Room Floor Drains and Sumps

Each unit has one sump and sump pump located in their respective high-pressure coolant injection (HPCI) rooms. Each sump pump is started automatically by a float switch on a high-level signal and the pump trips on a low-level signal. Flow is directed to the reactor building floor drain sump. A high sump level alarm is also provided in the main control room.

9.3.4 Chemical and Volume Control System

This section is not applicable to Dresden Station.

shutdown from full power to a subcritical condition, with a reactor core boron concentration of 600 ppm.

The quantity of liquid control is determined by the negative reactivity required to render and maintain the reactor subcritical with the control rods withdrawn to their full power position. Allowance for nonuniform mixing of the liquid poison injected into the reactor coolant has been provided.

The design of the SBLC system assumes certain conditions as the bases. It is assumed that the reactor is operating at maximum power, 2527 MWt, at xenon equilibrium with the control rods in a normal operation pattern. Further, it is assumed that the operator is unable to insert control rods either by scram or by the normal mode of insertion. The SBLC design results in a core boron concentration which produces k_{eff} of 0.97 in the cold, xenon-free core with the control rods in the configuration defined above. This assures existence of a shutdown margin of 3% Δk which is adequate to account for uncertainties and off-standard initial conditions.

Control rod drive malfunctions sufficiently severe to prevent insertion of a single rod are highly unlikely, and the coincidental occurrence of such malfunctions in all fully or partially withdrawn drives is more unlikely. Therefore, the assumption that no control rods can be inserted is extremely conservative, as is the design shutdown margin imposed, 3% Δk. In view of this inherent conservatism, an additional assumption of peak xenon conditions is not warranted.

The maximum licensed reactor power for the units is 2527 MWt. Raising power to the average power range monitor (APRM) rod block line at 100% flow would be in violation of the operating license; therefore, operation at the rod block line would not occur. The present analysis is valid whether or not the local peak power approaches rod block monitor (RBM) limits. Only large changes in total initial power would materially affect the boron concentration determinations.

The basis assumed for the reactor water level is the normal operating level. This water level is assumed because there is no loss of feedwater or vessel level control during insertion of the liquid control solution.

The system design provides for an additional margin of 25% boron to compensate for possible losses and imperfect mixing of the chemical solution in the reactor water. This results in an average concentration of 750 ppm of boron in the reactor core.

An additional operational criterion imposed by 10 CFR 50.62 (Reference 9.3.6.7) requires the system to deliver 86 gal/min of 13% (minimum) sodium pentaborate solution or equivalent. To satisfy this requirement, an additional performance objective is to provide a system flowrate (using both pumps) of 80 gal/min of 14% sodium pentaborate solution, which is equivalent to 86 gal/min of 13% solution.

In order to meet the shutdown requirements, a gross volume of 3391 gallons of 14% sodium pentaborate solution at a temperature of 110°F is required. This volume includes an additional volume of solution contained below the pump suction that is not available for injection. Other equivalent combinations of increased concentration and reduced volume have been evaluated for temperature and net positive suction head requirements. See Table 9.3-3.

9.3.5.2 System Description

The equipment for the SBLC system is located in the reactor building and consists of an unpressurized tank for low-temperature sodium pentaborate solution storage; a storage tank heater; two positive displacement pumps; two explosion-actuated shear plug valves; the poison sparger ring; and the necessary piping, including pump suction piping heat tracing, valves, and instrumentation. This system does not require external cooling or power for such cooling. A diagram of the standby liquid control system is shown on Drawing M-33. Table 9.3-3 summarizes the principal design parameters.

The SBLC tank is equipped with a top cover, vent, and drain. Redundant SBLC system pump suction lines are arranged and constructed to minimize entry of particulate material which might settle on the tank bottom. Heaters are provided to heat the water during initial mixing and to maintain temperature as required during normal operation. The tank has a total gross volume of 5393 gallons from the bottom of the tank to the overflow piping. The neutron absorber solution used is a 14% percent solution, with a saturation temperature of 62°F. As required by Technical Specifications, the solution temperature is maintained at least 20 degrees F above this saturation temperature as added margin against boron precipitation. The solution storage tank is heated by an immersion heater and the pump suction piping is heat traced. The ambient temperature of the solution is maintained below 110°F to ensure adequate NPSH. Temperature and liquid level alarms for the system are annunciated in the control room.

The sodium pentaborate solution is delivered to the reactor by either one or both of two 40-50 gal/min, 1500-psi, positive displacement stainless steel pumps. The pumps and piping are protected from overpressure by two relief valves set at approximately 1500 psig which discharge back to the SBLC tank.

The explosion-actuated valves are double squib-actuated shear plug valves. A low-electrical monitoring system gives visible (pilot light) indication of circuit continuity through both firing squibs in each valve.

The two explosion-actuated injection valves provide high assurance of opening when needed and ensure that boron does not leak into the reactor even when the pumps are being tested. Each explosion-actuated valve is closed by a plug in the inlet chamber. The plug is circumscribed with a deep groove so the end is readily sheared off by the valve plunger, opening the inlet hole through the plug. The sheared end is pushed out of the way by the plunger; it is shaped so it does not block the ports after release. The shearing plunger is actuated by an explosive charge, with dual ignition primers, inserted in the side chamber of the valve.

The operator operates a five position key switch if it is determined that neutron absorber solution should be injected into the reactor. A turn from neutral to the first position (single pump position) in either direction starts one pump and opens one of the two parallel valves. Turning the switch to the second position on either side of neutral (two pump position) starts both pumps and opens both valves for use in terminating an anticipated transient without scram (ATWS) event. (See Sections 7.8 and 15.8 for additional description of ATWS.) Use of the key switch minimizes the probability of an accidental injection of the neutron absorber solution.

A red light beside the keylock switch illuminates when liquid is flowing through an orifice flow switch downstream of the explosion-actuated valves. Cross-piping and check valves assure a flow path through either pump and either explosion-actuated valve. Either pump will start even though its local switch at the pump is in the "stop" position.

A test tank and demineralized water supply are an integral part of the system to facilitate system testing and flushing. All tanks and piping in the system are designed in accordance with ASME codes.

9.3.5.3 Safety Evaluation

The reactivity requirements for the SBLC system are sufficient to shut down the reactor from full power in the absence of any control rod motion. The resulting reactivity in the shutdown condition is k_{eff} less than or equal to 0.97 (equivalent to the 3% Δk subcritical specified in Technical Specifications). The shutdown requirement can be achieved with 600 ppm boron in the moderator. A margin of 25 % additional boron (150 ppm) is added to compensate for possible imperfect mixing of the chemical solution in the water (resulting in 750 ppm boron in the moderator). For the controlling case, with normal moderator level in the reactor vessel, 3391 gallons of a 14.0 weight% sodium pentaborate solution, or equivalent, is required.

Using the single pump injection rate, the SBLC system is capable of reducing power at a rate of 1% per minute; thus the time required to reach the zero power or hot shutdown condition from full rated power is 80 to 100 minutes. The maximum xenon decay and burnup causes a reactivity change equivalent to a power increase of only 0.5% per minute. Therefore, the rate of boron addition causes a steady, constant rate power decrease, even if actuated during the maximum xenon decay and burnup removal transient.

The rate of power change with time is expected to be constant until the power is too low to produce boiling in the core. When the reactor becomes subcritical, the injection rate is sufficient to maintain the reactor subcritical indefinitely.

Stability considerations impose an upper limit on the rate of solution injection. Power oscillations, resulting from boron concentration oscillations, would be possible if the time for solution injection were equivalent to the recirculation loop transit time. Because the loop transit time is on the order 10 to 15 seconds, injection of sufficient solution to reduce power to zero over an interval of 100 minutes is slow enough to assure that the poison concentration in the core does not oscillate but increases monotonically.

In the event that the SBLC system interlock fails to isolate the reactor water cleanup system, the cleanup system would start to remove the boron from the core. This removal rate would be extremely small because of the flow path of the boron; the boron is inserted into the bottom of the vessel, moves up through the core, then to the outside of the core shroud. If the recirculation pumps are still in operation, one-third of the flow outside the core shroud is taken out through the recirculation loop; the remaining two-thirds are inserted back into the bottom of the vessel. Of the one-third taken out through the recirculation loop, only 2% is diverted to the cleanup system. Therefore, of the amount of boron which gets outside the core shroud, only about 0.7% is removed by the cleanup system.

A failure of the reactor water cleanup system to isolate would be observed in the control room and remote manual isolation of the cleanup system would be completed. Conservative SBLC system design assumes failure of the operator to isolate the cleanup system. This type of failure could result in a cleanup system

Should the SBLC system ever be used to shut down the reactor, the sodium pentaborate would be removed from the primary system by flushing for gross dilution and by operation of the reactor water cleanup system for final polishing.

Boron concentration of the solution is periodically determined by chemical analysis.

A quarterly inservice test (IST) is conducted to verify the operational readiness of the SBLC pumps. It also verifies operability of the SBLC pump discharge check valves.

Quarterly testing is performed on the SBLC pumps to identify any potential operational degradation. Acceptance criteria for this testing is based on a one-time dual / single pump test correlating dual pump flows to a minimum required single pump flow and associated concentrations. The system Design Basis Document describes this in detail.

9.3.5.5 Instrumentation Requirements

The SBLC system consists of boron injection pumps, explosion-actuated injection valves, and related piping and instrumentation. The instrumentation and controls for the SBLC system are designed to:

A. Actuate the injection pumps,

B. Open the boron injection line into the vessel,

C. Maintain the boron solution above its saturation temperature,

D. Function so that the system is testable during operation,

E. Provide indication to the operator of system operation and operations status, and

F. Isolate reactor water cleanup system.

The SBLC system is actuated by a five-position keylock switch on the control room console. This assures that switching from the "off" position is a deliberate act. Switching to either side starts that injection pump, opens the corresponding explosion-actuated valve, and closes the reactor cleanup system isolation valves to prevent boron dilution. Switching to the far right and left positions on either side of the switch starts both pumps and opens both valves, as well as isolating the reactor cleanup system.

Automatically controlled heaters are provided in the SBLC tank to maintain adequate margin above the boron solution saturation temperature during initial mixing and during normal plant operation.

The SBLC system functional control logic is shown on Figure 9.3-9.

Indicators are provided in the control room to verify the operability of the system and to verify operation if the system should ever be used.

Each explosion-actuated injection valve's ignition circuit continuity is monitored by a trickle current, and an alarm occurs in the control room if either circuit opens. Indicator lights show which primer circuit opened. A green light at the local start switch in the plant indicates that power is available to the pump motor contactor. A red light indicates the contactor is closed (pump running). When an SBLC pump is started, a red light in the control room will indicate the pump motor contactor is energized. There is a red light for each pump. Also in the control room, a red light will energize indicating flow through the pipes. A level switch is provided in the SBLC tank which actuates an alarm in the control room on high or low liquid level. Also, a temperature sensor in the SBLC tank actuates an alarm in the control room on high or low liquid temperature. A pressure indicator downstream from the check valves from each pump indicates the pump pressure during testing or actual system operation.

9.3.6 References

1. M12-2(3)-84-119 and Onsite Reviews Nos. 86-26 and 87-24.

2. Letter to L. O. DelGeorge (CECo) from J. D. Neighbors (NRC), July 22, 1982, "Post Accident Sampling System NUREG-0737, II.B.3 Evaluation Criteria Guidelines"; Regulatory Guide 1.97, Revision 2, "Instrumentation for Light-Water-Cooled Nuclear Power Plants to Assess Plant and Environs Conditions During and Following an Accident," U.S. Nuclear Regulatory Commission (NRC), Office of Standards Development, December 1980.

3. "Instrumentation for Light-Water-Cooled Nuclear Power Plants to Assess Plant and Environs Conditions During and Following an Accident," Regulatory Guide 1.97, Revision 2, U. S. Nuclear Regulatory Commission (NRC), Office of Standards Development, December 1980.

4. "Design Specification for High Radiation Liquid and Gas Sampling System for Normal and Post-Accident Operations - Model A," June 1981, Sentry Equipment Corp. (SEC); "System Design Descriptions for Commonwealth Edison Company Dresden Nuclear Station Units 2 and 3," NUS Corp., March 10, 1981, Rev. 0, Document No. 5308-SDD.

5. 10CFR Part 50, "Domestic Licensing of Production and Utilization Facilities," Appendix A, "General Design Criteria 19 for Nuclear Power Plants," USNRC, May, 1977, Wash. D.C.

6. NUREG-1228, "Source Term Estimation During Incident Response to Severe Nuclear Power Plant Accidents," United States Nuclear Regulatory Commission, October, 1988.

7. M12-2(3)-84-119 and Onsite Reviews Nos. 86-26 and 87-24.

8. NED-M-MSD-2, "Revised Sodium Pentaborate Requirements for the SLCS, Dresden 2 & 3, Quad Cities 1 & 2."

Table 9.3-3

STANDBY LIQUID CONTROL SYSTEM PRINCIPAL DESIGN PARAMETERS

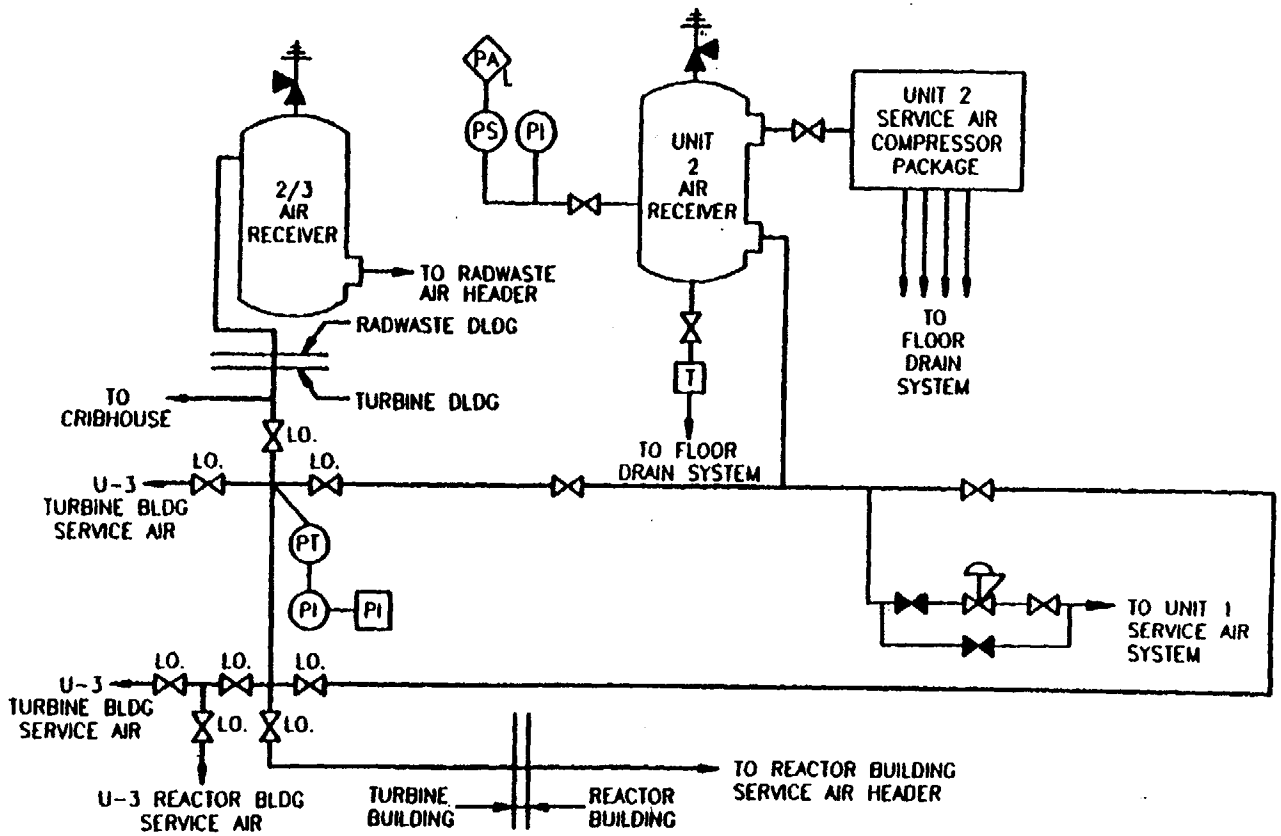
System	
Design negative reactivity (% Δk/k)	3.0
Required reactor boron concentration	750 ppm
Poison injection rate per pump	40 gal/min
Poison compound	$Na_2B_{10}O_{16} \bullet 10H_2O$
Standby liquid control tank capacity	5393 gal
Pumps	
Type of pump (postitive displacemnt)	Triplex plunger
Number	2 (two required)
Normal Operating Conditions (each pump)	
Capacity	40 gal/min
Total developed head	1500 psi
Suction pressure	Atmospheric
Pumping temperature	70°F
Available net positive suction head	25 feet
Type of drive	Electric motor
Rating	50 hp
Power Sources	
Pumping and control	Unit Auxiliary Transformer 21 (31), Reserve Auxiliary Transformer 22 (32) or diesel-generator [MCC 28-1(38-1) for 2A(3A) standby liquid control pump; MCC 29-1(39-1) for 2B(3B) standby liquid control pump]

Table 9.3-3 (continued)

STANDBY LIQUID CONTROL SYSTEM PRINCIPAL DESIGN PARAMETERS

Standby Liquid Control Tank Volume Requirements (gallons):

Temperature	14.0% Solution	15.4% Solution	16.5% Solution
110	3391	3097	2901
120	3830	3532	3333
130	4388	4086	3883



UFSAR REVISION 4, JUNE 2001

DRESDEN STATION
UNITS 2& 3

SERVICE AIR SYSTEM
(TYPICAL OF UNIT 3)

FIGURE 9.3-5

Drawings M-273, Sheets 1 and 2, and M-3121.

