Table of Contents

List of Tables

List of Figures

9.0 Auxiliary Systems

THIS IS THE LAST PAGE OF THE TEXT SECTION 9.0.

THIS PAGE LEFT BLANK INTENTIONALLY.

9.1 Fuel Storage and Handling

9.1.1 New Fuel Storage

9.1.1.1 Design Bases

New fuel for each unit is stored dry in racks (Figure 9-1) which are bolted to the floor of the New Fuel Storage Buildings. The new fuel racks are designed to accommodate 98 fuel assemblies for each unit at a nominal center-to-center spacing of 21 inches. Storage cells are formed by 1/8 inch nominal thickness, minimum cell wall thickness 0.12 inches, type 304 stainless steel that completely encloses the fuel on four sides, whereas the supporting racks are fabricated from painted carbon steel conforming to AISC tolerances and specifications.

The nominal fuel cell interior dimension is nine inches square with all interior edges finished to a minimum 1/16 inch radius of chamfer. If chamferred, all intersecting edges are blended. All interior surfaces which may come in contact with the fuel assemblies are smooth and clean of all weld spatter, dirt, and grease. Design conditions that could cause hang-up during insertion or withdrawal of fuel assemblies have been avoided.

The new fuel racks are designed to withstand normal operating loads as well as SSE seismic loads meeting ANS Safety Class 3 and AISC requirements.

Note:

This section of the FSAR contains information on the design bases and design criteria of this system/structure. Additional information that may assist the reader in understanding the system is contained in the design basis document (DBD) for this system/structure.

The new fuel storage racks are located in the New Fuel Storage Buildings which protect the racks from weather conditions and external forces such as those resulting from tornado or wind loads.

The minimal nominal center-to-center spacing of 21 inches is sufficient to meet the criticality criteria of ANSI N18.2-1973 under the postulated conditions of complete flooding with unborated water or an optimum moderator. The racks are designed to prevent the insertion of fuel between the storage positions.

The criticality analysis of the new fuel storage racks is discussed in Section 9.1.1.3.

9.1.1.2 Facilities Description

Each unit of the Catawba Station has an independent new fuel storage system. The New Fuel Storage Buildings are Seismic Category I, reinforced concrete structures, (Figure 9-2). The structures are designed to withstand static and SSE seismic loads as well as tornado winds and tornado generated missile impact loads. The New Fuel Storage Racks are contained entirely within the structure and further segregated from other equipment and operations by a reinforced concrete wall.

9.1.1.3 Safety Evaluation

The calculated values of K_{eff} for the storage arrays, including the effects of calculational and geometrical uncertainties, are less than those required by ANSI N210-1976, "Design Objectives for Light Water Reactor Spent Fuel Storage Facilities at Nuclear Power Stations" Sections 5.1.12.1 and 5.1.12.2 when a full loading of the low-enriched uranium (LEU) fuel assemblies described in Chapter 4 is considered. The computer codes and techniques utilized in the analysis have been validated against experimental data for water moderated UO_2 lattices with characteristics similar to the fuel analyzed. The computer codes and techniques utilized in the analysis are further described in Section 4.3.2.6.

In the analysis, the new fuel assemblies are assumed to be in their most reactive condition, namely unirradiated with 5.05 wt. percent enrichment U-235 and no control rods or supplemental neutron poisons present. The worst case enrichment assumption allows for a specified maximum nominal enrichment of 5.0 w/o U-235 with an enrichment tolerance of ≤ ± 0.05 w/o U-235. All parameters are chosen to maximize K_{eff}, and the effects of reflectors other than water are included if their neglect would have been non-conservative.

The design of normally dry new fuel storage racks is such that the effective multiplication factor does not exceed 0.98 with fuel of the highest anticipated enrichment in place, assuming optimum moderation (under dry, fogged, or flooded conditions). For the fully flooded condition assuming cold, clean, unborated water, the value of K_{eff} is less than or equal to 0.95. Credit is taken for the inherent neutron-absorbing effect of the materials of construction.

The calculated worst case k_{eff}s for a fuel assembly with the maximum enrichment of 5.05 wt. percent U-235 under fully flooded and optimum moderation conditions in the Catawba new fuel vault are as follows.

Optimum Moderation	k_{eff}=0.9324
Fully Flooded	k_{eff}=0.92688

These values were calculated for the most reactive fresh fuel design in the Catawba new fuel storage vault, of all LEU fuel types stored at Catawba. These values also include geometrical and material biases and uncertainties at a 95 percent probability and a 95 percent confidence level as required to demonstrate criticality safety. Fuel cage tolerances are included in the geometrical uncertainty.

Since each unit has its own independent New Fuel Storage Facility and related racks, there are no safety considerations related to sharing of components.

Analysis and design of the New Fuel Storage Buildings and new fuel storage racks are performed as stated in Section 3.8.4. Details of the seismic analysis and design are provided in Section 3.7.Governing codes are designed as stated in Table 3-32.

9.1.2 Spent Fuel Storage

9.1.2.1 Design Bases

Conformance with Regulatory Guide 1.13, "Fuel Storage Facility Design Basis" is as follows:

1. Regulatory Position 1

   The spent fuel storage facility including the spent fuel storage racks and the spent fuel pool liner plate, as part of the Auxiliary Building, is analyzed and designed as a Category I structure (see Table 3-1). For details of the loading conditions and loading combinations of the spent fuel pool, refer to Table 3-32.

2. Regulatory Position 2

   a. Tornado winds are discussed in Section 3.3.2 and tornado missiles in Section 3.5.1.4.

b. The spent fuel pool superstructure and the New Fuel Building together provide protection from normal and tornado winds, and prevent tornado generated missiles from contacting fuel within the pool.

3. Regulatory Position 3

   See Sections 9.1.4.2.3, under Fuel Handling Cask Crane, and 9.1.4.3.1, for a discussion of Position 3.

4. Regulatory Position 4

   Refer to the response above for position 1 for a discussion of the type of building enclosing the fuel pool. For a discussion of the ventilation and filtration system, see Sections 9.4.2.2, 9.4.3 (paragraph 2), and 5.4.5.

5. Regulatory Position 5

   a. Refer to the above response to Position 3.

   b. Refer to the above response to Position 3.

   c. The cask storage area can be segregated from the fuel storage area by a water-tight gate if a dropped cask should cause leakage in the cask area.

6. Regulatory Position 6

   See Section 9.1.3.2, paragraph 2, for a discussion of Position 6.

7. Regulatory Position 7

   For a discussion of instrumentation which monitors full storage pool water level see Section 9.1.3.2. See Section 11.5.1 for a discussion of instrumentation which monitors radiation level in the spent fuel pool area.

8. Regulatory Position 8

   See Section 9.1.3.3 for a discussion of Position 8. Consideration of the fuel pool leakage rate is discussed in Section 3.8.4.1.1.b "Spent Fuel Buildings" and Section 9.1.3.1.4.

   Quantity of fuel to be stored is discussed in Section 9.1.2.2; shielding requirements are discussed in Section 9.1.4. Design Loads are discussed in Section 9.1.2.3.

9.1.2.2 Facility Description

Each unit of the Catawba Station has an independent spent fuel storage system. The Fuel Handling System associated with the pool is discussed in Section 9.1.4, and Spent Fuel Cooling System is presented in Section 9.1.3. Radiation shielding and monitoring are presented in Sections 12.1 and 11.3, respectively. There are sufficient fuel storage racks to accommodate the number of fuel assemblies discharged from approximately 19 normal Catawba refueling cycles plus one complete Catawba core. Provisions are also made to store control rods and burnable poison rods. The dimensions and location of the fuel pool are included on Figure 9-4 and Figure 9-5. For location of the fuel pool in the station complex see Figure 1-4 and Figure 1-5. Major components, piping, valves and instrumentation in contact with the fuel pool water are stainless steel. The fuel pools, transfer canals, and cask pits are lined with stainless steel plate. This fuel pool liner plate is designed, fabricated, and installed as a nuclear safety related, QA Condition 1 system.

The spent fuel assemblies are held in a vertical position by the spent fuel pool storage racks. The fuel assemblies are supported within the fuel storage racks by a stainless steel plate located six inches above the fuel pool floor. Openings are provided that allow coolant water to flow through the rack and up around the fuel assembly. A lead-in assembly is provided at the top of each rack to guide fuel into its proper storage location. The spent fuel is stored in canned racks (Figure 9-5). The storage cell is formed by 1/4 inch nominal thickness type 304 stainless steel that completely encloses the fuel on all four sides. The nominal internal can dimension is 9 inches and the nominal center-to-center spacing is 13.5 inches. Space between storage location is blocked to prevent insertion of fuel in other than designated positions.

The fuel racks are designed as free standing, self-supporting, independent modules which stand on the fuel pool floor. There are 1421 accessible storage locations in each spent fuel pool, all of which are eligible for fuel assembly storage. Spent fuel storage rack plans and details are provided in Figure 9-9 and Figure 9-10.

9.1.2.3 Safety Evaluation

In the fuel storage racks, fuel is stored vertically in an array with a nominal center-to-center distance of 13.5 inches between assemblies to assure $K_{eff} < .95$. The racks are designed to preclude insertion of fuel assemblies at other than permitted locations, thereby assuring the necessary spacing between assemblies. To further assure subcritical arrays in the fuel handling facilities, only one assembly can be manipulated at a time and a minimum concentration of boron (per COLR) must be present in the spent fuel pool water before fuel movement may begin.

Spent fuel storage racks have been designed to prevent significant lifting forces from being applied to the racks. This is done by a design which eliminates protrusions in the racks including the elimination of projecting weld beads. In addition, tests are performed both in the shop after fabrication and in the fuel pool after installation to insure that there are no drag forces in excess of 50 pounds during removal of fuel assemblies from storage racks.

Since each unit has its own fuel pool, there are no safety considerations related to sharing of components.

To preclude the cask entering the spent fuel pool, the cask crane stops are located in a position to prevent the cask from being moved into the fuel pool area. The cask area is separated from the spent fuel pool by a three-foot reinforced concrete wall (Reference Figure 9-4 and Figure 9-5).

An evaluation has been performed to assess the possibility of the cask entering the spent fuel pool in the lifted (vertical) and tipped position. To evaluate the cask in the lifted position, the crane is assumed to impact against the crane stops traveling at the maximum crane speed of fifty feet per minute with the cask in a position to give the maximum swing and horizontal displacement.

Assuming that the cask rotates about the center of the crane drum and a rigid crane and rail stop, the cask center of gravity remains on the cask area side of the three-foot divider wall. For details of this cask position, refer to Figure 9-6. To evaluate the cask in the tipped position, the cask is assumed to catch the edge of the concrete wall of the cask area and tip toward the spent fuel pool. For this condition the maximum envelope (dimensions) are used for the possible casks to be used at Catawba. As shown in Figure 9-7, the center of gravity of the cask remains on the cask area side of the divider wall. Based upon this evaluation it is concluded that the cask would not enter the spent fuel pool due to dropping or tipping of the cask.

The consequences of a postulated drop of a weir gate onto the liner plate of the fuel pool has been evaluated. It was determined that there would be no significant deflection or deformation of the liner plate following such a drop. The integrity of the fuel pool would not be degraded following a postulated drop of a weir gate onto the liner plate.

The design of the Catawba spent fuel pool racks complies with the NRC staff position on "Minimum Requirements for Design of Spent Fuel Racks" (Appendix D to Standard Review Plan Section 3.8.4) with the following exceptions:

1. The materials used in the fabrication of the racks conform to the applicable ASTM specifications. These materials are not, however, designed or fabricated per ASME code.
2. Duke's procedure for seismic design is as discussed in Section 3.7.2.
3. Impact loads of fuel assemblies onto cell walls were not considered in the rack design. The small gap between assembly and cell, coupled with the cushioning effect provided by submergence, led to the conclusion that these impact loads are insignificant.

The fuel pool is designed to withstand the following:

1. normal dead and equipment loads plus design seismic loads,
2. all normal dead, equipment and live loads,
3. normal dead and equipment loads plus tornado wind load,
4. thermal stresses, and
5. cask drop accident

Additionally, Section 9.1.3.3 presents a safety evaluation of the Spent Fuel Cooling System explaining in detail the provisions for continuous spent fuel cooling as required by Regulatory Guide 1.13 and further clarified in ANSI N211, "Design Criteria for Spent Fuel Storage Facilities." These provisions include:

1. Redundant active components.
2. Capacity to cool the maximum amount of spent fuel based on an Oconee-McGuire-Catawba cascade of fuel with the highest heat load possible. (See Section 9.1.2.4)
3. Slow heatup rate which provides time to perform maintenance in the case of multiple component failures or moderate energy, through-wall pipe cracks.
4. Safety related, redundant makeup water supplies from the Nuclear Service Water System in addition to normal, clean makeup water supplies.
5. System connections such that the pool cannot be inadvertently drained or siphoned below the level required for shielding.

The ACI Standard 318-71, Building Code Requirements for Reinforced Concrete, and the AISC Steel Construction Manual were used for design.

The fuel racks are designed in accordance with applicable sections of the AISC specifications. All normal dead and equipment loads plus design seismic loads and thermal loads are considered. The load combinations and allowable stresses are as follows:

	Loading Combination	Allowable Stress
1.	D. L. of Rack + Weight of Fuel Assembly	0.6 Fy
2.	D. L. of Rack + Weight of Fuel Assembly + SEE	0.9 Fy
3.	D. L. of Rack + Weight of Fuel Assembly + Thermal	0.9 Fy

	Loading Combination	Allowable Stress
4.	D. L. of Rack + Weight of Fuel Assembly + Impact	0.9 Fy

The spent fuel hoist has two trip-off switches which protect a fuel assembly from excessive drag forces. The switches are set to fuel manufacturer's recommendations for overload drag (observed when raising a fuel assembly) and underload drag (observed when lowering a fuel assembly). A secondary overload trip-off switch with a higher setpoint ensures that excessive uplift forces cannot be exerted.

The heaviest object moved by the crane over the racks is a fuel assembly. The highest level above the fuel storage racks from which it could be dropped is three feet two inches through water. The environmental consequences of such an accident is discussed in Section 15.7.4.

The fuel pool and fuel racks are located in the Auxiliary Building which is a Category I structure designed to protect the fuel pool and racks from tornado missile hazards as discussed in Section 3.5. Fuel handling devices are designed with a minimum safety factor of five based upon the ultimate stress of the material. The safety factor is consistent with overhead crane and wire rope industrial standards.