9.4.1.1 Design Bases

The control room ventilation system is designed to:

A. Maintain the control room between 70°F and 80°F with outside temperatures varying between -6°F and +93°F;

B. Provide adequate radiation protection to permit access and occupancy of the control room under accident conditions without personnel receiving radiation exposures in excess of the General Design Criteria (GDC) 19 or Standard Review Plan (SRP) 6.4 limits;

C. Provide protection from toxic gas release;

D. Provide protection from fire and smoke; and

E. Provide HVAC to the control room emergency zone as described in Section 6.4.2.1.

9.4.1.2 System Description

The control room HVAC system consists of two independent HVAC subsystems sharing some common ductwork: one multizone subsystem (Train A) and one single zone subsystem (Train B). Train A is the primary temperature control and air distribution subsystem for the control room emergency zone. Train B is a backup system which serves the control room emergency zone when Train A is not available. Train B is described in Section 6.4.

The Train A HVAC system provides individual zone temperature control by blending air from the hot and cold decks of the air handling unit (AHU) to satisfy the individual room thermostats. During cooling operation, the air is cooled and dehumidified by means of a direct expansion coil within the AHU. During heating operation, air is passed over a hot water coil within the AHU. A steam humidifier is provided in the discharge duct to the control room and auxiliary computer room to maintain the rooms at a minimum of 40% relative humidity. The system supplies the air to three separate zones as follows:

A. Zone 1 - This zone was permanently isolated from the control room emergency zones,

B. Zone 2 - control room, and

C. Zone 3 - Train B HVAC equipment room.

The Train A air distribution system is divided into three separate ducting arrangements, each serving one of the areas indicated above. Zone 1 has been permanently isolated and does not serve any area. The system is sized to dissipate both the internal and external heat loads within each space, and the design of 75°F is based on maintaining personnel comfort. Return air from each zone is collected and routed back through a common duct system via a vane-axial return air fan. The Train A unit can be operated in the event of a loss of offsite power (LOOP) if the 4-kV nonessential switchgear is backfed.

During normal operation of the Train A HVAC system, the control room emergency zone is maintained at a positive pressure by a maximum inlet flow of 2000 ft^3/min through the inlet damper. The exhaust damper remains closed during normal operation.

During normal operation of the Train B HVAC system, the control room emergency zone is maintained at a positive pressure. Outdoor air is introduced at the rate of 2000 ft^3/min into the control room emergency zone to maintain the positive pressure. Emergency operation of Train B requires operator action as described in Section 6.4.4.1.

9.4.1.3 Safety Evaluation

Section 6.4 contains an evaluation of the control room HVAC system.

9.4.1.4 Inspection and Testing Requirements

Section 6.4 describes inspection and testing of the control room HVAC system.

9.4.2 Spent Fuel Pool Area Ventilation System

The spent fuel pool area ventilation system is an integral part of the reactor building ventilation system described in Section 9.4.5. Filtered, tempered air is supplied to the refueling floor, which includes the spent fuel storage pool and the dryer and separator storage pool areas. Exhaust air flow from the operating floor is regulated by a series of manually operated dampers. The exhaust ducts carry the effluent directly to the reactor building vent stack or, if secondary containment is isolated, to the standby gas treatment system (SBGTS).

9.4.3 Radwaste Facility Ventilation System

The radwaste area ventilation system is comprised of subsystems which service the following areas:

A. Radwaste building;

B. Radwaste control room;

C. Radwaste solidification building; and

D. Maximum recycle radwaste building.

These are described in the following subsections.

9.4.3.1 Radwaste Building Ventilation

The radwaste building ventilation system has been designed to maintain the following conditions with outside temperatures varying between -6°F and +93°F:

{PRIVATE }A. Occupied areas	Minimum 50°F Maximum 103°F
B. Cells and collector tank room	Minimum 50°F Maximum 120°F
C. Concentrator and concentrator waste tank cells	Minimum 50°F Maximum 150°F

The radwaste building HVAC system is shown in Drawing M-272.

The outside air for the radwaste building system is drawn into the building through stationary louvers, filtered, heated as necessary, and distributed by supply air ducts and registers throughout the building. Normally the airflow sequence starts from the clean areas and moves progressively to the areas of greater potential contamination. The system includes three 50% capacity supply fans and three 50% capacity exhaust fans. Normally, the system operates on one supply fan and two exhaust fans. The other fans are on standby. The standby supply and exhaust fans will start automatically on low airflow or auto trip of a running fan. The system is balanced to maintain a slight negative pressure in the general areas of the building, with certain areas of highest contamination potential maintained at ¼-in.H_2O negative pressure. All supply fans trip on building overpressure, and all exhaust fans trip on excessive building vacuum.

The system exhausts air out of the building to the 310-foot chimney. The exhaust fans draw building air into the exhaust vents located throughout the building and through two parallel filter trains, each composed of a prefilter followed by a high efficiency particulate air (HEPA) filter before discharging the air to the 310-foot chimney. Each supply and discharge fan is equipped with backdraft dampers that open when the fan is in operation.

9.4.3.2 Radwaste Control Room HVAC

The radwaste control room is cooled by a dedicated refrigeration unit which rejects heat to the outside atmosphere. The unit is equipped with an electric heater coil for use in cold weather. Control room air is recirculated through a filter and supply fan, and air lost by exfiltration is made up by outside air. The radwaste control room HVAC system is shown in Drawing M-760.

9.4.3.3 Radwaste Solidification Building HVAC

A fan in each of the two trains of the radwaste solidification building ventilation system draws outside air into the building through a rough prefilter, a heat recovery heat exchanger, two trains of supply filters and electric heaters, and discharges to the truck bay, and the high and low level drum storage areas. Air infiltration to the truck bay is expected. The ventilation system circulates the air through the drum storage and processing areas of the building, and discharges the exhaust air through two trains of exhaust fans, prefilters, and HEPA filters before being directed to the heat recovery heat exchanger and the 310-foot chimney. A slight negative pressure is maintained in the solidification building by modulating the exhaust fan dampers.

A separate air handling unit in the solidification building control room recirculates air through a filter, twin cooling coils, and an electric heating coil. Air lost by exfiltration is made up by outside air. The HVAC condensing unit is located on the roof of the control room.

In addition, the HVAC equipment room has its own dedicated air conditioning unit.

Electric power is supplied by nonessential motor control centers. Each flow path of the air supply and exhaust systems is equipped with two fail-closed dampers, one on each end of each flow path. In addition, isolation dampers on the inlet and discharge of each flow path are employed to isolate the supply and exhaust systems when not in operation.

The radwaste solidification building ventilation system is shown in Drawings M-850, M-851, and M-852.

9.4.3.4 Radwaste Maximum Recycle Building Ventilation

The maximum recycle building ventilation system draws outside air by a single supply fan through a filter, heat recovery heat exchanger, and heating and cooling coils. The air is ducted through the building from area to area in the direction of increasing radioactivity potential. Air is discharged from the building through two redundant flow paths, each including a flow damper, prefilter, HEPA filter, exhaust fan, and butterfly isolation damper. This exhaust fan system discharges the air to the 310-foot chimney through the heat recovery heat exchanger. A slight negative pressure is maintained in the building.

Isolation in this system is primarily isolation of the ventilation from the 310-foot chimney by dampers on each of the redundant exhaust fan outlets.

The maximum recycle building ventilation system is shown in Drawing M-760.

9.4.4 Turbine Building Area Ventilation System

The turbine building ventilation system has been designed to maintain area temperature between 65°F and 120°F with outside temperatures varying between -6°F and +93°F.

The turbine building ventilation systems are made up of the main turbine room ventilation system, the reactor feedwater pump ventilation system, the recirculation pump motor-generator (M-G) room ventilation system, the east turbine room ventilation system, the off-gas recombiner room ventilation system, the auxiliary electrical equipment room/auxiliary computer room cooling system, and the battery room ventilation system. These are separate systems with separate intake and exhaust points. Only the main turbine room system is exhausted to the 310-foot chimney.

9.4.4.1 Main Turbine Room Ventilation System

The supply air to the main turbine room in each unit is provided by the south turbine room system and the north turbine room system. The two 100%-capacity south turbine room supply fans and three 50%-capacity north turbine room supply fans draw outside air through separate filters, steam heating coils, and evaporative air wash units. This air is then ducted throughout the main turbine area, including the operating floor, the ground floor, and mezzanine areas. The Unit 3 south turbine room system also provides ventilation to the Unit 3 battery charger room. Pneumatically operated backdraft dampers isolate fans not in use. Control systems, using pitot tubes and differential pressure sensors, operate pneumatically actuated flow control dampers on each of the two air supply systems and the exhaust system to maintain the turbine operating floor at a slight negative pressure relative to the atmosphere. Additional fans and dampers in the return air ducts maintain the steam jet air ejector rooms, moisture separator areas, and feedwater heater areas at a negative pressure of ¼-in.H_2O relative to the turbine operating floor. This ensures airflow from cleaner to potentially more contaminated areas.

In the exhaust system, there are three 50% capacity fans, two operating and one on standby, which draw air from the feedwater heater, moisture separator, and steam jet air ejector areas, and discharge to the 310-foot chimney.

Exhaust air from the clean and dirty oil storage tank room and the toilet are discharged to the atmosphere.

The main turbine room ventilation systems are shown in Drawings M-270 and M-530, Sheets 1 and 2.

9.4.4.2 Reactor Feedwater Pump Ventilation System

The reactor feedwater pump ventilation system removes heat generated by the reactor feedwater pump motors. This is a separate ventilation system housed in the turbine building. Two 100% capacity ventilation fans draw outside air through an air filter and duct it to the three reactor feedwater pump motors. A recirculation air duct is provided. Temperature-controlled dampers are provided to allow the air to be recirculated back to the inlet of the supply fans or replaced with up to 100% outside air. One of the ventilation fans must be operating before a reactor feedwater pump motor can be started. Exhaust air is discharged directly to the atmosphere separately from the main turbine room system.
This system is not essential for safe shutdown, and upon loss of offsite power, the ventilation system will shut down. However, should it be necessary, the system can be connected to the emergency diesel generator power by operator action.

The reactor feedwater pump room ventilation system is shown in Drawings M-270 and M-530, Sheets 1 and 2.

9.4.4.3 Motor-Generator Room Ventilation System

The recirculation pump M-G room ventilation system removes heat generated by the M-G sets and control cabinets. This is a separate ventilation system within the turbine building. Two full capacity supply fans draw outside air through parallel air filters and duct it to the M-G set equipment. Temperature-controlled dampers are provided to allow the air to be recirculated back to the inlet of the supply fans or replaced with up to 100% outside air. Air that is not recirculated is discharged directly to the atmosphere separately from the main turbine room exhaust system. This system is not essential for safe shutdown.

The M-G room ventilation system is shown in Drawings M-270 and M-530, Sheets 1 and 2.

9.4.4.4 East Turbine Room Ventilation System

The east turbine room ventilation system draws outside air into the building through fixed louvers. This air is filtered, heated as necessary, and distributed through plenums and ducts by three 50% capacity supply and exhaust fans. Two fans are normally in operation and one on standby. Air is directed to the north and south HVAC equipment rooms, the switchgear room, the Unit 2 battery room, the auxiliary electrical equipment room, the aux computer room, the demineralizer room, and other areas in this part of the turbine building. The supply and exhaust systems are balanced to provide a slight positive differential pressure relative to the atmosphere. Depending on the temperature of the return air, it is either recirculated or fully exhausted to the atmosphere. The demineralizer area discharges to the atmosphere through a separate fan.

The east turbine room ventilation system is shown in Drawing M-936.

9.4.4.5 Battery Room Ventilation System

The Unit 2 battery room, located above the main control room, is served by the east turbine room ventilation system. Air is ducted into the battery room and exhausted to the north HVAC equipment room through an opening in the wall.

The Unit 3 battery and battery charger rooms are located in the southwest corner at the mezzanine level. Air is ducted into the charger room by the south turbine building ventilation system and discharged into the turbine room by an exhaust fan. The battery room has its own dedicated air conditioning system to maintain the room temperature between 70°F and 85°F for reliable battery operation. Air is discharged into the turbine room by a fan installed in an opening in the wall.

Following a loss of offsite power, ventilation to the battery rooms will be lost. Hydrogen gas emitted from the batteries as they are recharged by the diesel generators will accumulate in the rooms, but the hydrogen concentration will not reach the lower flammability limit.

The battery room ventilation systems for both units are shown in Drawing M-973.

9.4.4.6 Off-Gas Recombiner Rooms

The off-gas recombiner area ventilation system for each unit draws outside air into the system through stationary louvers. This air is filtered, heated as necessary, and discharged to the upper level operating aisle ("penthouse"). The system consists of two parallel supply and exhaust trains, one supply and exhaust train in operation and one in standby. The parallel exhaust fans draw from the recombiner rooms, condenser rooms, and the off-gas instrument and control panel. This air is discharged without further filtering to the 310-foot chimney. The system is isolated by dampers in each parallel inlet and exhaust duct, with one set of exhaust dampers normally closed. The off-gas instrument and control panel is ventilated with a separate exhaust blower. Additional heating is supplied by steam area heaters.

The off-gas recombiner room ventilation system is shown in Drawings M-625 and M-633.

9.4.4.7 Auxiliary Electrical Equipment Room and Auxiliary Computer Room Cooling Systems

The AEER and computer room are cooled by the AEER A/C Unit which is a package water cooled unit located at elevation 549'0" and/or the AEER/ACR HVAC. The AAER/ACR HVAC consists of an air handling unit located in the mask area of the turbine building and an air cooled condensing unit located outside. In addition to this cooling system, backup ventilation to the AEER is provided by the east turbine building ventilation (See Section 9.4.4.4).

9.4.5 Reactor Building Ventilation System

The reactor building ventilation system is designed to maintain the reactor building area temperatures between 65 °F and 103 °F based on outside temperatures varying between -6 °F and +93 °F.

The reactor building is also divided into distinct zones based on environmental conditions. Refer to Table 3.11-1, Environmental Zone Parameters for Normal Service Conditions.

Special ventilating and ducting systems are used on the refueling floor to continually exhaust air from the spent fuel storage pool area, dryer/separator storage pit, and drywell head cavity. See Section 9.4.2.

The normal ventilation system provides at least one free-volume change of air per hour in the reactor building. Normally the air flows from the filtered supply through ducts to the uncontaminated areas, through potentially contaminated areas, and then is returned and exhausted through the exhaust fans to the reactor building ventilation stack. Cooling and heating units in various rooms of the reactor building provide for personnel comfort and equipment protection.

The Unit 2 and 3 air supply systems tempers the filtered outside air by means of a non-freezing type steam heating coil or by chilled water cooling coils. Cooling water for the chilled water coils is provided by a piping system from air-cooled chiller units located outside the reactor building (M-269, Sheet 3 and M-529, Sheet. 3). Tempered air is directed by three 50% capacity fans through a redundant pair of pneumatically operated isolation butterfly valves to the building's duct system. Each of these three 50% capacity supply fans is equipped with a pneumatically actuated backdraft damper to isolate each fan when the fan is not in operation. Power to the fans is supplied by electrical buses which may be connected to the emergency diesel power in the event of an offsite power failure.

The conditioned supply air is then directed to all working areas and equipment rooms of the reactor building as shown in Drawings M-269, Sheet 2 and M-529, Sheet 2. Flow to and within these areas is indicated and controlled by means of differential pressure indicators and pneumatically operated dampers.