Details of the seismic design and testing are presented in Sections 3.7 and 3.8.

9.1.2.3.1 Criticality Analysis

The design methodology which ensures the criticality safety of the LEU fuel assemblies in the spent fuel storage rack is discussed in Section 4.3.2.6 and in Reference 20. The design methodology ensuring criticality safety of the MOX fuel assemblies described in Section 4.3.2.1.3 is provided in Reference 17.

9.1.2.3.1.1 Neutron Multiplication Factor

Criticality of fuel assemblies in the spent fuel storage rack is prevented by the design of the rack which limits fuel assembly interaction. This is done by fixing the minimum separation between assemblies.

The design basis for preventing criticality outside the reactor is that, including uncertainties, there is a 95 percent probability at a 95 percent confidence level that the effective multiplication factor (k_{eff}) of the fuel assembly array will be less than 0.95 as recommended in ANSI/ANS-57.2-1983 and in Reference 19.

9.1.2.3.1.2 Normal Storage

Under normal storage conditions, the following assumptions were used in the criticality analysis.

1. All LEU fuel assemblies are analyzed as unirradiated (zero burnup) and at maximum allowed enrichment (5.0 wt. % U-235). The input assumptions for MOX fuel assemblies differ slightly and are further detailed in Reference 17.
2. All LEU and MOX fuel assembly designs used or stored at Catawba are explicitly analyzed. This includes the fuel assemblies described in Section 4.2. Additionally, a small number of lead test assemblies (LTAs) described in Section 4.3.2.1 are evaluated.
3. The storage cell nominal geometry is shown in Figure 9-3.
4. The moderator is pure water at the temperature within the design limits of the pool which yields the largest reactivity. No dissolved boron is included in the water for normal storage in

the spent fuel pool racks. Credit is taken for soluble boron for some conditions as described in Section 4.3.2.6.

5. All fuel storage criticality calculations are performed in 2-D, with perfect axial reflection. This is acceptable because only fresh fuel is considered in the criticality evaluation for the storage racks. It is also conservative because it ignores axial neutron leakage. In addition, the array is either infinite in the lateral extent or is surrounded by a conservatively chosen reflector, whichever is appropriate for the design.
6. Mechanical uncertainties and biases due to mechanical tolerances during construction are treated by either using "worst case" conditions or by performing sensitivity studies and obtaining appropriate values. The items included in the analysis are:
   a. Can ID
   b. Center-to-center spacing
   c. Fuel enrichment
   d. Fuel pellet density
   e. Fuel pellet OD

   Other applicable uncertainties and biases are discussed in Section 4.3.2.6.
7. No credit is taken for the assembly spacer grids.
8. No credit is taken for fuel assembly control components which can be removed (e.g. burnable poisons and control rods).
9. Credit is taken for the inherent neutron absorbing effect of some of the rack structure materials in accordance with Section 6.4.2.2.8 of ANSI/ANS-57.2-1983.

9.1.2.3.1.3 Postulated Accidents

Most accident conditions will not result in an increase in k_{eff} of the rack. Examples are loss of cooling systems (reactivity decreases with decreasing water density) and dropping a fuel assembly on top of the rack (the rack structure pertinent for criticality is not excessively deformed and the dropped assembly has more than eight inches of water separating it from the active fuel height of stored assemblies which precludes interaction).

However, accidents can be postulated which would increase reactivity. Therefore, for accident conditions, the double contingency principle of Reference 19 is applied. This states that it is not required to assume two unlikely, independent concurrent events to ensure protection against a criticality accident. Thus, for accident conditions, the presence of soluble boron in the storage pool water can be assumed as a realistic initial condition since not assuming its presence would be a second unlikely event. The presence of the required concentration of boron (per COLR) in the pool water will decrease reactivity by about 30 percent $\Delta k/k$. Thus for postulated accidents, should there be a reactivity increase, k_{eff} would be less than or equal to 0.95 due to the effect of the dissolved boron.

The "optimum moderation" accident is not a problem in the spent fuel storage racks because possible water densities are too low ($\leq$0.01 gm/cm^3) to yield k_{eff} values higher than for full density water and the rack design prevents the preferential reduction of water density between the cells of a rack (e.g. boiling between cells).

9.1.2.3.1.4 Acceptance Criteria for Criticality

The neutron multiplication factor in the spent fuel pools shall be less than or equal to 0.95 with credit taken for soluble boron, and less than 1.0 with no credit for soluble boron, as specified in Reference 19 and 10 CFR 50.68(b).

9.1.2.3.1.5 Cask Drop Accident

Cask drop accidents are not analyzed for criticality consequences since the dropping of a cask into the fuel storage areas at Catawba is precluded by design features and cask handling procedures.

9.1.2.3.1.6 Postulated Drop of a Weir Gate

An analysis of the postulated drop of a weir gate onto the cells in the fuel pool has been performed. The boron concentration in the fuel pool was taken to be up to 2700 ppm. The dropped weir gate was assumed to damage seven fuel assemblies on impact (i.e., the maximum number of fuel assemblies which could be directly impacted in such an accident). The geometry of the impacted fuel assemblies was modeled to yield the highest value of $k_{eff.}$. It was determined that $k_{eff} \leq 0.95$ everywhere in the spent fuel pool following this postulated event.

9.1.2.4 Storage of Oconee and McGuire Spent Fuel

In the event Duke experiences a limitation in spent fuel storage at other nuclear facilities, alternative means of accommodating further storage must be explored. One alternative is the storage of some Oconee and McGuire spent fuel assemblies in the Catawba spent fuel pools. A detailed description of Oconee fuel assemblies is given in Final Safety Analysis Report, Oconee Units 1, 2, and 3. Oconee fuel storage is within the system design bases listed in Section 9.1.2.1. A detailed description of McGuire fuel assemblies is given in Final Safety Analysis Report, McGuire Units 1 and 2 and McGuire fuel storage is also within the system design bases listed in Section 9.1.2.1.

The Oconee fuel assemblies are accommodated within the spent fuel pool storage racks by the placement of spacers in those locations designated for Oconee fuel storage. The spacers are necessary to allow proper interfacing of the fuel assemblies with the Oconee fuel handling tool. The spacers are designed to allow their insertion or removal from the manipulator crane bridge.

The spacers in the Catawba Spent Fuel Racks are located six inches above the floor of the fuel pool. They rest on the support plate that would normally support the Catawba fuel assemblies. The spacer is 5 1/2 inches high. It is constructed of a section of 8 inch diameter stainless steel pipe with an 8-3/4 x 8-3/4 x 3/16 inch stainless steel plate welded to the top of the pipe section. A 5x5 inch square opening is located in the center of the 3/16 inch plate to allow cooling water to flow up and around the fuel assembly. See Figure 9-8 for a drawing of the spacer.

The scope of the Safety Evaluation presented in Section 9.1.2.3, did not consider fuel designs from Oconee. A criticality analysis has been performed to demonstrate that acceptable criticality safety margin exists when storing Oconee fuel in the Catawba spent fuel storage racks. To perform this criticality analysis, the SCALE Version 4.4 system of computer codes (Reference 21) was employed. These calculations used the CSAS25 sequence of codes in the Criticality Safety Analysis Sequences (CSAS) control module in SCALE 4.4. The CSAS25 control sequence first runs two processing codes (BONAMI for resonance self-shielding, and NITAWL-II to produce a working transport cross-section library) before performing the criticality calculations on the Oconee fuel model with KENO V.a (a 3-D Monte Carlo criticality code) to determine a system k_{eff}. The Oconee fuel criticality calculations used the SCALE-4.4 238-group neutron library based on ENDF-B Version 5 data. It has been determined from this analysis that an infinite array of Oconee assemblies stored in the Catawba spent fuel pools will have a value of k_{eff} less than 0.95. However, since none of the Oconee fuel designs were included in the current safety evaluation in Reference 20, a criticality analysis using NRC approved methods to demonstrate that the criticality acceptance criteria are met is required prior to storing any Oconee fuel in the Catawba spent fuel pools.

The following precautions are taken to prevent loading a Catawba fuel assembly into a spent fuel rack designated for Oconee fuel (with spacer): 1) A visual examination is performed to verify that the location receiving the fuel assembly is empty; and 2) Upon loading the assembly into the rack, a load cell (applied in tension) is monitored; should the assembly movement fall outside the range of the suspended weight ± 200 lbs, movement is to stop; and 3) Once the guide cable becomes slack, the correct position of the assembly is verified within ± ¼ inch. The following precautions are also taken to prevent loading an Oconee fuel assembly into a spent fuel rack designated for Catawba fuel (without spacer): 1) A visual inspection is performed to verify that the location receiving the fuel assembly is empty; and 2) Should the fuel handling tool and guide line be under any form of tension, the roll pin - which is required to be turned by hand in order to separate the handing tool from the fuel assembly would be difficult to turn as required and would allow for the observation and correction of the problem; and 3) Although an Oconee fuel assembly can be inserted into the Catawba spent fuel rack, it is considered impossible to remove the handling tool (due to the design and necessary clearance required to remove the grapples) and disengage the assembly in the spent fuel rack.

An evaluation of a fuel handling accident with Oconee fuel assemblies shows that the consequences would not exceed those presented in Chapter 15., Section 15.7.4.2.2.

9.1.2.5 Independent Spent Fuel Storage Installation

Due to a shortage of fuel pool storage room, Catawba installed an Independent Spent Fuel Storage Installation (ISFSI) to provide long-term dry storage of irradiated fuel assemblies. The ISFSI includes the ISFSI cask storage pad and the ISFSI haul road used to transfer spent fuel casks from the spent fuel pools to the storage pad. The major steps involved in transferring spent fuel from the spent fuel pools to the ISFSI include moving a specially designed cask into the fuel building, placing the cask in the spent fuel pool, loading qualified (adequately decayed) fuel assemblies into the cask, drying and sealing the cask, and then transferring the cask to the storage pad via the ISFSI haul road. The impact of the cask drop in the spent fuel pool has been considered, and it has been determined that, specifically, a NAC cask cannot fall into the fuel storage area of the spent fuel pool, provided that the designated load path per procedure in accordance with SLC 16.9-20 is followed. The overhead crane in the Spent Fuel Building has mechanical stops that prohibit violation of that load path (refer to CNC-1140.04-04-0002, "Qualification of Spent Fuel Transfer Cask and Canister for Postulated Drops in the Fuel Building (NAC)" for more details).

The ISFSI haul road passes over four buried 42" diameter Nuclear Service Water System (RN) supply and return lines. A protective structure (ground level bridge) was built over the buried RN supply and return lines to protect them from being damaged by the weight of the cask transporter and the loaded cask. The protective structure consists of a 24 ft wide concrete structure at grade level supported on piles that are designed to support the working loads of the cask transporter carrying the loaded cask. Catawba has prepared, and updates a document, the 10CFR72.212 Evaluation, which describes how the Catawba Part 50 Licensing interacts with the requirements of the NAC Part 72 Licensing. Refer to the Catawba ISFSI UFSAR and 10CFR72.212 Evaluation for more details on the Independent Spent Fuel Storage Installation.

9.1.3 Spent Fuel Pool Cooling and Purification

The Spent Fuel Pool Cooling System (KF) is designed to remove heat from the spent fuel pool and maintain the purity and optical clarity of the pool water during fuel handling operations. The purification loop provides an alternate means for removing impurities from either the refueling cavity/transfer canal water during refueling or the refueling water storage tank water following refueling.

9.1.3.1 Design Bases

KF System design parameters are given in Table 9-1.

9.1.3.1.1 Spent Fuel Pool Cooling

An identical KF System with two trains is provided for each unit. They are designed to remove the decay heat from the spent fuel assemblies stored in the pool. The KF System will maintain:

1. Pool water temperature less than 150°F with one cooling train operating assuming a "nominal" heat load of 1.85E7 Btu/hr. "Nominal" heat load is 1/3 core with full irradiation and 7 days decay, one full core of open spaces, and the remainder of the pool filled with fully irradiated fuel from previous yearly refuelings.
2. Pool water temperature less than 150°F with two cooling trains operating assuming a "maximum" heat load of 4.7E7 Btu/hr. "Maximum" heat load is a full core discharge consisting of fuel with batch burnups ranging from 19-58 GWD/t; plus 1/3 core fully irradiated and decayed 25 days with the remainder of the pool filled with fuel from previous yearly refuelings.

An analysis of temperature versus time for Q = 47.0 x 10^6 BTU/hr was performed using only one spent fuel pool heat exchanger and the poolwater as heat sinks. The results of this analysis are presented in Figure 9-13. The additional heat and humidity load would not affect the fuel building ventillation system.

9.1.3.1.2 Water Purification

The system demineralizer and filters are designed to maintain adequate purification to permit unrestricted access to the spent fuel storage area for plant personnel, provide means for purifying transfer canal and refueling pool water during refueling, and provide purification capability for the refueling water storage tank. The KF System also maintains the optical clarity of the spent fuel pool water surface by use of the skimmer trough, strainers, and skimmer filters.

The Spent Fuel Pool will be sampled per a program derived from industry standards. Boron concentration is set by Technical Specifications.

Samples will also be collected at the outlet of the Spent Fuel Pool per a program derived from industry standards.

The pre and post filters of the purification loop have local pressure gauges that will be monitored. The maximum allowable pressure drop across these filters is 75 psid (element collapses at approximately this value). The pressure gauges will allow monitoring so that the filters may be replaced before the pressure drop exceeds approximately 45 psid.

9.1.3.1.3 Spent Fuel Pool Dewatering Protection

System piping, with the exception of the Standby Makeup Pump supply line, is arranged so that failure of any pipe cannot drain the spent fuel pool below the water level required for radiation shielding. In case of a Standby Makeup Pump suction line break, sufficient time exists to close the fuel transfer tube isolation valve and install the transfer tube weir gate before fuel pool water level drops below that which is required for shielding. A water level of 10 feet or more above the top of the stored fuel assemblies is maintained to limit direct gamma dose.

9.1.3.1.4 Spent Fuel Pool Makeup

In order to provide specified shielding and water volumes in the fuel pool during plant operation, system piping provides makeup capabilities. Borated makeup water can be supplied to the spent fuel pool from the refueling water storage tank or the Recycle Holdup Tanks. Demineralized water can be supplied to the pool by the Reactor Makeup Water Pumps, and emergency makeup water can be supplied to the pool from the Nuclear Service Water System. All means of makeup are manually initiated and manually terminated.