Exhaust air is collected by a network of ducts throughout the reactor building and is returned to the exhaust fan plenum through a pair of pneumatically operated isolation dampers. The air exhaust system consists of a set of three 50% capacity fans which exhaust to the reactor building vent stack. The drywell purge system is also ducted to these exhaust fans so that drywell effluent is exhausted by this system when the drywell is inerted, purged, or opened for access. The three exhaust fans are powered by emergency diesel-powered electric buses. Reactor building infiltration is discussed in Section 6.2.3.

9.4.6 Emergency Core Cooling System Ventilation System

The emergency core cooling system (ECCS) rooms consist of two low pressure coolant injection (LPCI)/core spray pump rooms and one high pressure coolant injection (HPCI) pump room per unit, all of which are served by the reactor building ventilation system. Each of the rooms has a water-cooled heat exchanger/fan unit which functions as a room cooler. The fans for these units are powered by the emergency bus and are capable of operating following a LOOP. The LPCI/core spray rooms are normally maintained at less than 104°F. The HPCI rooms are normally maintained less than 140°F. These temperatures are below the qualification temperatures of the mechanical and electrical components in the rooms that are required for safe shutdown of the plant. Section 3.11 contains a further discussion of equipment qualification.

The LPCI/core spray pump room cooler fan motors are supported from rod hangers in a seismically qualified pendulum fashion from the room ceiling.[1]

During normal plant operating conditions, the cooling water for the ECCS room coolers is provided by the service water system. The service water system is discussed in Section 9.2.1. The containment cooling service water system provides backup cooling water to the ECCS room coolers. The CCSW system is described in section 9.2.1.

If the reactor building ventilation system is shut down due to secondary containment isolation or LOOP, the equipment in the ECCS rooms are cooled solely by the room coolers. Loss of the room coolers is discussed in Section 3.11.4.

9.4.7 Diesel Generator Ventilation System

Each diesel generator room (Unit 2, Unit 3, and the 2/3 diesels) has an independent ventilation system. These ventilation systems are shown in Drawings M-273, Sheet 1 and M-974.

The Unit 2 and Unit 3 diesel generator room ventilation systems each have a supply fan which draws in either outside air or turbine building air through temperature-controlled modulation dampers, isolation dampers, and fire dampers. The air returns to the turbine building through a pneumatically operated, normally open damper. These systems are powered by the emergency bus and are used only when a diesel generator is operating. During normal station operation, when the diesels are not operating, ventilation air is supplied by the turbine building ventilation system at a nominal 1000 ft^3/min through isolation and fire dampers.

The 2/3 diesel generator room ventilation system draws air from the outside atmosphere through an isolation damper and a supply fan. Air is discharged to the outside through another isolation damper.

9.4.8 Drywell Ventilation System

The drywell ventilation system has been designed to maintain the drywell at an average temperature of 135°F during normal operations and an average temperature of 105°F eight hours after shutdown, with outside temperatures varying from -6°F to +93°F.

The drywell ventilation system is shown in Drawing M-273, Sheet 3 and 4.

The drywell ventilation system contains seven air coolers (water-cooled heat exchanger/fan units) which cool the drywell atmosphere to approximately 135°F. The drywell atmosphere is circulated through the coolers and throughout the drywell by fans and ductwork. The reactor building closed cooling water (RBCCW) system provides a source of cooling water to remove heat from the coolers. By maintaining drywell ambient air temperature less than 150°F during normal plant operation, the insulation on motors, isolation valves, operators and sensors, instrument cable, electrical cable and sealants used at the penetrations will have a sustained life without premature degradation.

The seven drywell coolers are checked for leakage under normal cooling water pressure at each major outage. Operation of the fan is also observed at this time. During normal reactor operation, the temperature sensors in the drywell monitor the effectiveness of the coolers.

Provisions have been made to ensure that the drywell ventilation system remains operational in the event of a loss of station ac power. Drywell cooler fans are fed by the emergency power system and are therefore available following a loss of power. The fans will trip on a loss-of-coolant accident (LOCA). Spare cooling fan capability is provided with this system. Drywell temperature monitoring is described in Section 6.2.1.

The telephone system within the station is a private branch exchange (PBX) which is owned by IBT. The normal power feed for the system is from the security electrical bus. Phones are provided to the control room, all offices and routinely occupied areas, and central areas in the plant.

Dedicated communications systems at Dresden Station allow effective coordination of any emergency response. These systems include:

A. A nuclear accident reporting system (NARS) which links the control room; the technical support center (TSC); the bulk power operations office; the emergency operations facility (EOF); the Illinois Emergency Management Agency (in Springfield) (IEMA); the Illinois Department of Nuclear Safety (in Springfield) (IDNS); the Grundy County emergency operating center (EOC); the Grundy County Sheriff's Department; the Will County EOC; the Will County Sheriff's Office; the Kendall County EOC; and the Kendall County Sheriff's Office (green phone).

B. A microwave voice channel between the control room, the TSC, and the EOF (gray phone).

C. A telephone link that enables communication between the TSC and the EOF (yellow phone).

D. A telephone link that enables communication between the control room, the TSC, and the operational support center (OSC) (beige touchtone phones).

E. A radio voice channel between the control room, the TSC, the EOF, mobile vehicles, and portable, two-way radios in the field.

F. An emergency notification system (ENS) (red phone), and a health physics network (HPN) that allow communications between the station and the NRC. This system is owned by the NRC and is part of the Federal Telecommunications System (FTS).

Key personnel are provided with pagers and can receive messages via a transmitter accessed from the PBX system.

Located in the turbine building is a 250-W, 37.6-Mhz FM radio base station with a control station in the main control room. This radio permits direct contact with the system load dispatcher. Contact is also maintained with the alternate system load dispatcher.

Microwave and telephone communication equipment is provided to interface with the EOF. Signals from the computer systems (Process and Station Mini Computer) and designated phones located in the TSC and station are the sources of information. The interface between station equipment and microwave/land line equipment is through modems.

For emergency conditions the station has cellular telephones available for use by Operations and Emergency Response personnel as needed.

9.5.2.3 Performance Analysis

The evacuation and station fire annunciation system includes alarms located at strategic points throughout the plant to warn of a nuclear incident or other emergency conditions.

During normal operation and in particular during emergency conditions, communications offsite and onsite are of paramount importance. The communication systems for the Dresden Station are of such a diversity of design that the operating group is assured of maintaining voice contact both onsite and offsite. For a discussion of maintaining communications within the plant during a fire see, Section 7.6 of the Safe Shutdown Report (FPR Volume 2).

9.5.2.4 Testing and Inspection Requirements

The evacuation and station fire annunciation system is tested periodically.

9.5.3 Lighting Systems

9.5.3.1 Design Basis

The objective of the station lighting system is to provide adequate lighting for the operation and maintenance of equipment.

The Main Control Room lighting is designed to provide illumination levels sufficient for task performance, consistent with human factors guidelines found in the Human Factors Engineering Design Criteria and Standards Manual. See Section 7.5.4 for further discussion of the Detailed Control Room Design Review.

Fuel is transferred from the 15,000-gallon diesel fuel oil storage tank to the 750-gallon diesel oil day tank with the diesel oil transfer pump. Transfer is accomplished automatically by level switches on the day tank. Diagrams of the Unit 2, Unit 3, and the Unit 2/3 DG fuel oil storage and transfer system are shown on Drawing M-41, Sheet 2 and Figure 9.5-2.

Each day tank contains sufficient fuel to sustain emergency diesel generator operation for 1 hour of operation at rated load. The configuration of the system is such that the minimum normal operating level in the day tank is above the low level alarm setpoint. The low level alarm setpoint is maintained above the minimum required 1 hour fuel storage level. This ensures that the day tank provides a minimum 1 hour of fuel for operation of the diesel generator at 10% above rated load (205 gallons). The fuel oil transfer system, which is safety-related and seismically qualified, ensures the delivery of fuel for diesel generator operation beyond the 1-hour supply of the day tank. Each diesel fuel oil storage tank has a capacity adequate to sustain system operation pending normal commercial deliveries of fuel. The diesel generator uses a fuel which is readily available.

The Technical Specifications require a minimum of 10,000 gallons of diesel fuel to be kept on site for each DG. Figure 9.5-3 shows diesel fuel consumption versus load. At the 10% overload condition (2860 kW) each DG will consume 205 gallons of fuel per hour; at a rated load of 2600 kW, each DG will consume 192 gal/hr, and at 50% rated load, 105 gal/hr. An original FSAR analysis, using original diesel loads, postulated that two DGs are connected to the emergency buses in a unit which has experienced a design basis accident concurrent with a loss of offsite power and that a third DG is connected to the non-accident unit which is being shut down after having also experienced a loss of offsite power. This analysis conservatively estimated a total fuel consumption of 340 gallons for the first hour. After the first hour the reactor will probably have been sufficiently cooled such that some emergency core cooling system (ECCS) pumps can be shut off and the loads diminished on the diesels, resulting in a fuel consumption of about 250 gal/hr. The analysis estimated that the maximum onsite diesel fuel supply (47,250 gallons total) would last 7.9 days and that the minimum onsite diesel fuel supply, as required by Technical Specifications, would last 5.2 days.

To provide an adequate margin of safety beyond the anticipated 8-hour delivery time for fuel oil, the actual basis for the minimum onsite fuel supply specification is a two-day supply to each diesel with the diesel operating at a 10% overload condition. This basis resulted in the specified 10,000 gallon minimum supply for each diesel.

The diesel oil day tank level is sensed by a level switch, which initiates a signal to automatically start or stop the fuel oil transfer pump. The fuel oil transfer pump starts automatically when its respective day tank level drops below a predetermined level.

Upon initiation of a DG start signal, fuel from the fuel oil day tank is supplied through a strainer via an electrically-driven fuel oil priming pump and a duplex filter to the injectors. Any excess fuel is returned to the fuel oil day tank. At an engine speed of approximately 200 rpm, the priming pump deenergizes and the engine-driven fuel oil pump continues to supply fuel oil.

from the circulating pump is warmed to keep the oil system in standby readiness. A portion of closed loop cooling water is constantly routed through a temperature switch manifold; temperature switches on the manifold monitor cooling water temperature and transmit high temperature signals to a local alarm panel and the DG trip circuitry. Diagrams of the DGCW system are shown on Figure 9.5-5 and Drawing M-517, Sheets 1, 2, and 3.

The open loop portion of the DGCW system provides cooling water to the DG heat exchangers. A separate DGCW pump is provided for each cooling water system. The open loop portion of the DGCW system consists of three pumps (one for the Unit 2 DG, one for the Unit 3 DG, and one for the shared 2/3 DG) in the crib house, the components cooled by the system and the associated piping and valves. The open loop portion of the DGCW system is discharged into the service water system (SWS) discharge header.

The DGCW pumps can be cross-connected so that each pump can supply any of the other pumps' cooling loads, but they are normally isolated from each other and operated as separate subsystems. Thus, a failure in one subsystem would not affect the safety function of the other cooling water subsystems.

The pumps are driven by submersible, canned rotor motors which ensure pump availability in the event of flooding. The motors are cooled by the discharge of the pump which is returned to the pump suction. The pump suction is taken from the circulation water bays. A crosstie header allows the pumps to take suction from alternate bays while maintenance is being performed on a circulation water bay.

The DGCW pumps are located in Class II structures, but have been afforded Class I protection. They are located at elevation 490'-8" in the crib house where the circulating water pumps are located. This floor is 8 feet below the ground level in an area surrounded by a 2-foot thick reinforced concrete slab. The remaining part of the system's piping and valves traverse to and from the missile-protected diesel and reactor buildings via a reinforced concrete tunnel that runs below ground. Therefore, the DGCW system is adequately protected against tornado missiles. The concrete structure of the crib house would not be affected by earthquake.

Under normal operating conditions, the SWS supplies flow to the DGCW system loads through check valves. Normally closed manual valves in the crib house can be opened to cross-connect the discharge piping of any DGCW pumps to any or all DGCW heat loads, except for the DGs. There are no power-operated valves in the DGCW system. The DGCW pump jackets and bearings are cooled by the pumped fluid, and the pumps do not depend on other systems for cooling or lubrication.

Also, a connection is provided to the CCSW keep fill system by the emergency core cooing system (ECCS) room cooler crosstie header. The CCSW keep fill system is normally supplied by the SWS, but the DGCW pumps may be used as an alternate water supply.

The capacity of each DGCW pump is 1100 gal/min at a total discharge head of 115 feet. It has been determined from various evaluations that safety related, DGCW pump flows required to service the respective heat loads are dependent on inlet cooling water temperatures. The minimum flow versus inlet temperature based on the S & L calculation number MPED 9215111-01 are as follows:

TEMPERATURE	FLOW
95°F	810 GPM
90°F	690 GPM
85°F	610 GPM
80°F	530 GPM
75°F	480 GPM

This calculation is based on not exceeding a high cooling water temperature alarm (190°F) and to prevent a high cooling water temperature trip (200°F) during normal operation. The high cooling water temperature trip is bypassed in the "Auto Start" mode. The flow identified above are the minimum DGCW flow versus inlet temperature necessary to maintain engine coolant temperature less than 190°F alarm set point.

The DGCW pump trip alarms in the control room, and remotely, on the generator relay and metering panel. A restriction orifice type flow indicator is also provided in the DGCW pump discharge line in accordance with Regulatory Guide 1.97.

The Unit 2 pump receives electrical power from 480-V motor control center (MCC) 29-2. The Unit 3 pump receives electrical power from MCC 39-2. The 2/3 DGCW pump normally receives power from MCC 28-3, but an automatic device connects the pump to MCC 38-3 (Unit 3) if MCC 28-3 is deenergized. The pumps can be operated in manual mode or in automatic start mode. In the event of a loss of offsite power, the pumps are connected to the DG bus.

Each DG can operate without cooling water for 3 minutes at full load with a speed of 900 rpm assuming an initial cooling water temperature of 100°F prior to engine start. The DG operating time increases to 10 minutes with no load on the generator (at 900 rpm). At its idling speed each diesel generator can run for 42 minutes without cooling water, again assuming an initial water temperature of 100°F.

9.5.6 Diesel Generator Starting Air System

The purpose of the diesel generator (DG) starting air system is to store and deliver sufficient air to start the diesel under all conditions. The safety function of the air start piping is to provide a means to start the diesel engine in case of a loss of offsite power.

The DGs are started by air-driven starting motors. A separate starting air system is provided for each DG. Each DG starting air system has two starting air compressors and two air-driven starting motors. If the starting solenoid valve is energized, two air-driven starting motors engage a flywheel ring gear. After the two air-driven starting motors engage, the air start relay valve opens and four air receiver units supply the air which cranks the starting motors. Two air compressors maintain the air receiver pressure at greater than or equal to 220 psig. At an engine speed greater than 200 rpm, the starting solenoid valve deenergizes, interrupting the air to the starting motors and venting off the pressure which causes the air motors to stop and disengage. If the air receiver pressure is reduced to 175 psig, sufficient pressure would remain to start the DG once with no air compressor action. A diagram of diesel starting air piping is shown on Drawing M-173. The safety-related portion of the system is shown on Drawing M-173.

Some minor modifications to the DG starting air system resulted from design concerns raised by the Dresden Safety System Functional Inspection (SSFI). These concerns have been addressed in the "Operability Assessment of SSFI Report Concerns".[2] The modifications have enhanced the DG starting air system, and have been implemented on the Unit 2 and Unit 3 DGs and the Unit 2/3 swing diesel generator. These modifications included the following:

A. Addition of a single 1½-inch check valve to the combined discharge header of both air receiver units in each starting air train;

B. Removal and replacement of the air receiver inboard isolation drain valves with higher pressure rated valves in each diesel starting air train; and

C. Resupport of drain piping from each DG starting air receiver.

The diesel start-up air piping (P&ID M-173) is designed to provide starting air from both A and B receivers for diesel starts. Should either of the receivers become depressurized, check valves in the piping will isolate the depressurized receiver from the pressurized receiver; thus allowing air from the pressurized receiver to start the diesel.

The second modification replaced each air receiver inboard isolation drain valve (200-psi gate valve) with higher pressure rated valves. Since the system pressure is 250 psi, replacement with higher pressure valves would allow using these valves as isolation points without undue potential for leakage across the valve seat.

The third modification resupported the air receiver drain piping as a design enhancement. Pipe supports for the air receiver drain line were added as a part of the modification.

Power for the Unit 2 DG starting air compressors is supplied by 480-V motor control centers (MCCs) 28-2 and 29-2. Power for the Unit 3 DG starting air compressors is supplied by 480-V MCC 38-2 and 39-2. Power for DG starting air compressor 2/3A is supplied by 480-V MCC 28-1, and power for DG starting air compressor 2/3B is supplied by 480-V MCC 38-4.