9.1.3.2 System Description

An identical Spent Fuel Cooling System, as shown in Figure 9-11 and Figure 9-12, is provided for each unit. The system consists of two cooling loops, one purification loop, and one skimmer loop.

The fuel pool cooling pumps take suction from the spent fuel pool. These pumps circulate the water through the cooling loops and the purification loop in various combinations prior to returning the water to the spent fuel pool. The spent fuel pool heat load is transferred to the Component Cooling System by the fuel pool cooling heat exchangers. The fuel pool cooling pre-filter, demineralizer, and post-filter will adequately remove corrosion and fission products from the spent fuel pool water.

The fuel pool skimmer pump takes suction from the skimmer trough, that collects water from the spent fuel pool surface. Floating debris is removed by the fuel pool skimmer strainer and filter. Optically clear water is then discharged below the pool surface at various locations. Discharge throttling valves are provided for optimizing the spent fuel pool skimmer loop operation.

The Pool Cooling and Purification System is manually controlled from a local control panel. High temperature and low liquid level in the fuel pool and high radiation in the fuel pool area alarms are provided in the Control Room as per Regulatory Guide 1.13. Also alarmed in the Control Room is high liquid level in the fuel pool. Local gauges are provided for high differential pressure across each strainer and filter and low discharge pressure on each pump.

9.1.3.2.1 Pool Cooling Subsystem

The cooling subsystem of the Spent Fuel Pool Cooling System is a closed loop system consisting of two full-capacity pumps and two full-capacity heat exchangers. Each pump-heat exchanger loop is designed to accommodate the decay heat from the one-third core case.

The fuel pool contains water with approximately 2000 to 4000 ppm of boron and has the capacity to store 1421 spent fuel assemblies including one and one-third cores of freshly discharged fuel. A capacity of one and one-third cores enables handling the removal of one full core during that period of time when one-third core is stored in the fuel pool following a refueling. When in storage racks the fuel elements are spatially distributed so as to preclude criticality in the event of an accidental dilution of the fuel pool water. The fuel pool water is maintained at refueling water storage tank concentration to assure that mixing of the fuel pool water and the refueling canal water cannot dilute the refueling canal water concentration.

The pool cooling subsystem removes the decay heat from the spent fuel stored in the fuel pool. The System is designed to limit the fuel pool temperatures as given in Section 9.1.3.1.1.

9.1.3.2.1.1 Component Description

Component design parameters are given in Table 9-1.

Fuel Pool Cooling Pumps

The two fuel pool cooling pumps are designed for 2840 gpm per pump and installed for parallel operation. Under normal operating conditions one pump is operating. The pump has mechanical seals provided with leakoff, vent and drain connections. The internal wetted surfaces of the pumps are stainless steel. The units are constructed in accordance with Section III, Class 3 of the ASME Code.

Fuel Pool Cooling Heat Exchangers

The two fuel pool cooling heat exchangers are shell and tube design. The shell side component cooling water flow is 3000 gpm per heat exchanger, which is the flowrate required to remove the design heat load. Both the shell and tube side of the unit are constructed in accordance with Section III, Class 3 of the ASME Code. The tube side is stainless steel, and the shell side is carbon steel.

Fuel Pool Cooling Pump Strainers

Submerged debris and trash that might be harmful to the fuel pool cooling pump is collected by this strainer.

9.1.3.2.2 Pool Purification Subsystem

The purification subsystem removes particulates, dissolved fission products and surface dust from the fuel pool and the canal, thereby maintaining clarity of the fuel pool water and the refueling canal water and permitting visual observation of underwater operations. The purification subsystem can also remove dissolved fission products from the refueling water storage tank.

One spent fuel pool water volume can be circulated through the purification loop every 24 hours, which should be sufficient to maintain the water chemistry specified for the spent fuel pool in WCAP-7452, Rev. 1, "Chemistry Criteria and Specifications for Westinghouse Pressurized Water Reactors", dated July 30, 1973.

The fuel pool water or refueling water is circulated by its respective pump through a fuel pool cooling pre-filter, which removes particulates, and then through the fuel pool cooling demineralizer which removes ionic material. The purified water then goes through the fuel pool cooling post filter before it is returned to the fuel pool or the refueling water storage tank.

The pool purification subsystem also consists of a spent fuel pool skimmer loop which removes floating debris from the spent fuel pool surface by use of a skimmer trough, strainer, skimmer pump, and filter. The suction and return lines of the skimmer loop are arranged so that the maximum area of surface water is circulated through the skimmer loop.

9.1.3.2.2.1 Component Description

Component design parameters are given in Table 9-1.

Fuel Pool Cooling Pre-Filter

Suspended particles are collected on the pre-filter instead of on the fuel pool cooling demineralizer. The retention capability of the installed disposable filter cartridge may vary from 6 micron down to 0.1 micron depending on plant conditions.

Fuel Pool Cooling Demineralizer

The demineralizer is of the mixed bed type with H+ and OH- type resin which removes corrosion and fission product ionic contaminants from the spent fuel pool water or the Refueling Water System water.

Fuel Pool Cooling Post-Filter

Resin fines are collected on the post-filter. The disposable filter cartridge removes 98 percent of all particles 3 microns and larger.

Skimmer Trough

The skimmer collects water from the spent fuel pool surface. Surface skimming is optimized by adjusting the pool level.

Fuel Pool Skimmer Strainer

Floating debris and trash that might be harmful to the fuel pool skimmer pump is collected by this strainer.

Fuel Pool Skimmer Pump

This pump is sized to circulate 100 gpm through the skimmer loop and return the water to the spent fuel pool at six discharge points. Throttling valve (1KF73) can be used along with the six discharge valves to optimize skimmer loop operation.

Fuel Pool Skimmer Filter

Suspended particles are collected on this filter. The disposable filter cartridge removes 98 percent of all particles 3 microns and larger.

9.1.3.2.3 Piping

All piping used in the Pool Cooling and Purification System is stainless steel with welded connections throughout, except for flanged connections at the suction and discharge of the pumps.

9.1.3.2.4 Electrical Power Supply

Each fuel pool cooling pump is supplied power by its corresponding emergency diesel generator and can be restarted manually after a pre-determined delay following a LOCA or station blackout. These pumps are supplied from a reliable station bus during all normal operating periods.

The fuel pool skimmer pump is supplied power from the normal station bus. This pump is not required to operate during an emergency.

9.1.3.2.5 Water Chemistry

Spent fuel pool water chemistry requirements are as follows; reference WCAP-7452, Rev. 1, Chemistry Criteria and Specifications for Westinghouse Pressurized Water Reactors, Section 1, 5/1/73.

Solution pH 4.0 to 8.0

Boric Acid as ppm boron	2000 to 4000
Chloride, ppm, max.	0.15
Fluoride, ppm, max.	0.15
Makeup Water	Same quality as Reactor Coolant System makeup water

9.1.3.2.6 System Instrumentation and Control

9.1.3.2.6.1 Spent Fuel Pool Cooling Loop Instrumentation

Temperature

Spent Fuel Pool Temperature - This instrument measures the water temperature and it is indicated in the control room. High temperatures are alarmed in the control room.

Fuel Pool Cooling Heat Exchanger Inlet and Outlet Temperature - These instrument test points are used to check the temperature at each heat exchanger inlet and outlet.

Level

Spent Fuel Pool Level – A narrow range instrument channel measures the spent fuel pool water level and is indicated in the control room. High and low pool water levels are also provided from the narrow range instrument channel and are alarmed in the control room.

In addition, two wide range spent fuel pool level instrument channels were provided in response to NRC Order EA-12-051, “Order to Modify Licenses with Regard to Reliable Spent Fuel Pool Instrumentation.” These instrument channels are required to provide reliable spent fuel pool instrumentation to support effective prioritization of event mitigation and recovery actions in the event of a Beyond Design Bases External Event (BDBEE). The instrument channels were designed to be electrically independent, spatially separated, and are indicated in the control room.

Pressure

Fuel Pool Cooling Pump Suction Pressure - These instruments provide local indication of each pump's suction pressure.

Fuel Pool Cooling Pump Discharge Pressure - These instruments provide local indication of each pump's discharge pressure.

Fuel Pool Cooling Heat Exchanger Inlet and Outlet Pressure - These instrument test points are used to check the pressure at each heat exchanger inlet and outlet to monitor tube cleanness.

Flow

Fuel Pool Cooling Heat Exchanger Flow - These instruments provide local flow indication. High or low flow through the tubeside of each heat exchanger is alarmed through the computer.

9.1.3.2.6.2 Spent Fuel Pool Purification Loop Instrumentation

Pressure

Fuel Pool Cooling Pre-filter and Post-filter ∆P - These instruments provide local indication of the differential pressure across each filter. Filters are changed on either high pressure drop, or high radiation as measured by a probe inserted into each filter cubicle.

Flow

Fuel Pool Purification Loop Flow - This instrument provides local flow indication. High or low flow is alarmed through the computer.

9.1.3.2.6.3 Spent Fuel Pool Skimmer Loop Instrumentation

Pressure

Fuel Pool Skimmer Pump Suction Pressure - This instrument trips the fuel pool skimmer pump upon low suction pressure.

Fuel Pool Skimmer Filter ∆P - This instrument provides local indication of the differential pressure across the filter.

Fuel Pool Skimmer Pump Discharge Pressure - This instrument provides local indication of the pump discharge pressure.

Flow

Fuel Pool Skimmer Loop Flow - This instrument provides local flow indication. Low flow is alarmed through the computer.

9.1.3.3 Safety Evaluation

9.1.3.3.1 Availability and Reliability

The KF System is located in a Seismic Category I structure that is tornado missile protected. Active components of the cooling portion of the system are located above the design basis flood level in the Auxiliary Building. The KF System heat removal equipment is designed to remain functional for the Safe Shutdown Earthquake and within the required stress limits for the Operational Basis Earthquake.

Electrical power is supplied from emergency power buses to each of the spent fuel pool pumps. Each pump is connected to these emergency power buses so that it receives power from a separate diesel generator set from the other pump, should offsite power be lost. The use of emergency power buses assures the operation of these pumps for open reactor cooling during plant flooding conditions. This manually controlled system may be shut down for limited periods of time for maintenance or replacement of malfunctioning components. The pool is sufficiently large that an extended period of time would be required for the water to heat up appreciably if cooling were interrupted. In the event of a failure of one spent fuel pool pump, and/or the loss of cooling to one spent fuel pool heat exchanger, the backup pump and heat exchanger would be aligned and operated with no significant rise in pool water temperature.

Upon initiation of a postulated design basis accident LOCA, Component Cooling System flow would be terminated to the Spent Fuel Pool Cooling System for both the LOCA unit and the unaffected unit. Makeup from the Nuclear Service Water System may be initiated to remove decay heat in the spent fuel pool by boiling. The required makeup flow to remove the decay heat associated with maximum decay heat conditions (i.e., full core offload at 7 days decay) is approximately 100 GPM. The Nuclear Service Water piping to the spent fuel pool has been verified to be capable of delivering at least this flow rate in the event of loss of cooling during a LOCA. This value envelopes the required flow under any conditions. For the unit postulated to have sustained the LOCA, maximum decay heat will not exist in the spent fuel pool. The decay heat in the spent fuel pool for the LOCA unit will be caused from the discharged fuel decayed over the duration of the outage. The unaffected unit will be shut down, and design calculations model Standby Nuclear Service Water Pond depletion flow as suction supply to the Auxiliary Feedwater System. This flow is associated with the core at conditions immediately after shutdown. Hence, this flow envelopes the required flow rate to the spent fuel pool if the unaffected unit were in a refueling outage with the entire core unloaded to the spent fuel pool.

During an event in which the Standby Shutdown Facility is activated, 26 GPM would be supplied from the spent fuel pool to the Reactor Coolant System pump seals for the purpose of prevention of a seal LOCA. The borated water from the spent fuel pool will also ensure the maintenance of shutdown margin in the core on the affected unit. After 72 hours, the appropriate repairs are assumed to have been effected, and the affected unit may be brought to cold shutdown. There is sufficient water inventory in the spent fuel pool to maintain water over the top of the fuel assemblies assuming a) boiloff from the decay heat associated with normal conditions and b) 26 GPM supply to the Reactor Coolant System pump seals. During shutdown in preparation for a refueling outage, the seal supply to the Reactor Coolant System pumps is isolated. Hence, with a full core offload residing in the spent fuel pool, an event which requires activation of the Standby Shutdown Facility is not assumed to occur for purposes of evaluation of the spent fuel pool capabilities (i.e., 26 GPM supply to the pump seals is not necessary in mode 6).

9.1.3.3.2 Spent Fuel Pool Dewatering

The most serious failure of this system would be complete loss of water in the storage pool. To protect against this possibility, the spent fuel pool cooling suction connections enter near the normal water level such that it cannot be lowered appreciably by siphoning.

9.1.3.3.3 Water Quality

Except for operation of this system during refueling only a very small amount of water is interchanged between the refueling canal and the spent fuel pool as fuel assemblies are transferred in the refueling process. Whenever a fuel assembly with defective cladding is transferred to the spent fuel pool, a small quantity of fission products may enter the spent fuel cooling water. The purification loop provided removes fission products and other contaminants from the water. Radioactivity concentrations in the spent fuel pool water are maintained at a level such that the dose rate at the surface of the pool is low enough to allow unrestricted access for plant personnel.

9.1.3.4 Tests and Inspections

Active components of the SFPCPS are either in continuous or intermittent use during normal plant operation. Periodic visual inspection and preventive maintenance are conducted using normal industry practice.

9.1.4 Fuel Handling System

9.1.4.1 Design Bases

The Fuel Handling System (FHS) consists of equipment and structures utilized for the refueling operation in a safe manner meeting General Design Criteria 61 and 62 of 10CFR 50, Appendix A.

The following design bases apply to the FHS.

1. Fuel handling devices have provisions to avoid dropping or jamming of fuel assemblies during transfer operation.
2. Handling equipment has provisions to avoid dropping of fuel handling devices during the fuel transfer operation.
3. Handling equipment used to raise and lower spent fuel have a limited maximum lift height so that the minimum required depth of water shielding is maintained.
4. The Fuel Transfer System (FTS), where it penetrates the containment, has provisions to preserve the integrity of the containment pressure boundary.
5. Criticality during fuel handling operations is prevented by geometrically safe configuration of the fuel handling equipment.
6. Handling equipment will not fail in such a manner as to damage Seismic Category I equipment in the event of a Safe Shutdown Earthquake.
7. The inertial loads imparted to the fuel assemblies or core components during handling operations are less than the loads which could cause damage.
8. Physical safety features are provided for personnel operating handling equipment.