During a diesel engine starting sequence, the start failure relay energizes if the engine does not reach 200 rpm within 15 seconds after the start signal is initiated. An alarm annunciates on the engine panel and a DG fail-to-start alarm annunciates in the control room. Also, when the manual shutoff valve on the diesel starting air system is closed, the closure annunciates an alarm in the control room.

During DG testing, the diesel starting air compressor is checked for operation and for its ability to recharge the air receivers.

9.5.7 Diesel Generator Lubrication System

A separate lubrication system is provided for each diesel generator (DG). During operation, the diesel engine drives three oil pumps. The engine-driven oil pumps are the scavenging pump, the main lube oil pump, and the piston oil pump. During standby conditions, the DG lubrication system is kept warm by heat transferred via natural circulation from a 15-kW immersion heater (located in the cooling water system) to the DG oil coolers which, in a standby mode, act as heaters to heat circulating oil. Two electrically driven oil pumps circulate the warmed oil through the lubrication system. Diagrams of the Unit 2, Unit 2/3, and Unit 3 DG lubrication system are shown on Drawing M-478, Sheets 1, 2, and 3.

Local and remote annunciation is provided to alert operators in the event of a disruption in circulating lube oil system flow. Low lubricating oil temperature and/or low main bearing oil pressure initiate a DG trouble alarm in the main control room. One of two main bearing oil pressure switches can also initiate a DG shutdown when oil pressure decreases below the switch's predetermined setpoint.

Operability of the DG lubrication system is verified during DG testing.

9.5.8 Diesel Generator Combustion Air Intake and Exhaust System

A diagram of diesel generator (DG) combustion air intake and exhaust piping is shown in Drawing M-40. As shown in the drawing, outside air is drawn through an oil-bath filter to the DG for combustion. Diesel engine exhaust gases are directed through a turbocharger to the exhaust silencer. The safety-related portion of the system is shown in Drawing M-40.

Outside air is drawn to the DGs through the turbochargers to support combustion of diesel fuel oil. The turbochargers are driven by two motive sources. The primary turbo driving force is derived from high-energy exhaust gas flowing through the turbine section of the turbocharger. At the time of engine startup and during the period preceding load application, there is a relatively low level of energy generated in the exhaust gas. During this interim period, the engine uses the turbocharger gear train to drive the turbocharger at 18 times engine speed to provide compressed air for combustion.

Normally, high driving torque is transmitted through the turbocharger gear train for only a short time because, as engine load is applied, the exhaust gas energy proportionally increases its share of the drive burden. When full rated load is applied, the exhaust energy is sufficient to drive the turbocharger without gear train assist. The overrunning clutch then allows the turbocharger to speed up and run independently of the gear train; the gears continue to freewheel without transmitting torque.

Protection of the combustion air intake and exhaust system from tornado missiles was reviewed under Topic III-4.A of the Systematic Evaluation Program (SEP) performed for Unit 2. A probabilistic assessment of tornado missiles impacting the system was performed and it was concluded that the probability of exceeding the requirements of 10 CFR 100 is very low and, as such, acceptable.[4]

9.5.10 References

1. EGC, "Dresden Units 2 and 3 Fire Protection Reports, Volumes 1 through 5, and Fire Protection Program Documentation Package, Volumes 1 through 13," Current Amendment.

2. QAL 12-87-197 Quality Assurance, Dresden Station, August 28, 1987.

3. Deleted

4. Integrated Plant Safety Assessment Final Report, Systematic Evaluation Program, Dresden Nuclear Power Station, Unit 2, NUREG-0823, Supplement No. 1, October 1989, Section 2.3.2.

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Updated Final Safety Analysis Report

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Exelon Generation Company

10.0 STEAM AND POWER CONVERSION SYSTEM
LIST OF FIGURES

DRAWINGS CITED IN THIS CHAPTER*

*The listed drawings are included as "General References" only; i.e., refer to the drawings to obtain additional detail or to obtain background information. These drawings are not part of the UFSAR. They are controlled by the Controlled Documents Program.

DRAWING*	SUBJECT
M-12	Diagram of Main Steam Piping Unit 2
M-13	Diagram of Extraction Steam Piping Unit 2
M-14	Diagram of Reactor Feed Piping Unit 2
M-15	Diagram of Condensate Piping Unit 2
M-16	Diagram of Condensate Booster Piping Unit 2
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M-19	Diagram of Heater Miscellaneous Vent and Drain Piping Unit 2
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Table 10.1-1

MAJOR COMPONENT DESIGN AND PERFORMANCE CHARACTERISTICS OF THE POWER CONVERSION SYSTEM

A.	Turbine Data	
	1. Manufacturer	General Electric Company
	LP Rotor manufacturer	Brown Boveri Corp.
	2. Type	Tandem compound, six flow exhaust
	3. Number of HP sections	1
	4. Number of LP sections	3
B.	Gross generator nameplate	920,350 (kVA) at 0.9 PF
C.	Final feedwater temperature	340°F[1]
D.	Supply steam rating	
	1. Flow	$9.8 \times {}^{6}$ lb/hr[1]
	2. Pressure	950 psig
	3. Temperature	540°F
	4. Moisture content	0.28%
E.	Turbine cycle arrangement	
	1. Number of feedwater heating stages	4
	2. Heater drain system	Cascading
	3. Feedwater heater stages in condenser neck	1
F.	Type of condensate demineralizer	Ion exchange
G.	Main steam bypass capacity	40%

(1) The values given for feedwater temperature and supply steam flowrate serve as nominal reference values, but are not limits.

10.2 TURBINE-GENERATOR

10.2.1 Design Bases

The turbine-generator system converts the thermodynamic energy of steam into electrical energy. The turbine-generator was designed to the following specifications:

Steam Conditions:	
Throttle Pressure	950 psig
Quality	Saturated with 0.28% moisture
Exhaust Pressure	1.5 in.Hg abs.

The inlet pressure of the turbine is dictated by the choice of the optimum reactor pressure. As limited by the interfacing equipment, saturated steam quality is maintained as high as possible to minimize blade erosion, and exhaust pressure is maintained as low as possible for maximum turbine efficiency.

There are no industry codes related to the design, manufacture, or installation of the turbine rotor. The turbine and all components, including the turbine rotor, were designed in accordance with the manufacturer's standards.[1]

10.2.2 Description

The turbine-generator system consists of the turbine, generator, exciter, controls, and required subsystems.

The turbine is an 1800 rpm, tandem-compound, six-flow, nonreheat steam turbine. The turbine is designed for saturated steam conditions of 950 psig with 0.28% moisture, 1.5 inches mercury absolute exhaust pressure, and 0.5% makeup while extracting steam for four stages of feedwater heating (see Drawings M-12, Sheet 2 and M-13). The turbine unit consists of one double-flow, high-pressure element, and three double-flow, low-pressure elements. Exhaust steam from the high-pressure element passes through moisture separators before entering the three low-pressure elements. The low-pressure elements have 38-inch last stage buckets. The separators reduce the moisture content of the steam to less than 1% by weight.

The generator is directly driven from the turbine shaft and is rated at 920,350 kVA at a 0.9 power factor and 0.58 short circuit ratio. It is a synchronous generator with a 60-Hz, 18,000 V output at 1800 rpm. The generator armature and stator are cooled by hydrogen. The design operating pressure for the generator hydrogen system is 60 psig. Stator internals are water cooled. Generator-excitation is provided by an Alterrex exciter rated at 1910 kVA at a 0.97 power factor and 375 Vac. The ac output of the exciter is rectified to dc before feeding the main generator field. The main generator field is rated at 3592 A and 500 Vdc.

Turbine steam flow is controlled by a set of four hydraulically operated turbine control valves on the high-pressure element main steam supply as shown in Drawing M-12, Sheet 2. Four hydraulically operated main steam stop valves provide isolation of the main steam supply to the turbine. High-pressure element exhaust steam is routed to four moisture separators prior to entering the low-pressure elements. Steam flow from the moisture separators to the low-pressure elements is controlled by the combined intermediate valves (CIVs). Each CIV includes an intercept valve and an intermediate stop valve. The intercept valves throttle to control flow from the moisture separators during turbine overspeed conditions and the intermediate stop valves provide isolation between the moisture separators and the low-pressure elements (similar to the turbine control valves and main steam stop valves on the main steam supply).

Turbine controls include a speed control unit, a load control unit, a bypass control unit, a flow control unit, and a pressure control unit. An electrohydraulic control (EHC) system integrates the electronic control circuits with the hydraulic system. The EHC system positions the turbine control and bypass valves to control reactor pressure and consequently generator load and turbine speed and is driven by a pair of pressure regulators. Refer to Section 7.7 for a description of the turbine control system.

The unit follows system load by adjusting the reactor power level. Power level can be adjusted by regulating the reactor recirculating flow or by moving control rods. The economic generation control (EGC) system, together with the turbine control system, provides an automatic load control feature which can be used with automatic recirculation flow control in the 65 - 100% range of rated core flow with reactor power at or above 20%, per Technical Specification 3.3/4.3.N. The EGC system is discussed in Section 7.7. Dresden has not routinely used and does not anticipate in the future using the automatic flow control feature of the master flow controller for the recirculation pumps; therefore automatic flow control is no longer routinely analyzed for an operating cycle. If automatic flow control MCPR values ($MCPR_f$) are provided for an operating cycle in the Core Operating Limits Report (COLR) then automatic flow control is supported for that cycle of operation.

The turbine speed governor can override the pressure regulator and close the turbine control valves and intercept valves when an increase in system frequency or a loss of generator load causes the speed of the turbine to increase. In the event that the reactor is delivering more steam than the turbine control valves will pass, up to 40% of rated steam flow can be routed directly to the main condenser via a set of nine bypass valves. The bypass valves are controlled by the EHC system as part of the overall reactor pressure control scheme. The turbine-generator load controls are designed for a 20 MWe gross per second maximum rate of change of power demand.

The EHC system oil is supplied through numerous interconnected or interacting subsystems. Some of these are the fluid actuator supply (FAS), fluid actuator supply trip controlled (FASTC), and fluid jet supply (FJS) subsystems.

The FAS subsystem supplies the actuators for the main and intermediate stop valves, and the actuators for the bypass valves. FAS supplies the servo unit for No. 2 main steam stop valve via a ported manifold block between the servo unit and the control pac on the valve. FAS also supplies the FASTC subsystem through an orifice and relay trip valve. The FASTC subsystem supplies the actuators for the intercept and control valves. In addition, FASTC supplies the FJS to the servo units on the turbine control valves and No. 1, No. 3, and No. 5 intercept valves via a ported manifold block between the servo unit and the control pac. The FJS subsystem supplies the servo units for the bypass valves directly from the hydraulic power unit.

Both Units 2 and 3 have the ability to isolate the EHC fluid supply used for the FASTC subsystem, the main stop valves, the control valves and the intercept valves while allowing both FAS and FJS fluid to the bypass valves. This allows the reactor remain operational via the bypass valve operation below 40% of rated steam flow while the other subsystems of the EHC fluid have been isolated.

Loss of EHC system oil will cause two types of actuations:

A. A turbine trip will occur on FAS subsystem oil pressure of less than 1110 psig. A turbine control (loss of control oil pressure) scram will occur on decreasing FAS subsystem oil pressure at a setpoint greater than or equal to 900 psig.

B. A generator load rejection scram will occur on decreasing FASTC subsystem oil pressure at a setpoint greater than or equal to 460 psig (nominally set at less than 600 psig), via pressure switches tied to the load rejection scram logic. The area under the control valve disk dump valve is one-fourth of the area above the disk dump valve. The FJS subsystem oil (1600 psig) acts beneath the disk dump and FASTC subsystem oil acts above the disk dump, such that when the oil pressure above the disk dump drops to approximately 400 psig, the disk dump valve opens and the control valve fast closes. The pressure switches, one for each control valve, monitor the FASTC subsystem oil pressure to the disk dump valve and provide a signal to the reactor protection system, thus anticipating the turbine trip. This scram is further discussed in Section 7.2.

If a load rejection occurs, the turbine control valves throttle to limit turbine overspeed. Due to the large quantity of energy in the turbine and moisture separator fluid, steam flow to the low-pressure elements could continue after the turbine control valves are fully closed. The intercept valves provide overspeed protection by throttling intercept valves No. 1, 3, and 5 to control this steam flow at 105% of rated speed.

Intercept valves No. 1, 3 and 5 are positioning valves (one for each LP element) with each valve operated through a servo motor positioned by the output from a servo valve. A fast acting solenoid valve is installed on each intercept valve to close the valve on loss of load. Intercept valves No. 2, 4 and 6 are slaved to valves No. 1, 3 and 5, respectively. They are either full open or closed. This is done by a test solenoid valve actuated by limit switches on its respective positioning valve. This intercept valve also has a fast acting valve for rapid closing. The nonpositioning intercept valve will open when its companion positioning valve is open. The nonpositioning valve will close when the positioning intercept valve is lowered below half-stroke.

Nonreturn valves in the extraction steam lines to the B, C, and D feedwater heaters prevent steam from the feedwater heater fluid from flowing back to the turbine which would cause the turbine to overspeed. When a turbine trip signal occurs, the nonreturn valves lose air assist to open, thereby allowing them to close and prevent reverse flow. They also prevent water induction if high feedwater heater shell side water levels occur.

If the turbine speed were increased to 110%, a mechanical turbine trip would occur, closing the main steam stop valves as well as the control and CIVs. Backup protection for the mechanical trip is provided by an electrical overspeed trip at 112%.

10.2.3.2 Inservice Inspection and Testing

Tests and inspections are conducted to ensure adequate functional performance as required for continued safe operation and to provide maximum protection for operating personnel. One of these tests is periodic exercising of the main steam stop valves and the bypass valves. Each main steam stop valve is tested individually to full closure. The valves will close only 10% when multiple valves are tested simultaneously. The test procedure requires individual valve testing using individual test buttons to minimize the possibility of a transient. Other control valves not normally in motion are also periodically exercised. Mechanical and electrical overspeed trips are tested periodically.

During operation, prior to entering the EGC load control scheme, the EGC operating parameters are reviewed for acceptability in accordance with Technical Specification 3.3/4.3.N. The turbine, including rotors, is inspected periodically at intervals recommended by the vendor to preclude the probability of turbine missiles due to stress corrosion cracking of the turbine disk.[1]

Acceptance testing and operability verification of the new rotors have been performed using manufacturer's procedures, station start-up procedures, and engineering department procedures.

10.2.4 Evaluation

The effects of component failures in this system have been evaluated in detail. The turbine system component failure events having the most significant effects on the plant are as follows:

A. Generator load rejection without bypass;

B. Turbine trip, coincident with failure of the turbine bypass system;

C. Inadvertent closure of main steam isolation valves;

D. Turbine trip (main steam stop valve closure);

E. Loss of EHC system oil pressure;

F. Loss of condenser vacuum; and

G. Steam pressure regulator malfunction or failure.

Descriptions of these failures is contained in Chapter 15 and Section 5.2.2.

EGC's experience with turbines in its nuclear power plants has not shown significant radioactive contaminants during maintenance. A radiological evaluation of the turbine system is provided in Chapters 11 and 12.

10.3 MAIN STEAM SYSTEM

The Unit 2 main steam system (MSS) is shown on Drawing M-12, and Unit 3 MSS is shown on Drawing M-345. The main steam isolation valves (MSIVs) are further discussed in Section 6.2. The safety relief valves (SRVs) are discussed in Section 5.2.

10.3.1 Design Bases

The performance objective of the main steam piping is to supply steam to the turbine-generator from the reactor vessel. To achieve this objective, the main steam piping was designed using the following bases:

Design pressure and temperature	1250 psig at 575°F
Piping design code	USAS B-31.1

10.3.2 Description

The main steam piping consists of four lines which carry the reactor generated steam to the main turbine. Each steam line is equipped with two isolation valves, one on each side of the primary containment wall, and a combination flow restrictor and flow measuring venturi located between the reactor and the first isolation valve. The rated steam flow that the main steam line piping is designed to handle is 9.8×10^6 lb/hr at 965 psia. Unit operation would be permitted above rated steam flow rate and up to 9.90×10^6 lb/hr.

The MSS is dynamically designed upstream of the first anchor outside the drywell and statically designed downstream of that anchor. The internal and external design load combinations and criteria are addressed in Chapter 3.

Design, fabrication, and installation of the main steam piping are summarized in Table 10.3-1.