9.1.4.2 System Description

The Fuel Handling System consists of the equipment needed for the refueling operation on the reactor core. Basically, this equipment is comprised of cranes, handling equipment and a fuel transfer system. The containment polar crane is not used for fuel handling. The structures associated with the fuel handling equipment are the refueling cavity, the refueling canal, the spent fuel pit, and the new fuel storage area. The arrangement and location of fuel handling equipment in the Auxiliary Building is shown on Figure 9-1, Figure 9-2, Figure 9-4, and Figure 9-5.

9.1.4.2.1 Fuel Handling Description

New fuel assemblies received are removed one at a time from the shipping cask and stored in the fuel storage racks located in the fuel storage area.

New fuel is delivered to the reactor by placing a fuel assembly into the new fuel elevator, lowering it into the spent fuel pool and taking it through the fuel transfer system. New fuel may also be delivered to the reactor via the spent fuel storage racks.

The fuel handling equipment is designed to handle the spent fuel assemblies underwater from the time it leaves the reactor vessel until it is placed in a cask for shipment from the site. Underwater transfer of spent fuel provides an effective, economic and transparent radiation shield, as well as a reliable cooling medium for removal of decay heat. The boric acid concentration in the water further reduces the value of K_{eff} sufficient to preclude criticality.

The associated fuel handling structures may be generally divided into three areas: the refueling cavity and refueling canal which are flooded only during unit shutdown for refueling, the spent fuel pool which is kept full of water and is always accessible to operating personnel, and the new fuel storage area which is separate and protected for dry storage. The refueling canal and the spent fuel pool are connected by a fuel transfer tube. This tube is fitted with a blind flange on the canal end and a gate valve on the spent fuel pool end.

The blind flange is in place except during refueling to ensure Containment integrity. Fuel is carried through the tube on an underwater transfer car.

Fuel is moved between core positions or between the reactor vessel and the refueling canal by the Refueling Machine.

The upender at either end of the fuel transfer tube is used to pivot a fuel assembly. Before entering the transfer tube the upender pivots a fuel assembly to the horizontal position for passage through the transfer tube. After the transfer car transports the fuel assembly through the transfer tube, the upender at the end of the tube pivots the assembly to a vertical position so that it can be lifted out of the fuel container.

In the spent fuel pool, fuel assemblies are moved about by a fuel handling machine. A short tool is used to handle new fuel, and place it in the new fuel elevator which is used to lower the assembly to a depth at which the fuel handling machine can place the new assembly into the fuel transfer container in the upending device, or into the storage racks.

Decay heat, generated by the spent fuel assemblies in the spent fuel pool, is removed by the Spent Fuel Pool Cooling System. After a sufficient decay period, the fuel is removed from the racks and loaded into shipping casks for removal from the site.

9.1.4.2.2 Refueling Procedure

The refueling operation follows a detailed procedure which provides a safe, efficient refueling operation. The following significant points are assured by the refueling procedure:

1. The refueling water and the reactor coolant contains a concentration of dissolved boron which is sufficient to keep the core subcritical during the refueling operations. It is also sufficient to maintain the core subcritical if in the unlikely event that all of the rod cluster control assemblies were removed from the core.
2. The water level in the refueling cavity is high enough to keep the radiation levels within acceptable limits when the fuel assemblies are being removed from the core.

The refueling operation is divided into four major phases: 1) preparation; 2) reactor disassembly: 3) fuel handling; and 4) reactor assembly. A general description of a typical operation through the four phases is given below:

1. Phase I - Preparation

   The reactor is shutdown and cooled to cold shutdown conditions with a final K_{eff} <0.9 (all rods in). Following a radiation survey, the Containment Vessel is entered. At this time, the coolant level in the reactor vessel is lowered to a point slightly below the vessel flange. Then the fuel transfer equipment and refueling machine are checked for proper operation.

2. Phase II - Reactor Disassembly

   All cables, air ducts, and insulation are removed from the vessel head. The refueling cavity is then prepared for flooding by sealing off the reactor cavity, checking of the underwater lights, tools, and fuel transfer system; closing the refueling canal drain holes; and removing the blind flange from the fuel transfer tube. With the refueling cavity prepared for flooring, the vessel head is unseated and raised approximately 1 foot above the vessel flange for visual inspection of the lift rig and O-ring clips. The vessel head is slowly raised within the bounds of Catawba's current reactor vessel head drop analysis. If the reactor vessel head drop analysis requires that water be present during the lift, water from the refueling water storage tank is transferred into the Reactor Coolant System by the residual heat removal pumps, refueling water pump, or gravity fill. The vessel head is lifted to an appropriate height and moved to its storage pedestal. The control rod drive shafts are disconnected and, with the upper internals, are removed from the vessel. The fuel assemblies and rod cluster control assemblies are now free from obstructions and the core is ready for refueling.

3. Phase III - Fuel Handling

The refueling sequence is started with the refueling machine. Spent fuel assemblies are removed from the core in the sequence presented in the refueling procedure which is prepared before each refueling. All fuel assemblies are unloaded from the core and transferred to the spent fuel pool. In the spent fuel pool, rod cluster control units, burnable poison rod assemblies, and thimble plugs are transferred between fuel assemblies as appropriate.

The general fuel handling sequence is:

a. The refueling machine is positioned over a fuel assembly in the core.

b. The fuel assembly is lifted by the refueling machine to a pre-determined height sufficient to clear the reactor vessel and still leave sufficient water covering to eliminate any radiation hazard to the operating personnel.

c. The fuel transfer car is moved into the refueling canal from the spent fuel pool.

d. The fuel assembly container is pivoted to the vertical position by the upender.

e. The refueling machine is moved to line up the fuel assembly with the fuel transfer system.

f. The refueling machine loads a fuel assembly into the fuel assembly container of the transfer car.

g. The container is pivoted to the horizontal position by the upender.

h. The fuel container is moved through the fuel transfer tube to the spent fuel pool by the transfer car.

i. The fuel assembly container is pivoted to the vertical position. The fuel assembly is unloaded by the fuel handling machine.

j. The fuel assembly is placed in the spent fuel storage rack.

k. Sequence (a - j) is repeated until entire core is unloaded.

l. The new fuel assembly is brought from dry storage, lowered into the spent fuel pool with the new fuel elevator. RCCAs, thimble plugs and BPRA's are shuffled into their fuel assemblies using the insert handling tools. The fuel assemblies are then loaded into the fuel assembly container by the fuel handling machine. Alternatively, the new fuel assembly may be picked from temporary storage in the spent fuel racks.

m. The fuel assembly container is pivoted to the horizontal position and the transfer car is moved back into the refueling canal.

n. Partially spent fuel assemblies are reinserted in the reactor core, and new fuel assemblies are added to the core.

o. This procedure is continued until refueling is completed.

4. Phase IV - Reactor Assembly

If the reactor vessel head drop analysis requires that water be present during the lift, the proper water level is established. The vessel head is lifted from the storage location approximately 3 inches to perform inspection of the lift rig. The head is lifted enough to clean any obstructions. The crane bridge and trolley are aligned with centerline marks for the head set. Draining continues until the water level is below the vessel flange for entry into the canal. The drive rods and thermocouple nozzle assemblies are verified to be captured by the head penetration funnels as the head is lowered within the bounds of Catawba's current reactor vessel head drop analysis. Final head set and mechanical reassembly of the head, including cables, air ducts, and insulation, is performed.

9.1.4.2.3 Component Description

Refueling Machine

The refueling machine, Figure 9-14, is a rectilinear bridge and trolley crane spanning the refueling canal with a vertical mast extending down into the refueling water. The mast supports and guides the gripping and hoisting device for handling fuel assemblies. The bridge and trolley motions are used to position the mast over the fuel assembly positions in the core.

Fuel assemblies are lifted using a long tube with a pneumatic gripper on the end which is lowered down out of the mast to grip the fuel assembly. The gripper tube is long enough so that the upper end is still contained in the mast when the gripper end contacts the fuel. A winch mounted on the trolley raises the gripper tube and fuel assembly up into the mast tube. The fuel is transported while inside the mast tube to its new position.

All controls for the refueling machine are mounted on a console on the trolley. The console contains the Programmable Logic Controller (PLC), Human-Machine Interface (HMI) computer/touch screen display, motor drive controllers and manual inputs (power, load selector, gripper, override, and emergency stop switches travel controllers (joysticks) and associated dedicated indicators and resets). The bridge and trolley are positioned on a coordinate system defined by geared racks paralleling one bridge rail and one trolley rail. Dual redundant rotary encoders mounted to the bridge and trolley respectively, engage these gears and transmit position data to the PLC. The inputs are compared for reliability and the position information is displayed on the console touch screen.

Electrical interlocks and limit switches on the bridge and trolley drives are provided for minimizing the possibility of damage to the fuel during fuel handling operations. The winch is also provided with limit switches plus a mechanical stop to prevent a fuel assembly from being raised above a safe shielding depth should the limit switch fail. If necessary, the bridge, trolley, and winch can be operated manually using a handwheel on the motor shaft.

Fuel Handling Machine

The fuel handling machine, Figure 9-15, is similar to the refueling machine.

New Fuel Elevator

The new fuel elevator, Figure 9-16, consists of a box-shaped elevator assembly with its top end open and sized to house one fuel assembly.

The new fuel elevator is used exclusively to lower a new fuel assembly to the bottom of the spent fuel pool where it is transported to the fuel transfer system or the fuel storage racks by the fuel handling machine.

Fuel Transfer System

The Fuel Transfer System (FTS) (Figure 9-17) includes an underwater, electric-motor driven, transfer car that runs on tracks extending from the refueling canal through the transfer tube and into the fuel storage area and an hydraulically actuated lifting arm at each end of the transfer tube. The fuel container in the refueling canal receives a fuel assembly in the vertical position from the refueling machine. The fuel assembly is then lowered to a horizontal position for passage through the transfer tube. After passing through the tube, the fuel assembly is raised to a vertical position for removal by the fuel handling machine mast. The fuel handling machine then moves to a storage loading position and places the spent fuel assembly in the spent fuel storage racks. If necessary, fuel can be moved by using a long-handled tool suspended from an auxiliary hoist on the fuel handling machine.

During reactor operation, the transfer car is stored in the fuel storage area. A blind flange is bolted on the refueling canal end of the transfer tube to seal the reactor containment.

New Fuel Assembly Handling Fixture

This short-handed tool is used to handle new fuel on the operating deck of the fuel storage building; to remove the new fuel from the shipping container; and to facilitate inspection and storage of the new fuel and loading of fuel into the new fuel elevator.

Reactor Vessel Head Lifting Device

The reactor vessel head lifting device, Figure 9-19, consists of a welded and bolted structural steel frame with suitable rigging to enable the crane operator to lift the head and store it during refueling operations. The lifting device is permanently attached to the reactor vessel head. Attached to the head lifting device are the monorail and hoists for the reactor vessel stud tensioners.

Reactor Internals Lifting Device

The reactor internals lifting device (Figure 9-20) is a structural frame suspended from the overhead crane. The frame is lowered onto the guide tube support plate of the internals, and is mechanically connected to the support plate by three breech lock type connectors. Bushings on the frame engage guide studs in the vessel flange to provide guidance during removal and replacement of the internals package.

Reactor Vessel Stud Tensioner (used with the originally supplied nut design)

Stud tensioners, Figure 9-21, are employed to secure the head closure joint at every refueling. The stud tensioner is a hydraulically operated device that uses oil as the working fluid. The device permits preloading and unloading of the reactor vessel closure studs at cold shutdown conditions. Stud tensioners minimize the time required for the tensioning or unloading operation. Three tensioners are provided and are applied simultaneously to three studs located 120 degrees apart. A single hydraulic pumping unit operates the tensioners which are hydraulically connected in series. The studs are tensioned to their operational load. Relief valves on each tensioner prevent overtensioning of the studs due to excessive pressure.

Fuel Handling Cask Crane

The fuel handling cask crane is a CMSS specification No. 70 Class 1A electric overhead traveling bridge crane. The main hoist is rated at 125 tons and the auxiliary hoist is rated at 10 tons. The crane and accessories are used to handle both new and spent fuel assemblies contained in protective containers. Handling of fuel by the crane main hoist is limited to the area between the new fuel vault and the spent fuel shipping cask area. Handling of fuel by the auxiliary hoist is limited to the area between the new fuel vault and the new fuel elevator. The main hoist is not capable of being immersed in the spent fuel pool; however, the auxiliary hoist block and cable are submersible. Mechanical stops are installed to prevent the main hoist from being positioned over the spent fuel pool.

Design criteria for the 125-ton crane are as follows:

1. As a minimum the crane complies in all respects with the specification for electric overhead traveling cranes, C.M.A.A. Specification No. 70 and Service Class 1A.
2. Mechanical parts are designated to have a minimum safety factor of five when under rated load and based on the ultimate strength of the material used.
3. The main and auxiliary hoists are not required to handle rated capacity loads at the same time.
4. Mechanical parts are also proportioned to withstand loads produced by the rated pull out torque of the motors with the unit stress not to exceed 70 percent of the elastic limit of the material involved.
5. The maximum allowable stresses used in structural design of the crane are those established in the specifications for electric overhead traveling cranes, C.M.A.A. Specification No. 70.
6. The main and auxiliary hooks are load tested to 125 percent of the rated load. The hooks are annealed and design stresses of the hooks are limited to 10,000 psi tension in the stem and 20,000 psi combined tension and bending stress.
7. All welding design and procedures conform to "Welding in Building Construction", AWS D1.0-69. Component parts of built up members are fabricated with fillet welds. Butt welds, where used, are made from both sides and are full penetration welds. The structural welds for the bridge, trucks, drums, and trolleys are 100 percent inspected by magnetic particle testing or by liquid penetrant testing.
8. Materials used conform to the following:

a.	Structural Steel	A36
b.	Rivet Steel	A242
c.	High Strength Bolts and Nuts	A325
d.	Cold Finished Steel, GDS 1010 to 1040, Inclusive	A108

9. Wire rope is used with a minimum safety factor of five (5) based on the static rated load without allowance for impact, frictional resistance or for bending stresses over sheaves.
10. Gearing conforms to AGMA Standards.

The crane is seismically designed and is QA Condition 4, Seismic Category II as identified in Table 3-3. The seismic loads are not considered acting simultaneously with the crane loaded. Hold down devices are provided.

9.1.4.3 Safety Evaluation

Failure mode and effects analysis is presented where applicable for individual systems and components in this subsection and elsewhere throughout Section 9.1.

9.1.4.3.1 Safe Handling

Design criteria for the Fuel Handling System.

1. The primary design requirement of the refueling machine is reliability. A conservative design approach is used for all load bearing parts. Where possible, components are used that have a provided record of reliable service. Throughout the design consideration is given to

the fact that the machine spends long idle periods stored in an atmosphere of 100°F and high humidity. In general, the crane structure is considered in the Class A1, Standby Service, as defined by the Crane Manufacturers Association of American Specification No. 70.

2. Seismic design is discussed in Section 9.1.4.3.2.
3. All components critical to the operation of the crane and parts which could fall into the reactor are positively restrained from loosening. Fasteners above water that cannot be lockwired or tack welded are coated with locking compound.

   The refueling machine design includes the following provisions to ensure safe handling of fuel assemblies:

   a. Bridge, trolley, and hoist drives are mutually interlocked such that no hoist movement is permitted when either the bridge or trolley drive is active. Bridge and trolley drives are interlocked prohibiting simultaneous movement (X-Y) when under manual control. Automatic AND semi-automatic modes allow simultaneous X-Y operation when either the destination coordinates are entered by the operator or the move sequence has been preprogrammed into the PLC. A fuel movement plan, defining the start and stop locations for each move, and the moving assembly weight and type, is prepared by the reactor engineer and entered into the PLC prior to the refueling evolution. Hoist movement is under manual control at all times. When in semi-auto mode, movement of any controller will terminate the mode and place the machine in manual mode.

      Deleted Per 2012 Update.

   b. Bridge and trolley drive operation is prevented except when the fuel mast is in the full up position or when the fuel gripper is disengaged and raised to the "fuel gripper up disengaged" position. Up position is signaled by two redundant switches for the gripper tube.

   c. An interlock prevents opening of a solenoid valve in the air line to the gripper until the fuel assembly or component is properly supported as indicated by a load cell. As back-up protection for this interlock, the mechanical weight actuated lock in the gripper prevents operation of the gripper under load even if air pressure is applied to the operating cylinder.

   d. The fuel hoist has two trip-off switches which protect a fuel assembly from excessive drag forces. The switches are set to fuel manufacturer's recommendations for overload drag (observed when raising a fuel assembly) and underload drag (observed when lowering a fuel assembly). A secondary mechanical overload trip-off switch with a higher setpoint ensures that excessive uplift forces cannot be exerted.

   e. An interlock of the hoist drive circuit in the up direction permits the hoist to be operated only when either the open or closed indicating switch on the gripper is actuated.

      The hoist-gripper position interlock consists of two separate circuits that work in parallel such that one circuit must be closed for the hoist to operate. If one or both interlocking circuits fail in the closed position, or both show as open for more than 1 second, an audible and visual alarm on the console is actuated.

   f. Secure travel zones are defined within the PLC during the commissioning process and identify the area within which the crane can operate without risking collision with walls or other fixed structures or obstacles. The secure travel zones are presented as a graphic display on the console touch screen. The bridge and/or trolley drives are interlocked (disabled) whenever the encoder positioning system reports the mast to be outside the secure zone. In addition, programmed boundary limit switches and mechanical stops prevent collision of the mast with walls and other obstructions in the core area and the upender basket area.

Deleted Per 2012 Update.

g. Suitable restraints are provided between the bridge and trolley structures and their respective rails to prevent derailing due to the safe shutdown earthquake. The refueling machine is designed to prevent disengagement of a fuel assembly from the gripper under the safe shutdown earthquake.

h. The fuel and auxiliary hoists are equipped with two independent braking systems. A solenoid release - spring set electric brake is mounted on the motor shaft. This brake operates in the normal manner to release upon application of current to the motor and set when current is interrupted. The second brake is a mechanically actuated load brake internal to the hoist gear box that sets if the load starts to overload the hoist. It is necessary to apply torque from the motor to raise or lower the load. In raising, the motor cams the brake open; in lowering, the motor slips the brake allowing the load to lower. This brake actuates upon loss of torque from the motor for any reason and is not dependent on any electrical circuits. On the fuel hoist the motor brake is rated at 100 percent operating load and the mechanical brake at 100 percent, per CMAA Specification 70.

The fuel hoist system is supplied with redundant paths of load support such that failure of any one component does not result in free fall of the fuel assembly. Two wire ropes are anchored to the winch drum and carried over independent sheaves to a load equalizing mechanism on the top of the gripper tube. In addition, supports for the sheaves and equalizing mechanism are backed up by passive restraints to pick up the load in the event of failure of this primary support.

The working load of fuel assembly plus gripper is approximately 2500 pounds.

The gripper itself has four fingers gripping the fuel, any two of which will support the fuel assembly weight.

The gripper and hoist system are factory load tested to 3250 pounds.

The following safety features are provided for in the fuel transfer system control circuit:

1. Transfer car operation is possible only when both upenders are in the down position as indicated by the limit switches.
2. The remote control panels have a permissive switch in the transfer car control circuit that prevents operation of the transfer car in either direction when either switch is open, i.e., with two remote control panels, one in the refueling canal and one in the spent fuel pool, the transfer car can not be moved until both "go" switches on the panels are closed.
3. Interlocks allow upender operation only when the transfer car is at either end of its travel.
4. Transfer car operation is possible only when the transfer tube valve position switch indicated the valve is fully open.
5. The refueling canal upender is interlocked such that it cannot be operated unless the reactor manipulator crane fuel gripper tube is fully retracted with a fuel assembly engaged, the fuel gripper tube is completely in the mast with no fuel assembly engaged, or the crane is located over the core. Similarly, the fuel pool upender is interlocked such that it cannot be operated unless the fuel pool manipulator crane fuel gripper tube is fully retracted with a fuel assembly engaged, the fuel gripper tube is completely in the mast with no fuel assembly

engaged, or the crane is located outside of the upender basket area. The interlocks associated with gripper position are controlled by redundant interlocks.

6. All fuel handling tools and equipment handled over an open reactor vessel are designed to prevent inadvertent decoupling from crane hooks (i.e., lifting rigs are pinned to the crane hook and safety latches are provided on hooks supporting tools).

   Tools required for handling internal reactor components are designed with fail safe features that prevent disengagement of the component in the event of operating mechanism malfunction. These safety features apply to the following tool.

   Control Rod Drive Shaft Unlatching Tool: The air cylinders actuating the gripper mechanism are equipped with back up springs which close the gripper in the event of loss of air to the cylinder. Air valves are equipped with safety locking rings to prevent inadvertent actuation.

The fuel handling machine design includes the following provisions to ensure safe handling of fuel assemblies:

Deleted Per 2012 Update.

1. All of the features listed for the reactor manipulator crane also apply to the fuel pool manipulator crane except that the travel limits, hoist overtravel limit, and "slow zones" differ as follows:

   a. An interlock of the bridge and trolley drives prevents the bridge from entering the transfer canal area from either the upender basket area or through the transfer canal gate unless the trolley is positioned with the fuel mast centered on an unobstructed travel path. Similarly, an interlock prevents the bridge from entering or exiting the cask area gate unless the trolley is positioned with the fuel mast centered on the cask area gate. In both cases, the trolley drive is locked out when the crane enters the interlocked area. In addition, travel limit switches and mechanical stops prevent collision of the mast with walls and other obstructions throughout the spent fuel pool, transfer canal, and cask areas.

   b. The fuel manipulator crane has no hoist over the travel limit feature.

   c. Instead of the core slow zones, the fuel pool manipulator crane has slow zones entering the fuel storage racks (beginning approximately 10" above the rack and extending 10" into the rack) at the bottom of the fuel storage racks (approximately 10" above the rack bottom extending to the rack bottom) that prevent further downward hoist movement except in slow speed. Similar slow zones are provided for the new fuel elevator and upender entrance (beginning approximately 10" above the elevator/upender 10" into the elevator/upender) and bottom (approximately 10" above the elevator extending to the elevator bottom).

2. An interlock between the fuel pool manipulator crane and the new fuel elevator prevents the crane from bridging over the new fuel elevator (the crane must trolley over the elevator). Another interlock prevents the crane from trolleying over the new fuel elevator unless the bridge is positioned such that the mast is aligned with the new fuel elevator centerline. In addition, the trolley is prevented for moving over the new fuel elevator unless the elevator is in the full down position.

3. An interlock prevents operation of the manipulator crane hoists, bridge, and trolley drives unless the east monorail is in the full up position.

Deleted Per 2012 Update.

Industrial Codes and Standards used in the design of the fuel handling equipment.

1. Refueling Machine and Fuel Handling Machine: Applicable sections of Crane Manufacturer Association of America Specification No. 70.
2. Structural: AISC, Part 5, 7th Edition
3. Electrical: National Electric Code, NFPA#70, and NEMA Standards MGI and ICS shall be used in the design, installation, and manufacturing of all electrical equipment.
4. Materials: Main load supporting materials conform to the specifications of the ASTM standard.
5. Safety: OSHA Standards 29CFR1910, and 29CFR1926 including load testing requirements, the requirements of ANSI N18.2, Regulatory Guide 1.29 and General Design Criteria 61 and 62.

Similar information for the Fuel Handling Cask Crane is provided in Sections 9.1.2.2 and 9.1.4.2.3.

9.1.4.3.2 Seismic Considerations

The seismic classifications for the fuel handling equipment are listed in Table 3-2.

9.1.4.3.3 Containment Pressure Boundary Integrity

The fuel transfer tube which connects the refueling canal (inside the reactor Containment) and the spent fuel pool (outside the Containment) is closed on the refueling canal side by a blind flange at all times except during refueling operation. Two seals are located around the periphery of the blind flange with leak-check provisions between them.

9.1.4.3.4 Radiation Shielding

During all phases of spent fuel transfer, the gamma dose rate at the surface of the water will be maintained as low as reasonably achievable (ALARA) by maintaining sufficient depths of water above the assembly.

The two cranes used to lift spent fuel assemblies are the refueling machine and fuel handling machine. Both cranes utilize a geared limit switch and a backup lever switch which prevent the top of the fuel pellets in a fuel assembly from being raised to within a minimum of 10 feet of the normal water level in the refueling cavity and the spent fuel pool.

9.1.4.4 Tests and Inspections

As part of normal unit operations, the fuel-handling equipment is inspected for operating conditions prior to each refueling operation. During the operational testing of this equipment, procedures are followed that affirm the correct performance of the fuel handling system interlocks.

In response to NRC IE Bulletin 84-03, "Reactor Cavity Water Seal," which cited a failure of the reactor cavity water seal at the Haddam Neck Plant, evaluations and tests of the Catawba Nuclear Station Units 1 and 2 refueling cavity water seals were performed to determine the potential for and consequences of a refueling cavity water seal failure. Of particular concern in this bulletin was the potential for water inventory loss should the refueling cavity water seal between the reactor vessel and the refueling cavity fail. As concluded in the DPC final response to the NRC for IE Bulletin 84-03 (letter from H.B. Tucker to the NRC, dated November 12, 1985), the evaluations of both unit's refueling cavity water seals demonstrated that such failure was precluded due to inherent design features. Nonetheless, emergency operating procedures for both Catawba units were established to address operator actions in the unlikely event of unanticipated refueling cavity inventory reduction.

9.1.4.5 Instrumentation Requirements

The control systems for the Refueling and Fuel Handling Machines and Fuel Transfer System are discussed in Section 9.1.4.2.3. A discussion of additional electrical controls, such as the interlocks and main hoist braking system, for the FHS are discussed in Section 9.1.4.3.1.

9.1.5 Overhead Heavy Load Handling Systems

9.1.5.1 Introduction and Licensing Background

As a result of Generic Task A-36, “Control of Heavy Loads near Spent Fuel, NUREG-0612, “Control of Heavy Loads at Nuclear Power Plants,” was developed. Following the issuance of NUREG-0612, a Generic Letter dated December 22, 1980 (supplemented on February 3, 1981 by Generic Letter 81-07), was sent to all operating plants, applicants for operating licenses and holders of construction permits requesting that responses be prepared to indicate the degree of compliance with the guidelines of NUREG-0612. Phase I responded to Section 5.1.1 of NUREG-0612 and addressed applicable codes and standards for the subject cranes and special lifting devices, crane operator training and qualification and procedures for heavy load handling. Phase II responded to Sections 5.1.2, 5.1.3, 5.1.5, and 5.1.6 of NUREG-0612 and addressed the need for mechanical stops or electrical interlocks, the need for single- failure proof handling systems and load drop consequence analyses. By letters dated September 24, 1981; July 1, August 6, October 21, December 16, 1982; June 28, 1983; April 19 and May 11, 1984 Catawba provided responses to this NRC request.

The NRC completed their review of the Phase I and II submittals and documented these reviews in Appendix F of SER Supplements 3 and 4, respectively. In July 1984 the NRC concluded through SER Supplement 3 that the “guidelines of NUREG-0612, Section 5.1.1 have been satisfied. Therefore, Phase 1 of NUREG-0612 for Catawba Units 1 and 2 is acceptable.” In December 1984 the NRC concluded through SER Supplement 4 that the “guidelines of NUREG-0612, Section 5.1.2, 5.1.3, 5.1.5, and 5.1.6 have been satisfied. The staff concludes that Phase II of NUREG-0612 for Catawba Units 1 and 2 is acceptable.”