In addition to providing steam to drive the main turbine, the MSS also provides steam to the following:

A. Turbine gland seal system,

B. Steam jet air-ejectors,

C. Off-gas preheater and booster air-ejectors,

D. Main condenser low-load reheat coils, and

E. Liquid radwaste reboiler.

Downstream of the outboard isolation valves, the four main steam lines are connected by a 30-inch diameter main steam equalizing header. Two 18-inch diameter lines connect the equalizing header to either end of the turbine bypass

10.3.6 Steam and Feedwater System Materials

The condensate/feedwater and main steam system piping, fittings, and valves connected to the reactor pressure vessel from and including the first weld at the vessel to and including the first isolation or shut off valve conform to ASME Section I. This piping is constructed of A 106 Grade B. The feedwater piping maximum wall thickness is 1.375 in. The main steam piping has a maximum wall thickness of 1.031 in.

The condensate and feedwater systems are described in Section 10.4.7.

10.3.6.1 Fracture Toughness

The 1965 edition of the code does not require impact testing nor does the original specification or ASTM specification. Current ASME Section III for class I components require impact testing. The Dresden Systematic Evaluation Program (SEP) compared the original testing requirements of the feedwater and main steam piping from the reactor vessel to the outermost isolation valve with the later code which requires impact testing if certain exemptions are not met. An exemption for a material is permitted if the lowest service temperature (LST) exceeds 150°F. The LST is defined as the calculated minimum metal temperature whenever the pressure within the component exceeds 20% of the preoperational system hydrostatic test pressure. Due to the high service temperature, well above 150°F, feedwater and main steam piping brittle fracture is not a problem and fracture toughness testing is not required.

10.3.6.2 Materials Selection and Fabrication

The materials selected for the main steam and feedwater piping, within the scope of the design specifications (including pipes, fittings, flanges, bolts, and valves), were originally in accordance with ASA B-31.1, which specified approved ASTM Specifications. The welding procedures are in accordance with ASME Code, Section IX. Austenitic stainless steel is not used in the main steam or feedwater piping.

Table 10.3-1

DESIGN, FABRICATION, AND INSTALLATION OF THE MAIN STEAM PIPING

Pipe	
Size	20 in. and 24 in.
Type	Seamless
ASTM Specification	A 106 Grade B
Schedule	80
Weld Joint	
Root pass	Gas tungsten arc (TiG)
Second pass	Gas tungsten arc (TiG)
Remainder	Shielded metal arc (SMA)
Fittings	
Type	Butt weld
ASTM Specification	B 16.9
ASTM Specification	A 234 grade WPB
Schedule	80

Notes

1. For piping 2" and under, ASTM A335 Grade P11 or P22 may be substituted for ASTM A106 Grade B material for the same schedule. For fittings and valves 2" and under, ASTM A182 Grade F11 or F22 may be substituted for ASTM A105 for the same rating. Substitutions are allowed up to a maximum temperature of 450°F (operating or design).

10.4 OTHER FEATURES OF STEAM AND POWER CONVERSION SYSTEM

10.4.1 Main Condenser

The functions of the main condenser are as follows:

A. To provide a heat sink for the turbine exhaust steam;

B. To condense the bypass steam after a turbine trip;

C. To accommodate feedwater heater drains, extraction steam, and steam line condensate routed to the condenser during operation with feedwater heaters out of service;

D. To retain the condensate for 2 minutes to allow for the decay of short-lived isotopes;

E. To deaerate the condensate and remove fission product gases, hydrogen, and oxygen; and

F. To provide adequate net positive suction head for condensate pumps.

10.4.1.1 Design Basis

The main condenser is not credited to support safe shutdown or to perform any reactor safety function.

10.4.1.2 System Description

The main condenser is a divided water flow, single-pass, multipressure type condenser with backwashing capability for each half of the condenser.

The condenser is designed for 3 exhaust pressures which results in performance comparable to an average exhaust pressure of 1.5 in.Hg abs with 60°F cooling water. The condenser is designed to accept bypass steam up to 40% of throttle steam flow. The condenser water boxes are of fabricated steel construction.

The condenser hotwell is designed to provide sufficient retention time (2 minutes) to permit decay of N-16 and O-19 to levels which eliminate the need for shielding of the condensate pumps.

The main condenser is designed for internal hydrostatic pressure (when filled) and external atmospheric pressure.

One-half of the Main Condenser water box may be isolated at reduced reactor power to facilitate maintenance activities.

During plant operation, steam, after expanding through the low-pressure turbine elements, exhausts through the bottom of the turbine casing to the condenser. The circulating water system, discussed in Section 10.4.5, provides the cooling medium to condense turbine exhaust steam. The condenser shell is supported on the turbine foundation mat. An expansion joint is fitted between each low-pressure element exhaust hood and condenser inlet connection. The condenser is divided into three separate compartments by two division plates, as shown in Drawing M-15. Cold circulating water enters the cold compartment which has 100% condensing capacity. The intermediate compartment has 99% condensing capacity because of the warmer temperature of the circulating water. The warm compartment has 97 - 98% condensing capacity. The excess steam is called reheat steam and is used for deaerating purposes.

Reheat steam heats the condensate streams at the weir plate to a boiling temperature that liberates the dissolved noncondensible gases. Vent pipes passing through the lower deaerating weir plate and collecting tray vent the noncondensible gases to the tube bundle in the intermediate compartment. Air leaking into the condenser and noncondensible gases are transported via vent pipes to the air cooler trays which extend the entire condenser length. These gases are removed by the main condenser evacuation system described in Section 10.4.2.

The condenser hotwells retain the condensate for 2 minutes to allow short-lived radionuclides to decay. This condensate retention is accomplished by a series of baffles and tunnel arrangements at the condensate outlet. The condensate is pumped from outlet pipes by the condensate pumps described in Section 10.4.7.

The circulating water system, which provides the condenser tube single-pass cooling, is described in Section 10.4.5. Design data and operating performance requirements are shown in Table 10.4-1.

If core flooding or containment flooding is needed following a postulated loss-of-coolant accident, the standby coolant supply system provides an inexhaustible supply of water to the condenser hotwell so that feedwater flow to the reactor can be maintained. The standby coolant supply system is described further in Section 9.2.

10.4.1.3 Safety Evaluation

The condenser shell is protected by relief diaphragms on the turbine exhaust casing in the event of a failure of the turbine bypass valves to close on loss of condenser vacuum.

Double tube sheets prevent river water leakage through the tube joints to the condenser hotwell. Tube leakage is monitored by condensate demineralizer inlet conductivity. Plant operation in the event of high conductivity is discussed in Section 10.4.6

Tube leakage may be repaired during reactor operation by isolating one-half of the Main Condenser water box or by draining the condenser waterboxes after reactor shutdown.

If the Dresden Island Lock and Dam were to fail, the water level would recede within the condenser water box. Both units would be shutdown due to loss of condenser vacuum, as discussed in Section 9.2.5.3.1.

10.4.2.2 System Description

The main condenser evacuation system is shown in Drawings M-43, Sheet 1 and M-371, Sheet 1.

The main condenser evacuation system for each unit consists of steam jet air ejectors (SJAEs) for normal plant operation and a mechanical vacuum pump for startup.

The SJAEs discharge through the off gas system. In the off gas system, hydrogen and oxygen are recombined to reduce volume and eliminate the explosive hazard. Off gas is filtered and passed through a charcoal adsorber. See Section 11.3 for details.

The air ejector and off gas condensers are cooled by the condensate system. Moisture extracted from off-gas flow is drained back to the main condenser.

The steam jet driving flow is from the main steam supply through pressure regulating valves set at approximately 125 psig.

The mechanical vacuum pump system provides the initial vacuum in the condenser during unit startup. The gases from the turbine and condenser system are discharged from the pump to the stack via the gland seal exhaust piping system. The mechanical vacuum pump detail is discussed in Section 11.3.2.

10.4.2.3 Safety Evaluation

The off-gas flow from the main condenser is one source of radioactive gas in the station. An inventory of radioactive contaminants in the effluent from the SJAEs is evaluated in Section 11.3. The main steam flow to the ejectors dilutes the off-gas to less than 4% hydrogen by volume to minimize the possibility of hydrogen detonation. The entire system is designed to maintain its integrity in the event of hydrogen detonation.

The SJAE suction valves close when the supply steam pressure is low and decreasing. Main steam line radiation monitors isolate the mechanical pump on high fission product radioactivity. The hydrogen water chemistry system is addressed in Section 5.4.3.

10.4.2.4 Tests and Inspections

The off-gas systems are used on a routine basis and do not require specific testing to assure operability. Monitoring equipment is calibrated and maintained on a specific schedule and on indication of malfunction. Tests and inspections of the main condenser evacuation system equipment are performed in accordance with normal station practices and procedures.

10.4.2.5 Instrumentation Applications

The off-gas system is continuously monitored for radiation within the 36-inch holdup pipe by dual radiation monitors. A high-radiation alarm is provided in the control room. If the radioactivity exceeds the limits of the off-site dose calculation manual, the holdup line of the off-gas system is automatically isolated after a 15-minute delay. The holdup of the off-gas provides sufficient time between detection and isolation to prevent release. Off-gas instrumentation is discussed in Section 11.3.2.1.

10.4.3 Turbine Gland Sealing System

The purpose of the turbine gland sealing system is to prevent air leakage into, or radioactive steam leakage out of, the turbine shaft packings and turbine admission valve stem packings. See Section 11.3.2.2 for a description of the turbine gland seal exhaust system.

10.4.3.1 Design Bases

The turbine gland sealing system is not credited to support safe shutdown of the reactor or required to perform any reactor safety function. The turbine gland sealing system is designed in accordance with ASA B-31.1 Code.

10.4.3.2 System Description

The turbine gland sealing system is designed to provide turbine shaft sealing, prevent steam leakage to the atmosphere, prevent air inleakage, and prevent leakage between turbine sections. The system also provides sealing to the valve stem packing of the main steam stop valves, turbine control valves, combined intermediate valves, and bypass valves. The steam-air mixture from the gland seal system is removed by the turbine gland seal exhaust system.

The turbine gland seal exhaust system is shown in Figure 10.4-2, Drawings M-43, Sheets 1 through 3 and M-371, Sheet 1. The turbine gland sealing system consists of a steam-seal feed valve with bypass, a steam unloading valve with bypass, a steam-seal header, exhaust headers, valves, piping, and instrumentation. The turbine steam is sealed against leakage along the shaft to the atmosphere by the labyrinth pressure packing. Air inleakage to the turbine is controlled by the labyrinth vacuum packing. These packings limit the leakage by a series of throttling seals from the high-pressure space to the low-pressure space. Sealing steam is supplied to the pressure packing at low load and to the vacuum packing at all loads.

At low load, sealing steam is supplied from main steam via an air-operated control valve, which reduces the pressure to 2.5-4.5 psig. The steam seal feed MOV has throttling capacity to also perform this function. The sealing steam is supplied to the high-pressure element shaft seals, low-pressure element shaft seals, valve stem packings of the main steam stop valves, turbine control valves, combined intermediate valves, and bypass valves. A mixture of steam, moisture, and air is routed to the exhaust header. At full load, the steam from the high-pressure element packing provides enough pressure for the low-pressure element vacuum packing. The feed control valve completely closes and the unloading valve opens to maintain pressure. The steam seal feed MOV may also be used to close off the sealing steam supply. The steam unloading valve discharges to the extraction lines of low-pressure heater A. The exhaust header need only be maintained at sufficient vacuum to prevent steam from coming out of the seals.

10.4.3.3 Safety Evaluation

The system is designed to provide low-pressure sealing steam to the turbine shaft glands.

The relief valve will maintain the system at a safe pressure if the control valves fail. Manual pressure control is possible using bypass valves. Section 11.3 discusses radiation issues.

10.4.3.4 Tests and Inspections

Tests and inspections of the turbine gland sealing system equipment are performed in accordance with station practices and procedures.

10.4.3.5 Instrumentation Applications

The steam seal header pressure and the exhaust header vacuum are indicated by instruments in the control room. The steam seal header is provided with a low-pressure alarm, as well as a thermocouple.

10.4.4 Turbine Bypass System

The purpose of the turbine bypass system is to bypass up to 40% of the turbine-generator throttle steam flow to the condenser.

Although the bypass valves are not credited for safe shutdown, evaluation of the accidents and transients for which the plant is designed considered the bypass valves. The main accidents and transients that the bypass valves affect are turbine trip, load reject, and feedwater controller failure. The description of the bypass valve function during accidents and transients can be found in Sections 15.1, 15.2 and 15.8.

10.4.4.1 Design Basis

The turbine bypass system is not credited to support safe shutdown of the reactor or to perform any reactor safety function.

The turbine bypass system is designed in accordance with ASA B-31.1 Code.

10.4.4.2 System Description

The turbine bypass valves discharge reactor steam directly to the main condenser. They are used during unit startup and shutdown to regulate the steam pressure in the reactor vessel and are designed to pass up to 40% of the turbine-generator throttle steam flow. The capacities of the bypass valves and relief valves are sufficient to keep the reactor safety valves from opening in the event of a sudden loss of full load on the turbine-generator; thus, the turbine bypass system provides protection against reactor vessel overpressure. The relief valves alone would be sufficient if a reactor scram were assumed to occur simultaneously with turbine trip and bypass system failure (see Section 5.2.2.2.2).

The turbine bypass system is shown in Drawing M-12, Sheet 2. Two 18-inch diameter pipes extend from the 30-inch main steam equalizing header to the turbine bypass manifold. Nine turbine bypass valves are situated on the bypass manifold and are sequentially operated by hydraulic pressure of the turbine electrohydraulic control (EHC) system. Nine 8-inch diameter bypass lines are piped directly to the main condenser via pressure reducing orifices. The turbine bypass system is used during normal startup and shutdown to pass partial main steam flow to the condenser.

The bypass valves are automatically controlled by reactor pressure. Two independent pressure regulators are provided; one is used as a backup or standby regulator. The setpoint of the pressure regulators is adjusted manually from the control room. The bypass valves may be manually controlled from the control room by the bypass valve jack.

10.4.5.1 Design Bases

The circulating water system is not credited to support safe shutdown or to perform any reactor safety function.

10.4.5.2 System Description

The circulating water system takes supply from the Dresden cooling lake (with makeup from the Kankakee River) or directly from the Kankakee River, directs the flow through the condenser, and discharges it back to the Dresden cooling lake and/or the Illinois River system.

The circulating water system has three vertical, drypit, centrifugal, removable element, mixed flow volute, circulating water pumps which deliver water from the crib house intake to the condenser water boxes. See Drawing M-36. Each pump suction pit is sectionalized to permit dewatering of one pit for maintenance while the remaining two pumps are in operation. In addition, each pump is provided with a shutoff valve at its discharge.

At the condenser pit, the circulating water pipe becomes a supply header with two 10-foot diameter inlets to the condenser water boxes. Circulating water flows from the inlet water boxes through the condenser low-pressure section, intermediate-pressure section, and high-pressure section sequentially to the two outlet water boxes. From the outlet water boxes the circulating water is discharged to the discharge canal. Appropriate piping and valving is provided to permit reversing flow through the condenser thereby cleaning the tubes. An 8-foot ice melting line drains by gravity from upstream of the discharge flume weir back to the intake bays for ice melting during cold weather operation. The water reservoir in the discharge flume, the intake canal, and discharge canal also provides the ultimate heat sink for decay heat removal. The ultimate heat sink is addressed in Section 9.2.5.

Each circulating water pump has a capacity of 157,000 gal/min, with a total head of 36 feet and a speed of 236 rpm. Each pump is driven by a 1750-hp, 236-rpm, 3-phase, 60-Hz, 4000-V induction motor.

Equipment is provided to inject biocide and chemicals into the circulating water upstream of the condenser: sodium hypochlorite solution to minimize marine growth and bacteria, and aminomethlyene phosphonate and/or polyacrylate for scale inhibition and for solids dispersal to prevent settling on the condenser tubes.

Upstream of each circulating water pump there are traveling screens for removal of debris. Upstream of the traveling screens is a bar-grille trash rack with a rake for periodic removal of river debris.

The water from the discharge flume can be routed to the Illinois River or to the Dresden cooling lake. The circulating water discharge provides the necessary dilution for low level liquid radwaste discharges as discussed in Section 11.2. Station procedure provides guidance to operate within the limits of the National Pollutant Discharge Elimination System permit for circulating water discharge.

surges of 19,100 gal/min. The system can maintain effluent impurity levels at or below the following concentration limits:

Total dissolved solids	-	25 ppb
Total iron as Fe	-	8 ppb
Total copper as Cu	-	8 ppb
Total nickel as Ni	-	5 ppb
Total silica as SiO_2	-	10 ppb
Total chloride as Cl	-	10 ppb
Specific conductivity at 77°F	-	0.1 µmho/cm
pH at 77°F	-	7

The condensate pumps take suction from the condensers and discharge through the SJAE condensers, gland seal condensers, and off-gas condenser to a full-flow condensate demineralizer system to ensure the supply of high-purity water to the reactor. The condensate enters the mix-bed demineralizer vessel at the top and passes through the cation and anion resins. The resins remove dissolved cations and anions. The treated condensate exits the bottom of the vessel to the condensate booster pumps.