On June 28, 1985, the NRC issued Generic Letter 85-11. This generic letter concluded that Phase I had provided improvements in heavy load handling and that Phase II was no longer required. On April 11, 1996, the NRC issued Bulletin 96-02, "Movement of Heavy Loads over Spent Fuel in the Reactor Core or Over Safety Related Equipment". Duke's response concluded that existing regulatory guidelines associated with the control and handling of heavy loads while the plant is operating, were being met. In its summary of the NRC staff's review of licensee responses for Bulletin 96-02, the NRC concluded that Duke Power's response to the bulletin was acceptable. On October 31, 2005 the NRC issued Regulatory Issue Summary 2005-25, for the clarification of NRC guidelines for control of heavy loads, as a result of recommendations developed through Generic Issue 186, “Potential Risk and Consequences of Heavy Load Drops in Nuclear Power Plants,” and findings developed through the NRC inspection program. Furthermore, on May 29, 2007, the NRC issued Supplement 1 of RIS 2005-25 which addresses remaining recommendations associated with GI 186 and communicates regulatory expectations related to safe load handling. On September 14, 2007, an “Industry Initiative on Heavy Lifts” was initiated by NEI to specify those actions to be taken by each plant to ensure that heavy lifts continue to be conducted safely and that each plant’s licensing bases accurately reflected those plant practices.

9.1.5.2 Design Bases [1]

The design bases of the overhead heavy - load systems are to:

(1) Assure that the potential for a load drop is extremely small,

(2) That in the event of a postulated reactor vessel head drop, the core remains covered and cooled, and

(3) Assure the consequences of a load drop in the spent fuel pool meet the acceptance criteria of NUREG-0612 and the Standard Review Plan.

9.1.5.3 Scope of Heavy Load Handling Systems

All cranes and hoists lifting heavy loads over spent fuel or safe shutdown equipment comply with the guidelines of NUREG-0612 and are consistent with Catawba's responses and commitments related to the handling of heavy loads.

9.1.5.4 Control of Heavy Lifts Program

The control of heavy lifts consists of the following:

(1) Catawba's commitments in response to NUREG-0612, Phase 1 elements

(2) Catawba's response to the NEI Initiative on Heavy Load Lifts

(3) Reactor pressure vessel head lift load drop analysis assumptions (lift height and medium present) are incorporated into plant procedures

(4) Establishing the polar crane as single-failure-proof equivalent for lifting the reactor vessel head as outlined in NEI Initiative on Heavy Load Lifts (08-05, Rev 0) is an acceptable alternative method to the load drop analysis.

(5) Load drop analyses have been performed for loads over the spent fuel pool.

Catawba maintains a Lifting Program to minimize the potential for adverse interaction between overhead load handling operations and: 1) nuclear fuel assemblies to ensure a subcritical configuration and preclude radiological consequences and; 2) structures, systems and components (SSCs) selected to ensure safe, cold shutdown of the plant following a postulated heavy load drop event. A "heavy load" has been defined as one weighing 1500 lbs. or more. NRC's bases of acceptance for Catawba's Heavy Load program are summarized in Supplements 3 (Phase I analysis) and 4 (Phase II analysis) of the SER. The objective of the program is to ensure that all load handling systems are designed, operated, and maintained such that their probability of failure is uniformly small and their use appropriate for the critical tasks in which they are employed.

9.1.5.4.1 Catawba Commitments in Response to NUREG-0612, Phase 1 Elements

The Catawba Lifting Program is based on the NEI "Industry Initiative on Heavy Lifts" and the following general guideline areas of NUREG-0612, Section 5.1.1:

Guideline 1 - Safe Load Paths

Guideline 2 - Load Handling Procedures

Guideline 3 - Crane Operator Training

---

[1] From NUREG-0612, Section 5.1, Page 5-1

Guideline 4 - Special Lifting Devices

Guideline 5 - Lifting Devices (not specifically designed)

Guideline 6 - Cranes (inspection, testing and maintenance)

Guideline 7 - Crane Design

The following Sections summarize the commitments made by Catawba in compliance with Section 5.1.1 of NUREG-0612:

(1) Safe Load Paths

Safe load paths are "defined for the movement of heavy loads to minimize the potential for heavy loads, if dropped, to impact irradiated fuel in the reactor vessel and in the spent fuel pool, or to impact safe shutdown equipment."

The Duke Energy Nuclear Lifting Program Manual specifies that administrative controls shall be established at each site to control heavy loads in accordance with NRC commitments in regard to NUREG-0612.

The Crane Operator and the Flagger must review and be familiar with the Upper Containment Heavy Load Lift Load Path Book prior to making any lifts. If a heavy load travels over spent fuel, safe shutdown equipment or decay heat removal equipment, a load path deviation request form must be filled out by the crane operator and approved by the responsible Engineering Representative.

The commitment that the load travel path be marked and a spotter walking ahead of the load is satisfied by Catawba from the Duke Energy Nuclear Lifting Program Manual, which requires verification of clear load travel path and to rope off load travel path as required. Also, personnel making a lift where roping off or marking is not feasible must ensure that alternative measures that are required to meet NUREG 0612 have been met.

For Crane Movement in the Spent Fuel Buildings, loads in excess of 3000 pounds shall be prohibited from travel over fuel assemblies in the storage pool. Spent fuel pool weir gates may be moved by crane over spent fuel in accordance with the requirements of the Selected Licensee Commitments (SLC) Manual.

(2) Load Handling Procedures

It is required that Load Handling Procedures "should be developed to cover load handling operations for heavy loads that are or could be handled over or in proximity to irradiated fuel or safe shutdown equipment."

Duke Energy's response was to commit that, "Duke will include the requirements for safe load paths in both new and existing procedures pertaining to heavy load lifts."

One of the purposes of the Duke Energy Nuclear Lifting Program is to provide a program for the control, operation, record keeping, and maintenance for cranes, hoists and special lifting devices.

Polar Crane operators and flagmen are directed by maintenance procedure "Polar Crane Operation and Upper Containment Load Paths," and the Upper Containment Heavy Load Lift-Load Path Book to ensure that the proper sequence in handling the load is followed.

All critical lift movements such as the Removal and Replacement of the Reactor Vessel Head, upper and lower Internals, horizontal and vertical shield blocks, S/G enclosures or Reactor Coolant Pump Hatch Covers, shall be controlled by a qualified operator and flagger and shall travel in the area designated in the Upper Containment Heavy Load Path Book. Also the maintenance procedure mandates verification that all Crane Preventative Maintenance (PM) inspections are current.

(3) Crane Operators

NUREG-0612 requires that "crane operators should be trained, qualified, and conduct themselves in accordance with Chapter 2-3 of ANSI B30.2-1976,'Overhead and Gantry Cranes'."

Catawba concurred that the guidelines of ANSI B30.2 -1976 are to be followed for the qualification, training, and conduct of crane operators. Catawba further committed that it "will maintain suitable records of crane operator training."

The Duke Energy Nuclear Lifting Program Manual outlines crane operator training according to the requirements of NUREG-0612.

Deleted Per 2013 Update.

(4) Special Lifting Devices

NUREG-0612 mandates that "special lifting devices should satisfy the guidelines of ANSI N14.6-1978, 'Standard for Special Lifting Devices for Shipping Containers Weighing 10,000 Pounds (4500 kg) or More for Nuclear Material."

The following special lifting devices were determined to be designed, fabricated and load tested in compliance with the requirements or intent of ANSI N14.6-1978, as applicable:

- Reactor Vessel Head Lifting Rig
- Load Cell
- Reactor Internals Lifting Rig
- Reactor Coolant Pump Motor Lifting Rig
- Control Rod Drive Mechanism Missile Shield Lifting Rig.

Although not originally specified to be designed in accordance with ANSI N14.6, 1978, each of the special lifting devices was provided by Westinghouse or Duke Power in accordance with appropriate Quality Assurance and Quality Control procedures for a specific application. Each of the lifting devices was load tested by Westinghouse or Duke Power based on the current Industrial Practice.

This commitment is further enforced through Duke Energy Nuclear Lifting Program Manual stating "Special lifting devices used to handle heavy loads (NUREG-0612) shall be tested in accordance with ANSI N14.6 requirements as determined by the Lifting Coordinator".

Additional special lifting devices have been identified which were not included in Catawba's SER. These devices were designed and fabricated in accordance with ANSI N14.6 requirements.

- Lifting Yoke -Section 1.2.1.5.9, (reference 51 and 56)
- TFR Section 1.2.1.4, (reference 50 and 55)
- ISFSI Extension

(5) Lifting Devices that are not specially designed

"Lifting devices that are not specially designed should be installed and used in accordance with the guidelines of ANSI B30.9-1971."

Catawba committed that the lifting devices used in handling these loads consist of the appropriate size and number of chain-falls, chokers, and slings as determined by the rigger, and that maximum full load speeds of the hoist will be limited to 20 feet per minute. A lifting device is procured and maintained in accordance with ANSI B30.9-1971. In making his selection, the rigger draws on his experience and the Elementary and Advance Rigger Training provided on choker and sling sizing, which is determined by the estimated weight of the load. If additional information is needed, the Riggers Handbook is used. All lifts are made by qualified people who, by experience and/or training, are cognizant in the movement of loads.

This commitment is captured through the Duke Energy Nuclear Lifting Program Manual which requires rigging hardware not specially designed shall be installed and used in accordance with the guidelines of ANSI B30.9 "Slings" and applicable OSHA Standards for rigging equipment for material handling. Slings, not part of the pre-defined program, will be inspected in accordance with ANSI B30.9 prior to use.

(6) Inspection, Testing, and Maintenance

The crane is to be inspected, tested and maintained “in accordance with Chapter 2-2 of ANSI B30.2-1976, 'Overhead and Gantry Cranes,' with the exception that tests and inspections should be performed prior to use where it is not practical to meet the frequencies of ANSI B30.2 for periodic inspection and test, or where frequency of crane use is less than the specified inspection and test frequency."

Catawba Nuclear Station will comply with the requirements of ANSI B30.2 Chapter 2-2 pertaining to inspection, testing, and maintenance requirements. Records will be developed to show that each crane or hoist is in compliance. Also, each of the individual hoist analysis sheets show that crane inspection is to ANSI B30.2, 1976 Chapter 2-2.

It is also a prerequisite in maintenance procedures to have crane operators ensure that the crane has the most current inspection. The Duke Energy Nuclear Lifting Program Manual captures the NUREG 0612 requirements for inspection, testing and maintenance. Section 9.1 of the Manual contains the crane and hoist equipment inspection requirements which is in accordance with Chapter 2-2 of ANSI B30.2-1983.

(7) Crane Design

"The crane should be designed to meet the applicable criteria and guidelines of Chapter 2-l of ANSI 830.2-1976, 'Overhead and Gantry Cranes,' and of CMAA-70, 'Specifications for Electric Overhead Traveling Cranes'. An alternative to a specification in ANSI 830.2 or CMAA-70 may be accepted in lieu of specific compliance if the intent of the specification is satisfied."

According to the NRC “compliance with CMAA 70 does in fact constitute compliance with ANSI B30.2.” Therefore Catawba site procedure for the “Containment vessel polar cranes and fuel handling bridge cranes” specifies this compliance with CMAA Spec-70, “Specifications for Electric Overhead Traveling Cranes,” which satisfies ANSI B 30.2 requirements.

9.1.5.4.2 Catawba Response to NEI Initiative on Heavy Load Lifts

9.1.5.4.2.1 Reactor Vessel Head Lifting Procedures

In response to the September 14, 2007 NEI “Industry Initiative on Heavy Load Lifts,” Catawba procedures used to control the lift and replacement of the reactor vessel head establish limits of load height and the medium present under the load. These procedures are based on (1) analyses performed using the guidance and acceptance criteria developed by NEI as a part of its initiative, and (2) provide additional assurance that the core will remain covered and cooled in the event of a postulated reactor vessel head drop. The motion restrictions, such as load height and medium present under the load to cushion postulated drops, and load weight are identified in the plant procedures governing load handling.

As an alternative to controlling the lift and replacement of the reactor vessel head as described in the preceding paragraph, the existing polar crane may be classified as "single failure proof equivalent" in accordance with the guidance and acceptance criteria developed by NEI 08-05 initiatives. Therefore, the reactor vessel head can be lifted without the presence of the medium (water) under the load.

9.1.5.4.2.2 Load Drops in the Spent Fuel Pool Building

The area in which the spent fuel casks are handled is a structure composed of reinforced concrete with a rock foundation. To preclude the cask entering the spent fuel pool, the cask handling crane stops are located in a position to prevent the cask from being moved into the fuel pool area. The cask area is separated from the spent fuel pool by a three foot reinforced concrete wall. Based upon an evaluation to assess the possibility of the cask entering the spent fuel pool in the lifted (vertical) and tipped position, it was concluded that the cask would not enter the spent fuel pool due to dropping or tipping of the cask. Local damage to the concrete will be negligible and no safety related equipment is located in the cask travel path.

The evaluation and consequence of spent fuel cask drops in the Spent Fuel Pool are discussed in Section 9.1.2.3 of the UFSAR. The radiological consequence of loaded cask drops in the Fuel Building is discussed in Section 15.7.5 of the UFSAR.

The evaluation and consequence of a weir gate drop, while being maneuvered in the spent fuel pool, are discussed in Section 9.1.2.3.1.6 of the UFSAR. The radiological consequence of a weir gate drop is discussed in Section 15.7.4.2.3 of the UFSAR.

9.1.5.5 Safety Evaluation

The Catawba Lifting Program provides a defense-in-depth approach which ensures that all load handling systems are designed, operated, and maintained such that the probability of their failure is very small and the use of said handling systems appropriate for the tasks in which they are employed. In addition, procedures to lift and replace the reactor vessel head ensure the core remains covered and cooled when a reactor vessel head drop is postulated.

The consequences of a load drop meet the acceptance criteria of NUREG-0612 and the Standard Review Plan.

9.1.6 References

1. Deleted Per 2007 Update.
2. Deleted Per 2007 Update.
3. Deleted Per 2007 Update.
4. Nuclear Regulatory Commission, Letter to All Power Facilities Holding an Operating License (OL) or Construction Permit (CP) Except Fort St. Vrain, from Richard C. DeYoung, August 24, 1984, "Refueling Cavity Water Seal."
5. Duke Power Company, Letter to Dr. J.N. Grace (NRC) from H.B. Tucker, November 12, 1985, "NRC/OIE Bulletin 84-03."