The system and auxiliaries, as shown in Drawing M-17, include resin transfer, ultrasonic resin cleaner (Note: the ultrasonic resin cleaner on Unit 3 has been removed.), backwash, recycle pump, resin trap, and instrumentation and control for proper operation. The condensate demineralizer system can be used during refueling operation to treat suppression pool water.

The condensate demineralizer system is composed of seven mixed-bed demineralizer units (one of which is a spare). The demineralizer tanks are of the rubber-lined, carbon-steel-type and are rated by the manufacturer for a design flow rate of 3270 gal/min per tank to achieve proper performance within design parameters as related to ion exchange performance. Demineralizer flow rates that exceed 3270 gpm are acceptable with no anticipated mechanical damage to the demineralizer; however, higher flow rates will result in poorer effluent quality and shorter ion service times. Station water chemistry quality will determine the need to reduce demineralizer flow rates.

Exhausted resins are sluiced from a demineralizer unit to the resin separation tank. The resins are separately backwashed to remove insoluble material. After rinsing, the regenerated resins are sluiced to the resin storage tank for remixing of the resins and eventual reuse.

Any radioactive material removed from the exhausted resins by the rinse solutions is transferred to the radioactive waste system for analysis and treatment as required. Low-conductivity water is diverted to the waste collector tank, and high-conductivity water is routed to the waste neutralizer tank.

The condensate demineralizer and associated systems are manually controlled from a local panel. Integrated flow and conductivity monitors are provided for each demineralizer to indicate when backwash is required. Alarms and pressure drop recorders are provided in the control room.

10.4.7 Condensate and Feedwater Systems

The purpose of the condensate and feedwater systems is to deliver condensate from the condenser to the reactor. The portion of condensate and feedwater systems addressed in this section is from the outlet of the condenser up to the outboard feedwater check valve. The feedwater system from the outboard feedwater check valve to the reactor is addressed in Section 5.2. The condenser is addressed in Section 10.4.1. Feedwater system controls are addressed in Section 7.7.

10.4.7.1 Design Basis

The condensate and feedwater systems are not credited to support safe shutdown or to perform any reactor safety function. The feedwater system performance is, however, modeled in some of the Chapter 15.0 transients.

The objective of the condensate and feedwater systems is to supply the reactor vessel with demineralized water equivalent to the rate of water which is being generated into steam by boiloff. To achieve this objective, the condensate feedwater system was designed to supply 9,725,000 lb/hr of water at 1100 psia. Unit operation would be permitted above this flowrate and up to 9,870,000 lb/hr.

The condensate and feedwater systems are designed in accordance with ASA B-31.1 Codes.

10.4.7.2 System Description

The condensate and feedwater systems consist of condensate pumps, condensate booster pumps, a demineralizer system, feedwater heaters (high- and low-pressure), feed pumps, feedwater regulating valves, piping, controls and instrumentation, and subsystems that supply the reactor with regenerative feedwater heating in a closed steam cycle.

The condensate system is shown in Drawing M-15. The condensate booster system is shown in Drawing M-16. The feedwater system is shown in Drawing M-14 and M-347.

The Zinc injection process system is addressed in Section 5.4.

The extraction steam system is shown in Drawing M-13. The heater drain system is shown in Drawing M-18. The heater vent and drain piping is shown in Drawing M-19.

The hydrogen water chemistry system is addressed in Section 5.4.

Four condensate pumping units are located next to the condenser pit. Each unit consists of one condensate pump and one condensate booster pump driven by one common motor. The pumps are horizontal, single-stage, centrifugal-type with a capacity of 6825 gal/min, sized so that only 3 pumping units are required for normal full-load operation. The fourth unit serves as a backup and auto starts on an operating unit trip or on low-discharge pressure sensed at the Reactor Feed Pump (RFP) suction header. The drive motors are 1750-hp induction motors.

The four condensate pumps take their suction from both sides of the main condenser hotwell through a common 48-inch header that reduces to 24-inch piping. The condensate pumps then discharge throughout the cooling side of the SJAEs, gland steam condensers, and off-gas condenser to the condensate demineralizers. The condensate booster pumps take their suction from the full-flow condensate demineralizers and are used to raise pressure immediately before the condensate passes through the low-pressure heaters and on to the feed pump suction. Minimum flow is maintained by circulation to the condenser.

The condensate demineralizer system is addressed in Section 10.4.6.

The feedwater heaters are divided into three parallel strings. There are three low-pressure feedwater heaters, A, B, and C, and one high-pressure feedwater heater D in each string. Separate drain coolers are provided for each A heater, while the other heaters have integral drain coolers.

Separation of water in the extraction steam is accomplished in the heaters. All drains flow by pressure differential from the heater through the drain cooler to the next lower pressure heater. All heaters have stainless steel tubes welded to the tube sheets. Stainless steel baffles are provided at entering steam and drain connections.

Each feedwater heater shell is designed to receive quantities of steam and/or water under the conditions in the amounts listed in Table 10.4-4. The listed quantities are for one heater string only.

Valving and a bypass line permit bypassing each string of low-pressure heaters in the event of failure of any component in the string. Any of the three high-pressure heaters can be similarly bypassed.

The reactor feed pumps take suction from the low-pressure feedwater heater C and discharge through the feedwater regulating valves to high-pressure feedwater heater D. Three 2-stage horizontal feed pumps are provided, each with a capacity of 5,105,000 lb/hr. They are sized so that only two need to be in service during normal full load operation; the third pump serves as a standby. Each pump is driven by a 9000-hp, 4160-V, 3-phase, 60-Hz induction motor through a speed increasing gear unit with a rating of 10,350 hp. At an input speed of 1800 rpm, this unit drives the pump at a speed of 4521 rpm. Each pump has the design characteristics shown in Table 10.4-5.

A minimum flow of 900 gal/min is required from each reactor feed pump. When reactor feed requirements fall below this minimum, an air-operated flow control valve opens and allows feedwater recirculation back into the condenser hotwell. Loss of the running reactor feed pump starts the pump on standby. The feed pump trips on reduced suction pressure.

Feedwater to the reactor is controlled by throttling the feedwater regulating valves (FWRVs). Two 18-inch full-flow FWRVs are provided for power operation and are normally set to automatically maintain reactor water level. One low-flow regulating valve is used for lower power operation. The feedwater control valves provide stable reactor water level control.

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LIST OF FIGURES

11.0 RADIOACTIVE WASTE MANAGEMENT
DRAWINGS CITED IN THIS CHAPTER*

*The listed drawings are included as "General References" only; i.e., refer to the drawings to obtain additional detail or to obtain background information. These drawings are not part of the UFSAR. They are controlled by the Controlled Documents Program.

DRAWING*	SUBJECT
M-12	Diagram of Main Steam Piping Unit 2
M-39	Diagram of Reactor Building Equipment Drains Unit 2
M-40	Diagram of Turbine Building Equipment Drains and Diesel Air Intake and Exhaust Unit 2
M-43-1, -2, -3	Diagram of Off Gas Piping Unit 2
M-43-5	Off Gas Sample Conditioning System Piping and Instrumentation Diagram Unit 2
M-44	Diagram of Floor Drain Collector Subsystem Piping
M-45-1	Diagram of Radwaste Collector Subsystem Piping
M-45-2	Composite Diagram of Radwaste Filter Piping
M-45-3	Diagram of Radwaste Sample Tank and River Discharge Subsystem Piping
M-46-1	Diagram of Radwaste Sludge and Concentrated Waste Subsystem Piping
M-47-1	Diagram of Waste Neutralizer Subsystem Piping
M-178	Diagram of Process Sampling Part 2 Unit 2
M-178A	Diagram of Radwaste Sampling
M-179	Diagram of Process Sampling Part 3 Units 2 and 3
M-269-1	Diagram of Reactor Building Ventilation Unit 2
M-272	Diagram of Radwaste Ventilation
M-345	Diagram of Main Steam Piping Unit 3
M-369	Diagram of Reactor Building Equipment Drains Unit 3
M-370	Diagram of Turbine Building Equipment Drains
M-371-1, -2, -3	Diagram of Off Gas Piping Unit 3
M-371-5	Off Gas Sample Conditioning System Piping and Instrumentation Diagram Unit 3
M-420	Diagram of Process Sampling Part 3 Unit 3
M-421	Diagram of Process Sampling Part 2 Unit 3
M-422-1	Diagram of Process Sampling Part 4 Units 2 and 3
M-422-2	Diagram of Process Sampling Part 5 Units 2 and 3
M-529	Diagram of Reactor Building Ventilation Unit 3
M-720	Diagram of Maximum Recycle Radioactive Waste Piping
M-720A	Piping Diagram Isolok Sampling System
M-721	Diagram of Maximum Recycle Radioactive Waste Piping
M-722	Diagram of Concentrator Reboiler and Miscellaneous Equipment Piping
M-723	Diagram of Maximum Recycle Surge Tank Piping
M-724	Diagram of Maximum Recycle Equipment Vent and Drain Piping
M-3478	Piping Instrumentation Diagram, Liquid Radiation Monitor Radwaste System
M-3486	Piping Instrumentation Diagram, Liquid Radiation Monitor Service Water System Unit 3
M-3496	Piping Instrumentation Diagram, Liquid Radiation Monitor Service Water System Unit 2

The components of the system are designed and operated in such a manner as to minimize radiation exposure of personnel and significantly reduce the radioactivity levels below those limits set forth in 10 CFR 20; 10 CFR 50, Appendix I; and the regulations of the State of Illinois.

Discharge paths for the release of radioactive materials are monitored by the following systems.

A. Off-gas radiation monitor - The off-gas monitoring system actuates an alarm in the control room in the event that the gaseous discharge from the main turbine condenser significantly exceeds the normal emission rate. The monitoring system isolates the off-gas system after a time delay in the event that the release rate limit is exceeded. As a result of the action initiated by this system, the resultant doses will be below the guidelines set forth in 10 CFR 20 and 10 CFR 50, Appendix I.

B. Chimney effluent radiation monitor - The gaseous effluent discharged to the environment via the chimney is monitored for particulate, iodine, and noble gas activity. An alarm annunciates in the control room if the release rate limit is exceeded. Appropriate action, such as power reduction, etc., will be taken upon indication of the limits being exceeded.

C. Reactor building ventilation exhaust radiation monitor - In the event of high radiation levels in the reactor building ventilation exhaust duct or on the refueling floor, the monitors isolate the secondary containment and initiate the standby gas treatment system. The activity level necessary to isolate the secondary containment equates to a calculated dose rate less than the instantaneous effluent release limit of 500 mrem/year whole body and 3000 mrem/year skin.

D. Before any batch of liquid waste is discharged to the environment from the liquid waste treatment facility, the tank is isolated so that no additional water can be added to it. The batch of liquid waste is mixed by recirculation to assure that the sample obtained is representative. After mixing, the batch of liquid waste is sampled and analyzed for gamma isotopic activity. Factors for H-3, Fe-55, Sr-89 and Sr-90 which are based on previous discharges are calculated periodically. The factors may then be used to estimate H-3, Fe-55, Sr-89 and Sr-90 concentrations if the actual value is not known. Based upon these analyses, a discharge rate for the batch is determined so that when the batch is discharged and diluted by the plant circulating water discharge, the radioactivity level in the circulating water leaving the plant site will be less than the applicable effluent concentration limit (ECL), as stated in 10 CFR 20, Appendix B, Table 2. This ensures that the level of activity at the outlet of the discharge canal will be within the NRC limit for non-occupational use. Normally, the waste is a small percentage of the ECL, and at no time will waste discharge water leaving the discharge canal and entering the river exceed average ECL values over the course of a calender year.

Normally, an offline radiation detector monitors the radioactive system discharge line that feeds the circulating water discharge canal when a discharge is made. If an abnormal radioactivity level is detected, a grab sample is automatically collected, an alarm annunciates in the radwaste control room, and the operator terminates the discharge. Compliance with 10 CFR 20, 10 CFR 50 Appendix I, and 40 CFR 141 limits is further verified through programs delineated in the Offsite Dose Calculation Manual.

Leakage of fluids from the reactor coolant process systems will result in the release of radionuclides into plant buildings. In general, the noble radiogases will remain airborne and will be released to the atmosphere with little delay via the building ventilation exhaust ducts. The radionuclides will partition between air and water, and airborne radioiodines may plate out on metal surfaces, concrete, and paint. A significant amount of radioiodine remains in the air or is desorbed from surfaces. Radioiodines are found in ventilation air as methyl iodide and as inorganic iodine which is defined here as particulate, elemental, and hypoidodus acid forms of iodine. Particulates will also be present in the ventilation exhaust air.

An evaluation of the radioactive releases from ventilation systems, for compliance with 10 CFR 50, Appendix I and 10 CFR 20, is given in Section 11.3.

11.1.6 Other Releases

All other releases are covered in Section 11.2.

11.1.7 Radioactivity Sources for Ventilation Systems

The potential radioactivity sources for the ventilation system are from the following systems:

A. Drywell equipment drain sump system,

B. Reactor building equipment drain tank system,

C. Radwaste building equipment drain sump system,

D. Turbine building equipment drain sump system,

E. Drywell floor drain sumps system,

F. Reactor building floor drain sumps system,

G. Radwaste building floor drain sumps system, and

H. Turbine building floor drain sumps system.

Any dissolved radioactive gases will come to equilibrium between the liquid and compartment atmosphere and provide the source of any radioactivity in the ventilation systems during normal plant operation.

11.1.8 Sources Not Normally Part of the Radioactive Waste Management Systems

There are four site release points for gaseous effluent: the Unit 2 and 3 ventilation chimney, the Unit 1 chimney, the reactor building ventilation stack, and chemical cleaning building ventilation stack. There are no release points for gaseous effluent that are not a part of the radioactive waste management system.[11]

There is one site release point for liquid Potentially Radioactive and Radioactive effluent, which is the condenser cooling water discharge canal. There are no release points for liquid Potentially Radioactive and Radioactive effluent that are not a part of the radioactive waste management system. Radiation monitors are located for each line that discharges to the condenser cooling water discharge canal: Unit 2/3 liquid radwaste discharge line; Unit 2 service cooling water discharge line; and Unit 3 service cooling water discharge line.[11]

Radiation monitors are designed to continuously monitor the gaseous and liquid discharge streams and alert the control room operator in case the effluent stream exceeds the predetermined level of radioactivity. Requirements for continuing liquid discharge without the radiation monitors are specified in the ODCM.

The estimated quantity of tritium in the effluent stream discharged to the environment is discussed in subsection 11.1.3.7. and Section 11.2.

There are several areas of the Turbine Building that have floor drains that are routed to the non-radioactive wastewater processing systems. These areas include the Diesel Generator Rooms, Stator Cooling Rooms, Stator Cooling Area, EHC Skids, Feedwater Regulating Valve Area and the Trackways. Periodic sampling of the non-radioactive wastewater processing system effluent will detect intrusion of radioactive liquids from these floor drains.

released to the discharge canal. Evaporators, demineralizers, filters or a portable waste treatment system may be utilized to remove contaminants.

Liquid radwaste is divided into three categories:

A. Low conductivity;

B. Moderate conductivity; or

C. High conductivity.

The four systems utilized to process the liquid radwaste are, respectively:

A. Equipment drain system;

B. Floor drain system ; or

C. Maximum recycle system (which is part of the floor drain system).

D. Portable waste treatment system;

Filter sludges and spent resins are treated as solid radwaste - decanted, placed in appropriate containers, and dewatered or solidified. This is described in Section 11.4.

Overall control of the radwaste system is exercised from a local control room situated in the radwaste building. A main panel in this room contains the instruments, controls, and alarms for the operation of the system. Various radwaste system alarm signals are received in the radwaste control room.

Table 11.2-2 shows the locations and capacities of the radwaste tanks. The total allowed activity in the six tanks in the tank farm outside the radwaste building is 3 curies; the allowed activity in any one tank is 0.7 curies.

In accordance with the Systematic Evaluation Program (SEP) Topic III-4.A, the liquid radioactive waste systems and tanks in the radwaste building are adequately protected from tornado generated missiles. See Section 3.3.2.3.2 for additional discussion.

Seismic damage was evaluated for the liquid radwaste system. The tanks of radioactive waste of concern were those at grade outside the radwaste building. Assuming failure of all outside tanks and structures, the evaluation showed that the Effluent Concentration Limits (ECL) were not exceeded. Although the activities resulting from a tank failure condition that are released to the river indicate the applicability of 10 CFR 100 limits, the actual expected concentrations are sufficiently low to allow 10 CFR 20 limits to be applied (see Section 15.7.4 for details of accident considerations).

The general arrangement drawings referenced in Section 1.2 show the general building layout of various pieces of equipment comprising the liquid radwaste system. Drawings M-39 and M-369 show the reactor building equipment drains and the drywell equipment drains which are the sources of liquid radwaste collected for normal processing in the equipment drain system. Drawings M-39 and M-369 also show the floor drain system in the reactor building that collects liquid radwaste for normal processing in the floor drain system. The drywell drain systems shown in these drawings are normally routed to the equipment drain system. Drawings M-40 and M-370 show the turbine building equipment drain system which collects liquid radwaste from the turbine building area for treatment in the equipment drain system. Drawings M-40 and M-370 also show the turbine building floor drain system which collects liquid radwaste for normal processing in the floor drain system. Drawing M-45, Sheets 1, 2, and 3 show the equipment drain liquid radwaste process piping, tanks, pumps, and instrumentation. Drawing M-44 shows the floor drain liquid radwaste processing system piping, pumps, tanks, and instrumentation. Drawing M-47, Sheet 1 shows the piping and instrumentation for the waste neutralizer tanks and pumps. Drawings M-720, Sheets 1 and 2, M-721, M-722, M-723, and M-724 show the process piping equipment and instrumentation for the maximum recycle system. These drawings also show the interfaces between this system and other liquid radwaste systems. The liquid radwaste process sampling is shown in Drawings M-178A and M-720A. Drawing M-3478 shows the liquid radwaste radiation monitor. Drawings M-3486 and M-3496 show the liquid radiation monitors for the service water systems. Figure 11.2-21 (Offsite Dose Calculation Manual [ODCM] Figure 10-3) shows a simplified liquid radwaste processing diagram and also shows the liquid radwaste discharge points leading to the river.

Cross-connection of the equipment and floor drain systems allows processing of wastes in various modes depending upon the water quality and/or equipment availability.

The liquid radwaste system is piped such that transfer of liquid wastes can be made directly from Dresden Unit 1 to Dresden Unit 2/3 radwaste system. Dresden Unit 1 is in a safe storage (SAFSTOR) condition, although some portions of the Unit 1 radioactive waste system remain operable.

11.2.2.1 Process Description

11.2.2.1.1 Equipment Drain System

Input for the equipment drain system, also known as the waste collector system, includes seal leakage from pump and valve glands which is collected in equipment drain sumps in the drywells, reactor building, and turbine building (Drawings M-39, M-40, M-369,and M-370). The wastes handled by this system typically have a low conductivity (on the order of 10 μmho or less) and a low-solids content, but may have a low or high activity.

Where appropriate, sources of waste water are provided with heat exchangers and/or multiple sumps and sump pumps. The drywell equipment drain sump, for example, has a heat exchanger which operates intermittently, and one sump, which has two sump pumps. The drywell floor drain sump also has two sump pumps. The drywell floor drain sump is normally pumped to the radwaste waste collector tank. During a refueling outage it may be aligned to the floor drain collection tank. Also during normal operation the drywell floor drain sump may be aligned to the floor drain collection tank, depending on the water conductivity. The reactor building equipment drain tanks, drywell equipment drain sump, and the drywell floor drain sump are prevented from automatic pumping of the sump and/or tank contents to the radwaste waste collector tank during an accident. This is discussed further in Section 11.2.3.4.

In the processing (Drawing M-45, Sheets 1, 2, and 3) of the liquid radwaste from the equipment drain system, the normal process path for the low-conductivity wastes are as follows. These low-conductivity wastes are collected in the waste collector tank. The waste is pumped through a filter and then to the demineralizer unit. The normal process flow is to the waste sample tanks where the processed water is sampled. If the processed liquid radwaste in the waste sample tank meets certain specifications (typical criteria are listed in Table 11.2-3), the processed water is pumped to the condensate storage tanks. Dependent upon the station water inventory, the water may be discharged to the river through the discharge canal. In the flow path for discharge to the river, the water from the waste sample tanks or floor drain sample tanks can be transferred to the waste surge tank for discharge to the river. Water processed into the floor drain sample tanks can be discharged directly to the river if required. Other processing flow paths exist in this processing system and are addressed in Section 11.2.2.4.

11.2.2.1.2 Floor Drain System

Input for the floor drain system (shown in Drawing M-44) includes water from the floor drain sumps in the reactor buildings, turbine building, and radwaste building, the maximum recycle drains and vents, and the heating boiler (Drawings M-39, M-40, M-369, and M-370). The wastes handled by this system are those having a higher conductivity than the water in the equipment drain system.

The liquid radwaste collected in the floor drain collector tank is transferred into the waste neutralizer tanks, which are sampled and batched to the maximum recycle neutralizer tanks, and then processed through the maximum recycle system to remove as much radioactive contamination as possible. The liquid from the floor drain collector tank can also be transferred to the floor drain surge tank or to the floor drain neutralizer tanks for processing through the maximum recycle system.

Drywell floor drains are routed to the equipment drain system because that waste is expected to have a low conductivity (leakage from reactor coolant system), and this routing removes a potential source of activity from the floor drain system.

Sample sink drains are segregated to minimize activity input to the floor drain system. The sample system is addressed in Subsection 11.2.2.6.

Curbs are placed around certain equipment drain sumps to prevent activity and high conductivity from entering these sumps in the event of floor drain sump overflow.

Input to the floor drain system collected in the floor drain collector tank (in the radwaste building basement) are those liquid wastes having a higher conductivity than the wastes in the equipment drain system. These liquid wastes are processed through the maximum recycle system.

11.2.2.1.3 Maximum Recycle System

The maximum recycle system (Drawings M-720, Sheets 1 and 2, M-721, M-722, M-723, and M-724) consists of two identical trains of components. Normally one train is used at a time, and the other is in standby. The maximum recycle trains can be used in parallel. The maximum recycle demineralizers can be operated in series as well as in parallel.

Waste water to be processed by the maximum recycle system is sampled and the pH adjusted if necessary. The solids or sludge, commonly called concentrated waste, are solidified or further processed as solid radwaste by contract services (Section 11.4). The distillate is demineralized if required and then sent to a sample tank. After being sent to a floor drain sample tank or waste sample tank for sampling, the water may be reused as condensate, or it may be discharged to the river by way of the floor drain sample tanks or waste surge tank, processed through the waste filter and demineralizer, or recycled for further distillation/demineralization.

Heat for the maximum recycle concentrators is supplied by steam from one of the three closed loop reboilers. The maximum recycle reboilers are shell and tube heat exchangers which are heated by steam from the nuclear steam supply system. The radwaste reboiler is also a shell and tube heat exchanger which is heated by steam from the auxiliary heating steam boiler.

11.2.2.1.4 Waste Concentrator System

The waste concentrator system, excluding the closed loop radioactive waste reboiler system, has been partly removed and partly abandoned in-place. Although this system was a part of the initial licensing basis of the plant, liquid radwaste treatment methods have been improved such that this system is no longer efficient in treating the waste for discharge and/or solidification for shipment for burial.

11.2.2.1.5. Portable Waste Treatment System

System taps are provided to allow connection to portable waste treatment systems that are capable of processing liquid radwaste. A portable waste treatment system is any system that enables efficient processing of liquid radwaste. Portable waste treatment systems can either be connected to plant installed radwaste equipment to augment processing capabilities or may be self contained, skid mounted equipment, capable of all liquid radwaste processing needs and requirements.

Processed liquid radwaste is discharged to radwaste system tanks or from portable waste treatment system tanks to the radwaste system discharge line to the cooling water discharge canal.

11.2.2.2 Description of Major Components

The components addressed in this subsection comprise the liquid radioactive waste systems described in Subsection 11.2.2.1.

11.2.2.2.1 Waste Collector Tank

The waste collector tank (2001-461) provides a storage volume of 33,000 gallons for liquid radioactive waste. The waste collector tank is a closed tank. Input to the tank comes from the sources (shown in Table 11.2-4) which are considered low-conductivity sources.

11.2.2.2.5 Waste Surge Tank

The waste surge tank (2001-463) is used for liquid radioactive waste discharge from the station to the river, or the water may be reprocessed. Excess low-conductivity water can also be stored in the water surge tank temporarily until it can be processed through the waste filter and waste demineralizer to the waste sample tanks. Normally the waste surge tank contents are processed through filters and demineralizers to the waste sample tanks and to storage in the condensate storage tanks however, if the total organic carbon content is high, or condensate storage tank is not available, the contents may be discharged to the river or reprocessed. Inputs to waste surge tank are from the following sources:

A. The floor drain sample tanks and

B. The waste sample tanks.

The 77,000-gallon capacity tank is normally the single source for discharge of liquid radioactive waste, however floor drain sample tanks or portable waste treatment system tanks can also be discharged, if required.

11.2.2.2.6 Waste Surge Tank Pump

The waste surge tank pump (2011) transfers the liquid waste either to the waste collection system for further processing or to the discharge canal to the river. The pump can also transfer the waste surge tank contents to the Unit 1 radwaste storage, to the "B" waste neutralizer tank, and to the maximum recycle system. The waste surge tank pump is also used to recirculate the waste surge tank contents for mixing. The pump capacity is 400 gal/min.

11.2.2.2.7 Waste Sample Tanks

The waste sample tanks (2001-468A, 2001-468B, and 2001-468C) collect the processed liquid radioactive waste from either the waste collector system or the floor drain system. The three tanks have a capacity of 33,000 gallons each. The redundancy allows one tank to be isolated for sampling and pumping of the liquid waste while the other tanks are available to receive processed liquid effluent. The waste sample tank contents are normally transferred to the condensate storage tanks. The tank contents can be transferred to the floor drain surge tank if required.

11.2.2.2.8 Waste Sample Tank Pumps

The waste sample tank pumps (2001-80A, 2001-80B, and 2001-80C) recirculate the tank contents for mixing prior to sampling and then transfer the processed liquid contents of the waste sample tanks to any of the following places:

11.2.2.2.11 Floor Drain Filter

The floor drain filter was provided to remove fine particulate from the liquid radwaste stream, however this filter is no longer used. The equipment is bypassed.

11.2.2.2.12 Floor Drain Sample Tanks

The floor drain sample tanks (2001-484A and 2001-484B) collect the processed liquid radioactive waste from the maximum recycle system. The floor drain sample tanks have a capacity of 22,000 gallons each. The redundancy allows one tank to be isolated for sampling and pumping of the liquid waste while the other tank is available to receive processed liquid effluent. The contents of these tanks may be transferred to the condensate storage tank, reprocessed for additional cleanup, or discharged to the river as needed.

11.2.2.2.13 Floor Drain Sample Tank Pumps

The floor drain sample tank pumps (2016A and 2016B) recirculate the tank contents for mixing prior to sampling and then transfer the processed liquid contents from the floor drain sample tanks to any of the following places:

A. The maximum recycle floor drain neutralizer tanks;

B. The "B" waste neutralizer tank;

C. The waste collector tank;

D. The waste surge tank;

E. The floor drain surge tank;

F. The condensate storage tanks; and

11.2.2.2.14 Waste Neutralizer Tanks

The waste neutralizer tanks (2001-473A and 2001-473B) provide a 16,500-gallon capacity each for the storage, sampling, and processing of floor drain liquid wastes. Input to the waste neutralizer tanks are from the following sources:

A. Floor drain sample tanks;

B. Cask washdown;

C. Detergent drain from main turbine floor decontamination pit;

D. Floor drain collector tank/waste neutralizer tank A header;

E. Waste demineralizer area;

F. Unit 2 mechanical vacuum pump;

G. Unit 3 mechanical vacuum pump;

H. Drain from the 613' decontamination pit; and

I. Unit 1 radioactive waste system.

J. SBGT loop seal drains;

The redundancy allows one tank to be isolated for sampling and pumping of the neutralized liquid waste while the other tank is available to receive high- conductivity waste for neutralization.

11.2.2.2.15 Waste Neutralizer Pumps

The waste neutralizer pumps (2019A and 2019B) provide the following functions:

A. Recirculation of the tank liquid contents for mixing;

B. Transfer tank contents between the waste neutralizer tanks;

C. Transfer the tank contents to the maximum recycle floor drain neutralizer tanks;

D. Transfer the tank contents through the floor drain filter to the floor drain sample tanks;

E. Transfer the tank contents to the floor drain surge tank; and

F. Provide redundant pump capability in the event that one of the pumps is not available.

The design capacity of these waste neutralizer pumps is 400 gal/min with a design temperature of 200°F and a design pressure of 150 psig. These pumps are provided with seal water to minimize maintenance and replacement of these pumps seals due to wear from the chemical solutions.

11.2.2.2.16 Floor Drain Surge Tank

The floor drain surge tank (2/3-2012-359) provides the necessary surge volume (200,000 gallons) for the floor drain system. The tank is located outside the Unit 3 turbine building near the southwest corner. The tank is equipped with electric heaters to prevent freezing during cold weather. The tank bottom is sloped to reduce sludge buildup. The floor drain surge tank is considered a Class I Structure and is, therefore, not considered an above-ground tank for the purpose of the curies content requirements of the Technical Specifications. The following sources provide input to the floor drain surge tank:

11.2.2.2.24 Maximum Recycle Concentrator Vapor Heads

The maximum recycle concentrator vapor heads (2/3-2012-412A and 2/3-2012-412B) receive the radioactive liquid waste pumped from the floor drain neutralizer tanks. The maximum recycle concentrator is a stainless steel vessel which operates at atmospheric pressure. The vapor head which has a demisting pad contains the boiling liquid waste. The vapor exists the vessel at the top after passing through the demisting pad. The liquid is recirculated by a pump through a heat exchanger and returned to the vapor head vessel.

11.2.2.2.25 Maximum Recycle Concentrator Recirculation Pumps

The maximum recycle concentrator recirculation pumps (2/3-2012-413A and 2/3-2012-413B) circulate the liquid from the bottom of the concentrator vapor head through a heat exchanger and back to the bottom of the concentrator vapor head. The pump flowrate is approximately 11,500 gal/min so that a low differential fluid temperature is maintained to minimize fouling of the heat exchanger tubes.

11.2.2.2.26 Maximum Recycle Concentrator Heaters

The maximum recycle concentrator heaters (2/3-2012-419A and 2/3-2012-419B) heat the liquid radwaste circulated from the bottom of the concentrator vapor head. The normal operating temperature for the concentrator heaters is the boiling point of the liquid waste which is approximately 212°F. Steam heating for these shell and tube heat exchangers is provided by the maximum recycle reboilers and the radwaste reboiler.

11.2.2.2.27 Maximum Recycle Concentrated Waste Transfer Tanks

The maximum recycle concentrated waste transfer tanks (2/3-2012-416A and 2/3-2012-416B) collect the concentrated liquid waste from the maximum recycle concentrator system The liquid waste from the transfer tank may be recycled to the maximum recycle floor drain neutralizer tanks or the concentrated waste may be transferred to the concentrated waste tank.

11.2.2.2.28 Maximum Recycle Concentrator Condensers

The maximum recycle concentrator condensers (2/3-2012-414A and 2/3-2012-414B) condense the water vapor from the concentrator vapor head. The concentrator condensers are shell and tube heat exchangers cooled by the service water system. The condensed liquid (condensate) drains by gravity flow to the distillate tanks.

11.2.2.2.34 Floor Drain Demineralizers

The floor drain demineralizers (2/3-2012-418A and 2/3-2012-418B) are typically mixed deep bed (H-OH) polishing type resin. When the resins are depleted they are normally transferred to the spent resin tank for disposal of radioactive waste. Flow through the resin bed is 200 gal/min to ensure proper ion exchange. The liquid flow from the system is about 25 gal/min with a recirculation flow of about 175 gal/min back to the liquid feed tank from the demineralizer outlet.

11.2.2.2.35 Discharge Flow to the Discharge Canal

The tank contents to be discharged are sampled and must have a minimal radioactivity content so that the calculated discharge flowrate is greater than the pump capacity with dilution flow from the main condenser circulating water flow to the discharge canal. An effluent radiation monitor is located off-stream to warn of high-activity water being discharged. Requirements for continuing liquid discharge without the effluent radiation monitor are specified in the ODCM.

11.2.2.2.36 Discharge Line to the Discharge Canal

The discharge line (2/3-2019-3"L) outside the restricted area is fiberglass- reinforced, epoxy resin pipe.