6. Nuclear Regulatory Commission, Letter to All Licensees of Operating Plants and Applicants for Operating Licenses and Holders of Construction Permits, from Darrell G. Eisenhut, December 22, 1980, "Control of Heavy Loads."
7. Duke Power Company, Letter to Harold R. Denton (NRC) from W. O. Parker, Jr., September 24, 1981, "Catawba Nuclear Station Units 1 & 2, Docket Nos.50-413, 414, Control of Heavy Loads."
8. Duke Power Company, Letter to Harold R. Denton (NRC) from W. O. Parker, Jr., July 1, 1982, "Catawba Nuclear Station Units 1 & 2, Docket Nos.50-413, 414, Control of Heavy Loads."
9. Duke Power Company, Letter to Harold R. Denton (NRC) from H. B. Tucker, August 6, 1982, "Catawba Nuclear Station Units 1 & 2, Docket Nos.50-413, 414, Control of Heavy Loads."
10. Duke Power Company, Letter to Harold R. Denton (NRC) from H. B. Tucker, October 21, 1982, "Catawba Nuclear Station Units 1 & 2, Docket Nos.50-413, 414, Control of Heavy Loads."
11. Duke Power Company, Letter to Harold R. Denton (NRC) from H. B. Tucker, December 16, 1982, "Catawba Nuclear Station Units 1 & 2, Docket Nos.50-413, 414, Control of Heavy Loads."
12. Duke Power Company, Letter to Harold R. Denton (NRC) from H. B. Tucker, June 28, 1983, "Catawba Nuclear Station Units 1 & 2, Docket Nos.50-413, 414, Control of Heavy Loads."
13. Duke Power Company, Letter to Harold R. Denton (NRC) from H. B. Tucker, April 19, 1982, "Catawba Nuclear Station Units 1 & 2, Docket Nos.50-413, 414, Control of Heavy Loads."
14. Duke Power Company, Letter to Harold R. Denton (NRC) from H. B. Tucker, May 11, 1982, "Catawba Nuclear Station Units 1 & 2, Docket Nos.50-413, 414, Control of Heavy Loads."
15. Nuclear Regulatory Commission, Letter to All Licensees for Operating Reactors, from Hugh L. Thompson, Jr., June 28, 1985, "Completion of Phase II of Control of Heavy Loads at Nuclear Power Plants, NUREG-0612 (Generic Letter 85-11)."
16. Nuclear Regulatory Commission, Letter to M.S. Tuckman from Frank Rinaldi, May 1, 1998, "Completion of Licensing Action for NRC Bulletin 96-02, 'Movement of Heavy Loads Over Spent Fuel, Over Fuel in the Reactor Core, or Over Safety Related Equipment,' dated April 11, 1996, for McGuire Nuclear Station, Units 1 and 2 (TAC Nos. M95605 and M95606) and Catawba Nuclear Station, Units 1 and 2 (TAC Nos. M95569 and M95570)."
17. “Proposed Amendments to the Facility Operating License and Technical Specifications to Allow Insertion of Mixed Oxide (MOX) Fuel Lead Assemblies and Request for Exemption from Certain Regulations in 10 CFR Part 50”, Package Transmittal from M. S. Tuckman (Duke Power) to U.S. NRC Document Control Desk, February 27, 2003.
18. Letter from R. E. Martin, Project Manager – U.S. Regulatory Commission to H. B. Barron dated March 3, 2005, Issuance of License Amendments 220 and 215 for Catawba Nuclear Station concerning the use of mixed oxide fuel lead test assemblies.
19. Nuclear Regulatory Commission, Letter to All Power Reactor Licensees, from L. Kopp, August 19, 1998, “Guidance on the Regulatory Requirements for Criticality Analysis of Fuel Storage at Light Water Reactor Power Plants.”

20. Letter from Dhiaa Jamil (Duke) to U.S. NRC, “Catawba Nuclear Station, Units 1 and 2, Proposed Technical Specification Amendment, Technical Specification 3.7.16, Spent Fuel Assembly Storage, and 4.3, Fuel Storage,” – September 13, 2005.
21. Oak Ridge National Laboratory, SCALE 4.4 – A Modular Code System for Performing Standardized Computer Analyses for Licensing Evalution, NUREG/CR-0200 (Rev. 5), CCC-545, March 1997.
22. ANSI B30.11-1980, “Material and Under-hung Cranes.”
23. ANSI B30.2.0-1983, “Overhead and Gantry Cranes.”
24. ANSI B30.9-1984, “Slings.”
25. ANSI N14.6-1978, “American National Standard for shipping containers weighing 10,000 pounds (4,500 kg) or more for nuclear materials.”
26. Catawba Maintenance Procedure MP/0/A/7650/057, “Polar Crane Operation and Upper Containment Load Paths”
27. Catawba Maintenance Procedure MP/1(2)/A/7150/042, “Reactor Vessel Head Removal and Replacement”
28. Catawba Selected Licensee Commitment (SLC) Section 16.9-20, “Refueling Operations-Crane Travel- Spent Fuel Storage Pool Building”
29. Catawba UFSAR Section 15.7.4, “Fuel Handling Accidents in the Containment and Spent Fuel Storage Buildings”
30. Catawba UFSAR Section 15.7.5, “Spent Fuel Cask Drop Accident”
31. Catawba UFSAR Section 9.1.2.3, “Fuel Storage and Handling- Spent Fuel Storage Safety Evaluation”
32. Duke Energy Nuclear Lifting Program Manual.
33. Deleted Per 2013 Update.
34. Duke Power Company, Letter to Harold R. Denton (NRC) from H. B. Tucker, August 6, 1982, "Catawba Nuclear Station Units 1 & 2, Docket Nos.50-413, 414, Control of Heavy Loads."
35. Duke Power Company, Letter to Harold R. Denton (NRC) from H. B. Tucker, October 21, 1982, "Catawba Nuclear Station Units 1 & 2, Docket Nos.50-413, 414, Control of Heavy Loads."
36. Duke Power Company, Letter to Harold R. Denton (NRC) from H. B. Tucker, December 16, 1982, "Catawba Nuclear Station Units 1 & 2, Docket Nos.50-413, 414, Control of Heavy Loads."
37. Duke Power Company, Letter to Harold R. Denton (NRC) from H. B. Tucker, June 28, 1983, "Catawba Nuclear Station Units 1 & 2, Docket Nos.50-413, 414, Control of Heavy Loads."
38. Duke Power Company, Letter to Harold R. Denton (NRC) from H. B. Tucker, April 19, 1982, "Catawba Nuclear Station Units 1 & 2, Docket Nos.50-413, 414, Control of Heavy Loads."
39. Duke Power Company, Letter to Harold R. Denton (NRC) from H. B. Tucker, May 11, 1982, "Catawba Nuclear Station Units 1 & 2, Docket Nos.50-413, 414, Control of Heavy Loads."

40. Duke Power Company, Letter to Harold R. Denton (NRC) from W. O. Parker, Jr., September 24, 1981, "Catawba Nuclear Station Units 1 & 2, Docket Nos.50-413, 414, Control of Heavy Loads."

41. Duke Power Company, Letter to Harold R. Denton (NRC) from W. O. Parker, Jr., July 1, 1982, "Catawba Nuclear Station Units 1 & 2, Docket Nos.50-413, 414, Control of Heavy Loads."

42. NEI “Industry Initiatives on Heavy Load Lifts,” dated September 14, 2007

43. NRC Enforcement Guidance Memorandum 07-006, “Enforcement Discretion for Heavy Load Handling Activities,” dated September 28, 2007

44. Nuclear Regulatory Commission, Letter to All Licensees for Operating Reactors, from Hugh L. Thompson, Jr., June 28, 1985, "Completion of Phase II of Control of Heavy Loads at Nuclear Power Plants, NUREG-0612 (Generic Letter 85-11)."

45. Nuclear Regulatory Commission, Letter to All Licensees of Operating Plants and Applicants for Operating Licenses and Holders of Construction Permits, from Darrell G. Eisenhut, December 22, 1980, "Control of Heavy Loads."

46. Nuclear Regulatory Commission, Letter to M.S. Tuckman from Frank Rinaldi, May 1, 1998, "Completion of Licensing Action for NRC Bulletin 96-02, 'Movement of Heavy Loads Over Spent Fuel, Over Fuel in the Reactor Core, or Over Safety Related Equipment,' dated April 11, 1996, for McGuire Nuclear Station, Units 1 and 2 (TAC Nos. M95605 and M95606) and Catawba Nuclear Station, Units 1 and 2 (TAC Nos. M95569 and M95570)."

47. NUREG 0612, “Control of Heavy Loads at Nuclear Power Plants.”

48. The Upper Containment Heavy Load Lift- Load Path Book CNM-1125.01-144.

49. Westinghouse Electric Corporation CN-MRCDA-07-94, “Evaluation of a Closure Head Assembly Drop for McGuire Units 1 and 2, and Catawba Units 1 and 2”

50. Section 1.2.1.4, NAC-UMS FSAR

51. Section 1.2.1.5.9, NAC-UMS FSAR

52. NEI 08-05 (Rev. 0), "Industry Initiative on Control of Heavy Loads", dated July 2008

53. Nuclear Regulatory Commission, letter to Thomas C. Houghton from William H. Ruland, September 5, 2008 endorsing the NEI 08-05 document "Industry Initiative on Control of Heavy Loads", dated July 2008

54. Catawba Maintenance Procedure MP/0/B/7650/145, "EXH - Containment Polar Crane", Revision 11

55. Section 1.3.1.4, NAC Magnastor FSAR

56. Section 1.3.1 and 2.4.4, NAC Magnastor FSAR

THIS IS THE LAST PAGE OF THE TEXT SECTION 9.1.

THIS PAGE LEFT BLANK INTENTIONALLY.

9.2 Water Systems

9.2.1 Nuclear Service Water System

Note:

This section of the FSAR contains information on the design bases and design criteria of this system/structure. Additional information that may assist the reader in understanding the system is contained in the design basis document (DBD) for this system/structure.

9.2.1.1 Design Bases

The Nuclear Service Water System (RN) provides essential auxiliary support functions to Engineered Safety Features of the station. The system is designed to supply cooling water to various heat loads in both the safety and non-safety portions of each unit. Provisions are made to ensure a continuous flow of cooling water to those systems and components necessary for plant safety during normal operation and under accident conditions. Sufficient redundancy of piping and components is provided to ensure that cooling is maintained to essential loads at all times. See Table 3-4 for a listing of RN System component design codes, locations, missile protection and seismic consideration.

9.2.1.2 System Description

The Nuclear Service Water System is shown diagrammatically on Figure 9-22 through Figure 9-33. The piping and components shown on Figure 9-22 through Figure 9-25 are shared between units, while the piping and components shown on Figure 9-26 through Figure 9-33 are duplicated for each unit unless otherwise stated in the following text. Functionally the system consists of four sections which, when put together in series, serve to assure a supply of river water to various station heat loads and return the heated effluent back to its proper heat sink.

In order of flow, these are:

1. Source and intake section
2. RN Pumphouse section
3. Station heat exchanger section
4. Main discharge section

9.2.1.2.1 Source and Intake Section

Two bodies of water serve as a cooling water source for the components cooled by the RN System. Lake Wylie is the normal source of nuclear service water. A single transport line conveys water from a Class 1 seismically designed intake structure at the bottom of the lake to both the A and B pits of the Nuclear Service Water Pumphouse serving the RN pumps in operation. Isolation of each line is assured by two valves in series and fitted with electric motor operators powered from separate power supplies.

Should Lake Wylie be lost due to a seismic event in excess of the design of Wylie Dam; the Standby Nuclear Service Water Pond (SNSWP), formed by the Class 1 seismically designed SNSWP Dam, contains sufficient water to bring the station safely to a cold shutdown condition under all normal, transient, and accident conditions. The SNSWP has an intake structure designed to Class 1 seismic requirements, with two Class 1 seismic, redundant lines to transport water independently to each pit in the RN Pumphouse. Each line is secured by a single motor operated valve. Automatically upon loss of Lake Wylie (as detected by RN pump pit level instrumentation), Lake Wylie double isolation valves are closed and the SNSWP valves are opened to both pit A and pit B.

The Nuclear Service Water lines cross over the condenser cooling water lines. These RC lines are low-pressure lines and could only affect the NSW lines by undermining the surrounding soil due to a possible loss of cooling water. Detection of this loss and system shutdown would occur prior to any detrimental effects to the NSW lines; further, the carbon steel NSW lines are self-supporting over a considerable distance should any undermining occur. Supply lines to the Unit 2 Diesel Generators are high density polyethylene material, which is not self-supporting over long distances, and are supported by a seismically qualified bridge over the RC line washout zone.

Ultimate heat sink adequacy is discussed and analyzed in Section 9.2.5.

9.2.1.2.2 RN Pumphouse Section

The RN Pumphouse is a Class 1 seismically designed structure that contains two separate pits from which two independent and redundant channels of RN pumps take suction. Each pit can be supplied from both the normal source and also the assured source of water. Either pit is capable of passing the flow needed for a simultaneous unit LOCA and unit cooldown. Flow spreaders in front of all the intake pipe entrances prevent vortices and flow irregularities while removable lattice screens protect the RN pumps from solid objects.

Pumps 1A and 2A take suction from pit A and discharge through RN strainers 1A and 2A respectively. The outlet piping of the 1A and 2A RN strainers then join back together to form the channel A Supply line to channel A components in both units.

RN pumps 1B and 2B are physically separated from RN pumps 1A and 2A by a concrete wall, and take suction from pit B, discharging through RN strainers 1B and 2B respectively. The outlet piping of strainers 1B and 2B join together to form the channel B supply line to channel B components in both units. See Table 9-2 for a listing of RN System component design parameters.

The Nuclear Service Water lines cross over the condenser cooling water lines. These RC lines are low-pressure lines and could only affect the NSW lines by undermining the surrounding soil due to a possible loss of cooling water. Detection of this loss and system shutdown would occur prior to any detrimental effects to the NSW lines; further, the carbon steel NSW lines are self-supporting over a considerable distance should any undermining occur. Supply lines to the Unit 2 Diesel Generators are high density polyethylene material, which is not self-supporting over long distances, and are supported by a seismically qualified bridge over the RC line washout zone.

Outside the Auxiliary Building wall, the channel A supply line splits, with 1A supply header entering on the Unit 1 side, isolated by an EMO valve powered by the 1A normal and assured power supplies, and the 2A supply header entering the building on the Unit 2 side, isolated by an EMO valve powered by the 2A normal and assured power supplies.

Likewise, the channel B supply line splits with the 1B supply header entering on the Unit 1 side of the Auxiliary Building and the 2B supply header entering on the Unit 2 side, each isolated by EMO valves powered by corresponding normal and assured power supplies.