11.2.2.2.37 Liquid Radwaste System Piping

A major upgrade of the radwaste system piping (about 7000 feet) replaced approximately 2500 feet of piping and permanently removed approximately 1500 feet of piping. About 3000 feet of the piping remains in place. The replacement piping, fittings, and valves are stainless steel. The original piping is carbon steel.

11.2.2.3 Redundancy of Major Equipment

Redundancy of the major pieces of equipment discussed in Section 11.2.2.2 facilitates operation of the systems while a pump is down for maintenance; a filter is being backwashed; or an ion-exchange resin is being cleaned or sluiced to the spent resin tank. The redundancy in tanks provides for an available process tank while the contents of one tank are being recirculated, sampled, or transferred.

11.2.2.4 Alternate Process Pathways

There are several process pathways within the liquid radwaste system. The normal flow path for liquids collected in the waste collector tank is through the waste sample tanks to condensate storage. An alternate pathway exists for the waste sample tanks to be transferred to the waste surge tank. The floor drain collector tank flow pathway is through the maximum recycle process system to the floor drain sample tanks that transfer liquid to the waste collector tank. An alternate processing pathway exists such that the floor drain sample tank contents can be transferred to the waste surge tank through the waste collector tank and waste collector processing system.

11.2.2.5 Instrumentation and Control

The system is instrumented with temperature, pressure, and flow indicators. There are differential pressure transmitters across such equipment as the demineralizers and the filters. The high differential pressure alarms in the radwaste control room. There are temperature, pressure, and flow recorders located in the radwaste control room. Tank level indicators transmit the tank level indication to the radwaste control room where a high-level alarm sounds at a preset value to minimize tank overflow. The tank high-level alarms also annunciate in the main control room.

11.2.2.6 Process Monitoring and Sampling

The liquid radwaste system has a radiation monitoring and sampling station for the discharged effluent. This system is discussed in Section 11.2.3.

The liquid radwaste process sampling system is provided in three parts (see Drawing M-178A):

A. The radwaste sample sink;

B. The maximum recycle sample sink; and

C. The maximum recycle demineralizer sample sink.

The sample sources for the radwaste sample sink are listed in Table 11.2-6.

These sample points provide means at a centralized location to obtain liquid grab samples for radioisotopic analysis in the chemical laboratory. In addition to these liquid sample points, seven conductivity cells are located in the radwaste sample sink cabinet. The conductivity cells monitor the liquid conductivity for the following streams:

A. Waste sample tank pump "A" recirculation (range 0 to 10 μmho);

B. Waste sample tank pump "B" recirculation (range 0 to 10 μmho);

C. Waste sample tank pump "C" recirculation (range 0 to 10 μmho);

D. Floor drain collector tank pump discharge (range 0 to 500 μmho);

E. Waste collector pump discharge (range 0 to 100 μmho);

demineralizers, and other equipment within the radwaste building are contained within rooms so that leakage is contained within the building.

All Potentially Radioactive and Radioactive liquid waste discharges to the environment are routed through a single line to the discharge canal. This line has flowmeters, an offline radiation monitor, and double valves which are kept locked closed except when in use. The normal flow of liquid waste to the river is from the waste surge tank. The floor drain sample tank(s) or portable waste treatment system tank(s) can be discharged if necessary. Locked closed valves (2/3-2001-91, 2/3-2018A-504, and 2/3-2018B-501) prevent transfer to the discharge canal when transferring waste sample tank contents and floor drain sample tank contents to the waste surge tank. Procedurally, the waste surge tank must be sampled, analyzed, and a discharge rate determined prior to allowing discharge to the canal. The discharge procedure also requires the valve lineup for discharge to be independently verified and the discharge rate calculation to be independently verified. Once a transfer is initiated, the operator checks the flowmeter, the effluent radiation monitor, and the level recorder for the waste surge tank. Thus, the operator has a number of means of confirming the correct routing.

The only error that could cause inadvertent waste discharge from the radioactive waste management system to the canal would be leaving the canal discharge valves open so subsequent tank filling could result in flow to the canal. Most tank contents transferred to the waste surge tank are to be discharged. In the highly unlikely event that the canal discharge valves were left open so that a subsequent tank filling resulted in flow to the canal, no effluent concentration limit (ECL) should be exceeded.

It should be noted that procedural controls require the discharge valves to be locked closed at the end of a discharge. Also the discharge valves must be verified locked closed when transferring a tank of liquid to the waste surge tank.

11.2.2.9 Leakage Detection Systems

Provisions are made in the design of the station to detect leakage from vital fluid carrying systems at and beyond the reactor coolant pressure boundary. These leakage detection methods are discussed in detail in Section 5.2.

11.2.2.10 Ultrasonic Resin Cleaners

The ultrasonic resin cleaner is a device for cleaning the ion-exchange resins in the deep bed condensate treatment system. An ultrasonic resin cleaner (URC) is installed in the Unit 2 condensate demineralizer system. Both Unit 2 and Unit 3 condensate demineralizer systems are cross-connected to permit the Unit 2 URC to service either unit. The Unit 3 URC has been removed from the plant and will be replaced with a new resin cleaner at a later date. The accumulated crud (principally iron oxides) is removed as a thin water slurry to the waste collector subsystem of radwaste.

11.2.3 Radioactive Releases

11.2.3.1 Release Concentrations

Activity released with the liquid wastes is difficult to characterize since liquid wastes come from a number of sources and the quantity of activity is a strong function of plant operation, including holdup time. The total amount of activity and the relative quantities of each isotope will vary significantly from day to day with varying power levels and leakage from fuel elements.

Table 11.2-7 shows the typical isotopic content which may be present in the radioactive liquid waste discharged to the river. Table 11.2-8 shows the typical tritium content in the liquid waste discharged from the station. Table 11.2-9 shows the typical isotopic content discharged in the containment cooling service water.[1-10]

When discharged to the river, the liquid radioactive wastes from Units 1, 2 and 3 are diluted in the condenser cooling water discharge canal. This dilution of the liquid radioactive wastes lowers the concentration at the time of discharge to a level which is in accord with the limits prescribed by 10 CFR 20 and State of Illinois regulations. The expected average annual activity discharge is significantly less than that permissible under 10 CFR 20. Since this estimate assumes that the activity discharged consists only of radioisotopes Sr-90 and Pb-210, the estimate overstates the actual contribution to the environment radioactivity.

Since additional dilution of wastes by the normal river flow further reduces radioactivity, concentrations of waste activity actually in the river are of the order of one-hundredth of the ECL per 10 CFR 20 for the mixtures generally discharged.

On the basis that the tritium activity in the liquid waste originates in the reactor and is essentially associated with the water molecule, tritium concentrations in liquid wastes will be about the same as in reactor water. Because of the infrequent need to discharge wastes to the river, and the large dilution factor which results in a tritium concentration several orders of magnitude below the ECL, the radiological consequences of tritium activity in the liquid wastes are nil.

11.2.3.2 Effluent Monitoring and Sampling

The radwaste discharge monitor is an offline sampling type monitor (see Drawing M-347B). When a discharge occurs, the radwaste operator valves-in the monitor and energizes the instrumentation. The water sample is taken from the discharge to river line and is fed through the process detector, a grab sample valve, and into a receiver tank. Failure by any of several means provides audible annunciation in the radwaste control room. The high-activity alarm annunciates in both the radwaste control room and the main control room. The monitor is addressed in more detail in Section 11.5.

The liquid contents of the waste surge tank, floor drain sample tank or portable waste treatment system tank are sampled and analyzed before being discharged to the river. The discharge rate is determined based on the chemical analysis and the dilution flow in the discharge canal. If the radiation monitor high-radiation alarm sounds, an automatic sample is taken in the monitor cabinet for chemical analysis by the laboratory.

The service water system discharge stream for both Unit 2 and Unit 3 is monitored for radioactivity and is sampled for chemical analysis periodically as required by the ODCM (see Drawings M-3486 and M-3496).

11.2.3.3 Liquid Waste Release Points

There are three liquid Potentially Radioactive and Radioactive waste release points from the station to the discharge canal. The following release points (see Figure 11.2-21) are shown in the ODCM:[11]

A. The Unit 2/3 liquid radwaste discharge point;

B. The Unit 2 service water system discharge point; and

C. The Unit 3 service water system discharge point.

The typical isotopic quantities of activity found in these streams are given in Tables 11.2-7 and 11.2-9.

There are radiation monitors on each of these three discharge streams.

11.2.3.4 Liquid Waste Discharge from Containment During Accident Conditions

Following the Three Mile Island accident, the NRC requested that each licensee evaluate the possibility of an inadvertent transfer of potentially highly radioactive liquids from inside containment to the liquid radwaste area. The evaluation was conducted and the appropriate modifications were completed.

Plant design ensures that highly radioactive fluids are confined to the reactor building during a loss-of-coolant accident. Transfer of radioactive water from the following systems and components is prevented during an accident:

A. Reactor building equipment drain tank (RBEDT) pump;

B. East reactor building floor drain sump (RBFDS) pump;

C. West reactor building floor drain sump (RBFDS) pump;

D. Southeast core spray/LPCI corner room sump pump;

E. Southwest core spray/LPCI corner room sump pump;

F. High pressure coolant injection (HPCI) room sump pump;

G. Drywell equipment drain sump; and

H. Drywell floor drain sump.

The RBEDT and RBFDS pumps trip upon a receipt of a Group II primary containment isolation (PCI) signal and do not automatically restart after a Group II PCI is reset. Since the emergency core cooling system (ECCS) room sumps (Items D, E, and F above) are required to be operational during a Group II PCI condition, they are not tripped. The ECCS corner room sump pump discharges are routed to the RBFDSs to confine radioactive fluids to the reactor building while these ECCS sump pumps are operable. A PCI Group II signal bypass is provided so that the RBEDT pump and valves can be operated in both the discharge and recirculation modes with the PCI Group II signal still present, i.e., a separate PCI group reset is provided for the RBEDT system. A control room control switch and an annunciator is provided for each of the RBEDT, east RBFDS, and west RBFDS pumps and for the RBEDT recirculation and discharge valves.

Table 11.2-4

INPUTS TO THE WASTE COLLECTOR TANK

A. The cleanup demineralizers;

B. The pressurized drain pumps;

C. Unit 2 ultrasonic resin cleaner;

D. Unit 2 turbine building equipment drain sumps and pumps;

E. Unit 2 reactor building equipment drain tanks and pumps;

F. Unit 2 drywell floor drain sumps and pumps;

G. Unit 2 reactor building floor drain sumps and pumps;

H. Unit 2 drywell equipment drain sumps and pumps;

I. Unit 2 drywell equipment drain sump heat exchangers;

J. Unit 2 condensate demineralizer system;

K. Unit 3 condensate demineralizer system;

L. Unit 2 condensate demineralizer equipment relief valve discharge;

M. Unit 3 condensate demineralizer equipment relief valve discharge;

N. Unit 3 turbine building equipment drain sumps and pumps;

O. Unit 3 reactor building equipment drain tanks and pumps;

P. Unit 3 drywell equipment drain sumps and pumps;

Q. Unit 3 drywell floor drain sumps and pumps;

R. Unit 3 reactor building floor drain sumps and pumps;

S. Unit 3 drywell equipment drain sump heat exchangers;

T. Unit 3 recycle drain;

U. Unit 3 fuel pool heat exchanger;

V. Unit 2 fuel pool heat exchanger;

W. The waste demineralizer;

Table 11.2-5

INPUT TO THE FLOOR DRAIN COLLECTOR TANK

A. Waste collection tank/floor drain collection tank south header;

B. Waste collection tank/floor drain collection tank north header;

C. Unit 3 turbine building floor drain sump;

D. Unit 3 drywell floor drain sumps and pumps;

E. Unit 3 reactor building floor drain sumps and pumps;

F. Unit 2 turbine building floor drain sump;

G. Unit 2 drywell floor drain sumps and pumps;

H. Unit 2 reactor building floor drain sumps and pumps;

I. Surge tank transfer pumphouse sump;

J. Floor drain filter sludge tank;

K. Waste filter sludge tank and resin cleaner sludge tank;

L. Off-gas filter house floor drain sump;

M. Sample system sinks;

N. Floor drain demineralizers;

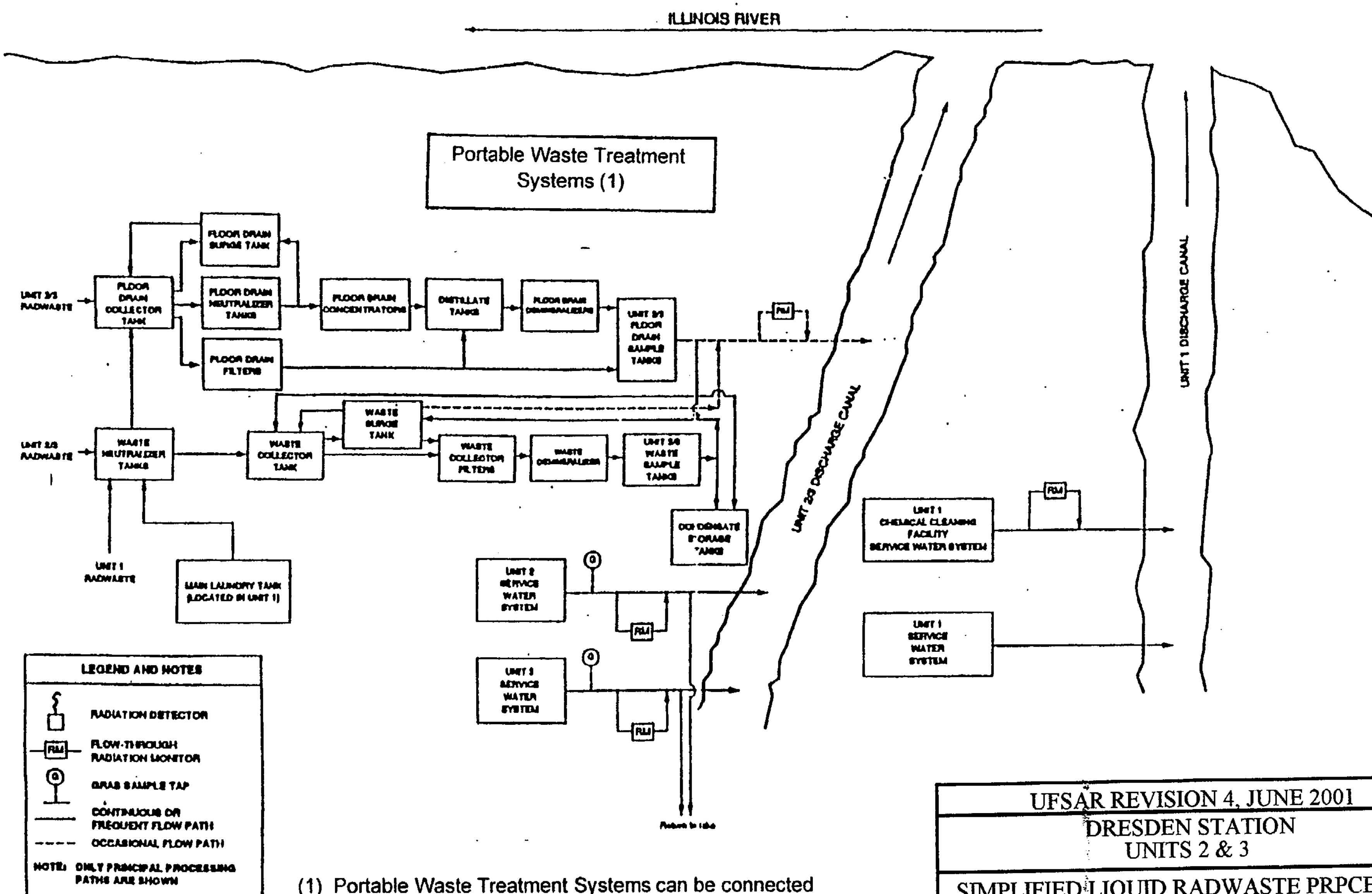
O. Radwaste floor drain sump and pump A;

P. Radwaste floor drain sump and pump B; and

Q. Turbine building floor drain.

R. Unit 2 Turbine Building Equipment Drain Sump and Pumps (see section 9.3.3.5)

S. Unit 3 Turbine Building Equipment Drain Sump and Pumps (see section 9.3.3.5)



(1) Portable Waste Treatment Systems can be connected at various locations within the Radwaste System.

UFSAR REVISION 4, JUNE 2001

DRESDEN STATION
UNITS 2 & 3

SIMPLIFIED LIQUID RADWASTE PRPCESSING AND LIQUID EFFLUENT FLOW DIAGRAM

FIGURE 11.2-21