The supply and return headers are arranged and fitted with isolation valves such that a critical crack in either header can be isolated and will not jeopardize the safety functions of this system or flood out other safety related equipment. The operation of any two pumps on either or both supply lines is sufficient to supply all cooling water requirements for unit startup, cooldown, and refueling and post-accident operation of two units. However, one pump has sufficient capacity to supply all cooling water requirements during normal power operation of both units or during post accident conditions if the unaffected unit is already in cold shutdown. All pumps (two per unit) are started during the hypothetical combined accident and loss of normal power. In an accident, the safety injection signal automatically starts both RN pumps on each unit, thus providing complete redundancy.

If a diesel generator (or an RN pump) is out-of-service for an extended period of time (then, its associated unit is in cold shutdown), one RN pump is sufficient to provide adequate cooling water requirements for the operating unit and maintain the other unit in cold shutdown in the event of a hypothetical combined accident and loss of normal power. If the RN system is aligned in the RN Single Supply Header Operation (see Section 9.2.1.7), aligning the RN system in the one pump analysis is prohibited.

The Nuclear Service Water System design basis is for operation under the worst initial conditions of operation. This condition is assumed to be the low probability combination of a loss of coolant accident in one unit, extended shutdown of the other unit, loss of the downstream dam, and a prolonged drought and hot weather and its effect on the Standby Nuclear Service Water Pond. In addition, the RN Pumphouse is designed to keep all valve and pump motors and other essential electrical equipment above water during the probable maximum flood (PMF) due to sudden occurrence of a rain induced failure of the upstream dam.

The RN pumps can take suction from Lake Wylie throughout the entire range of lake levels from 592.4 ft above MSL (maximum calculated flood elevation corresponding to a seismic failure of Cowans Ford Dam coincident with a Standard Project Flood) down to the maximum lake drawdown of 559.4 ft above MSL. The SNSWP is normally overflowing at 574 ft above MSL and has a minimum allowable water level of 571 ft as described in Section 9.2.5.

9.2.1.2.3 Heat Exchanger Section

Nuclear Service Water supplied by the RN pumps is used in both units to supply essential cooling water needs, as an assured source of water for another safety-related system, and as a backup cooling water supply to the RN nonessential headers.

Essential components are those necessary for safe shutdown of the unit, and must be redundant to meet single failure criteria. Nonessential components are not necessary for safe shutdown of the unit, and are not redundant. Each unit has two trains of essential heat exchangers, designated A and B, and one train of nonessential heat exchangers with a backup cooling water supply from either A or B and isolated on Engineered Safety Features actuation. However, when RN is aligned in Single Supply Header Operation, RN trains A and B do not isolate and remain cross-connected. This ensures that NSW cooling flow is available to all four essential headers while the RN system is aligned in Single Supply Header Operation as described in Section 9.2.1.7.

The following components or services are supplied by each essential header of the RN System. Some components are normally in operation, some are automatically supplied upon ESF actuation, and others are used when needed.

1. RN Pump Motor Cooler
2. RN Strainer Backflush
3. RN Pump Motor Upper Bearing Oil Cooler

4. Diesel Generator Engine Jacket Water Cooler
5. Deleted Per 2006 Update
6. Deleted Per 2006 Update
7. Component Cooling Heat Exchanger
8. Assured Auxiliary Feedwater Supply
9. Assured Fuel Pool Makeup
10. Assured KC System Makeup
11. Containment Spray Heat Exchanger
12. The Control Room Area Chiller Condenser (Condensers A and B are shared between units, so they are fed by Unit 1 Essential Headers only)
13. Auxiliary Shutdown Panel Air Conditioning Unit (assured cooling, normally cooled by KC)
14. Assured NW System Makeup

The Unit 1 RN nonessential header backup supply is fed from the Unit 1 crossover between channels 1A and 1B. The Unit 2 RN nonessential header backup supply is fed from the Unit 2 crossover between channels 2A and 2B.

The Containment Chilled Water System (YV) normally supplies the components on the Unit 1 and Unit 2 RN nonessential headers (listed below), but loses power on station blackout. The RN System nonessential headers may be aligned to supply backup cooling water during the blackout.

Deleted Per 2010 Update

1. Lower Containment Vent Units (4 per unit)
2. Incore Instrumentation Area Vent Units (2 per unit)
3. Reactor Coolant Pump Motor Air Coolers (4 per unit)
4. Upper Containment Vent Units (4 per unit)
5. Auxiliary Building Supply Units (2 per unit)

See Table 9-3 for nominal Nuclear Service Water System flow demands outside of the RN pumphouse. Nominal Nuclear Service Water Flow System flow demands inside of the RN pumphouse are listed separately in Table 9-5. Tables of nominal RN flow rates are provided as guides to help understand the operation of the RN System. Individual component flow rates and system alignments depicted thereon are not absolute. System conditions may dictate that additional components be put on line, or that individual components be taken off line. Flow tolerances through individual components are documented in controlling design documents for the system.

Essential components receiving Nuclear Service Water flow are described below:

The RN pump motors are of the totally enclosed, water cooled type which have internal water-to-air heat exchangers. Normally cooling water is provided to the RN pump motor coolers only when the motor is in operation. The control valves for the RN pump motor coolers are manually set.

Normally the RN pump motor upper bearing oil coolers are supplied cooling flow only when their respective RN pumps are in operation. The RN pump motor coolers and RN pump motor upper bearing oil coolers are located downstream of the associated pump's backflush RN strainer. A motor operated isolation valve is interlocked to open when the pump motor starts and close when the pump motor stops.

The nuclear service water strainers backflush automatically on a time cycle unless overridden by a pre-set high pressure drop. Internal water pressure is the motive force for dislodging strained particles as a backflush drive motor turns a backwash arm past the various strainer assemblies. The discharge is released to atmospheric pressure and dumps into a trash basket located inside the RN Pumphouse. Entrained trash is collected and the water is returned to the pump pit. This backwash alignment is used to accommodate environment permit restrictions associated with injecting chemicals into the RN system. Historically, there has been very little debris found in the trash basket. The pump pits are also inspected periodically and cleaned if necessary. If excessive backwashing occurs due to high differential pressure across a strainer, the system can be realigned so the strainers will backflush to the trash basket located outside the RN pumphouse. This realignment would occur after suspending chemical addition to prevent any non-permitted discharge from being sent to the Standby Nuclear Water Water Pond.

Cooling water is supplied to the diesel generator engine jacket water cooler only when the diesel is in operation. This is accomplished by an electric motor operated valve interlocked to open when the diesel starts, close when the diesel stops. The diesel generator jacket water cooler may also be supplied with cooling water during testing, maintenance activities and operational alignments requiring additional RN flow paths, when the diesel generator is not in operation.

Most heat exchangers in which a tube leak could allow radioactive fluid to enter the cooling water are cooled indirectly through the closed loop Component Cooling System (KC). Heat is then transferred to the RN System via the component cooling heat exchanger. The heat load provided by the RN normal loads will probably provide RN pump minimum flow requirements, but should this not be the case, one of the non-operating KC heat exchangers may be used to provide a minimum flow path.

The KC heat exchanger control valve on the non-operating KC train will receive a signal to modulate on RN pump flow. It will open upon low-flow (minimum flow) conditions, allowing the minimum flow to pass through the redundant KC heat exchanger. On receipt of a safety injection signal from its respective unit, these valves fail open to assure flow from the RN pumps. During normal operation, a loss of energy (such as loss of offsite power or loss of instrument air) will also cause these minimum flow valves to fail open.

The only heat exchanger which could allow radioactive liquid to be discharged to the environment in the event of a tube leak is the containment spray heat exchanger, which is only in service after a loss of coolant accident. A radiation monitor is installed at the outlet of this heat exchanger. Should a leak occur, that channel would be shut down, isolated, and repaired while the redundant channel provides the required cooling.

One of two control room area chiller condensers, which are located on the Unit 1 essential headers, is normally in operation. In the event of a single failure, the other chiller operates to pick up the entire load due to a one unit LOCA and one unit cooldown simultaneously. The automatic control valves for these components are electro-hydraulically actuated and powered from the Class 1E emergency diesels. These control valves can be aligned to the Class 1E emergency diesels from either unit and are designed to continue operation, maintaining control room area habitability by controlling condenser head pressure after loss of offsite power, LOCA, and earthquake.

The normal source of cooling to the auxiliary shutdown panel air conditioning units (ASPSUs) is the Component Cooling system. RN is manually aligned as the assured source of cooling to the ASPSUs at the initiation of any auxiliary shutdown panel event. A separate auxiliary shutdown panel air conditioning unit condenser is located on each of the four RN essential headers. Each of the four air conditioning units is independently controlled to maintain a controlled environment for functioning electrical equipment and to assure habitability for personnel in the event of a control room evacuation and simultaneous loss of offsite power. Their automatic control valves are self-contained and controlled by refrigerant head pressure, making this function independent of air supply.

Unless otherwise stated in the preceding description, all automatic control valves fail open on loss of air or signal, and have travel stops to limit the maximum flow through the corresponding heat exchanger.

9.2.1.2.4 Main Discharge Section

There are two main discharge headers, extending the width of the Auxiliary Building with channel 1A and 2A components returning flow to the A header, and channel 1B and 2B components returning flow to the B header. During normal station operation when RN pumps are taking suction from Lake Wylie, discharge crossover valves are open, and all heat exchangers in operation discharge through the channel A return to Lake Wylie via the Low Pressure Service Water discharge. Automatically upon emergency low pumphouse pit level (as in loss of Lake Wylie), double isolation valves close on the return line to Lake Wylie, double isolation valves close on the discharge header crossover, and single isolation valves open on each channel return to the SNSWP. This sequence, along with isolation of the non-essential header and supply header crossover valves ensures two independent, redundant supplies and returns, satisfying the single failure criteria. However, when RN is aligned in Single Supply Header Operation, RN trains A and B do not isolate and the discharge header remains cross-connected. This insures a discharge flow path for all four RN essential headers while the system is aligned in Single Supply Header Operation, as described in Section 9.2.1.7. The non-essential header double isolation valves for each unit will only isolate on P-signal from their respective units, not emergency low pumphouse pit level. An emergency low pumphouse pit level signal effectively isolates the non-essential header supply by closing the RN non-essential headers isolation valves. If damage is visually assessed, the non-essential header will be manually isolated.

The Auxiliary Building return headers contain isolation valves and access manways to allow for inspection and maintenance.

RN piping in each Diesel Generator Building also has discharge isolation valves that are aligned from lake discharge to SNSWP discharge on the same signals which cause the Auxiliary Building headers to align to the SNSWP.

The Nuclear Service Water lines cross over the condenser cooling water lines. These RC lines are low-pressure lines and could only affect the NSW lines by undermining the surrounding soil due to a possible loss of cooling water. Detection of this loss and system shutdown would occur prior to any detrimental effects to the NSW lines; further, the carbon steel NSW lines are self-supporting over a considerable distance should any undermining occur. Return lines from the Unit 2 Diesel Generators are high density polyethylene material, which is not self-supporting over long distances, and are supported by a seismically qualified bridge over the RC line washout zone.

The discharge lines to the SNSWP split and discharge flow to each "finger" of the SNSWP to assure that surface cooling will occur in all areas of the pond. An orifice is installed to create a pressure drop in the shorter of the two discharge lines to divert flow to the longer of the discharge lines and assure surface cooling over the entire SNSWP (during a simultaneous safe shutdown of both units).

9.2.1.3 Safety Evaluation

The Nuclear Service Water System is designed to withstand a safe shutdown earthquake and to prevent any single failure from limiting the ability for the engineered safety features to perform their safety functions. Sufficient pump capacity is included to provide the cooling water to shutdown each unit, and the valves are arranged in such a way that loss of one train does not jeopardize the entire system. Sufficient pump capacity is included to provide design cooling water flow under all conditions, and the headers are arranged in such a way that loss of a header does not jeopardize unit safety. Radiation monitors are located in the systems for detection of potentially radioactive leaks. The system is designed to operate at either maximum drawdown of the lake or Standby Nuclear Service Water Pond and also at a maximum water elevation in each body. As described in Section 9.2.1.2.2, the Nuclear Service Water System is designed to withstand both probable maximum flood and the effects of a prolonged drought. Sufficient margin is provided in the equipment design to accommodate anticipated corrosion and fouling without degradation of system performance.

The RN System is designed to supply the cooling water requirements of a simultaneous LOCA on one unit and cooldown on the other unit assuming a single failure anywhere on the system, loss of offsite power and loss of Lake Wylie. Upon complete channel separation, both units are assured of having a source of water, at least one pump capable of supplying required flow on its associated channel, and at least one essential header to provide cooling water to components served by RN. Channels A and B are connected together only at seven places: six between the RN supply headers and one between the RN discharge headers. Redundant motor operated isolation valves are provided on the normally open crossover lines, and manual isolation valves are used on normally closed, rarely used crossover lines.

Three crossovers between supply headers is in the RN Pumphouse. The RN general use header crossover line is normally open between the nuclear safety related supply header and the non-nuclear safety related general use header. During normal operation, this line provides a source of dilution water for the chemical treatment of the RN System. The redundant crossover valves on this line are automatically closed by a safety injection signal from either unit.

A crossover header connecting the discharge of the four RN pumps in the RN pump house will be used during single RN supply header operation.

A separate crossover line is provided for each unit in the auxiliary building. These lines are normally open to provide cooling flow to components on the RN non-essential headers and to provide flexibility in system operation. The supply header crossover valves and the non-essential header isolation valves close on the LOCA unit on the phase B isolation signal, unless the RN system is aligned in Single Supply Header Operation, in which case RN trains A and B do not isolate and remain cross-connected. This insures that NSW cooling water flow is available to all four RN essential headers while the system is aligned in Single Supply Header Operation, as described in Section 9.2.1.7. This assures adequate flow for the containment spray heat exchangers during sump recirculation operation. The supply header crossover valves on the non-LOCA unit remain open so that cooling can be maintained on the non-LOCA non-essential header. With this supply crossover valve open, there could be flow between the redundant channels. The system is protected against single active failure by interlocks and operator action. Upon a safety injection signal, the LOCA operator checks for the operation of the RN pumps. If a single RN pump is not operating, the crossover remains open and unnecessary components on the non-LOCA unit would be secured to assure sufficient flow to the remainder of the system. If an entire channel is inoperable, steps are taken to isolate the faulted channel. Upon emergency low level in either RN pit, interlocks automatically isolate the faulted channel and the RN non-essential headers. Credible passive failures result in leakage rates that are not significant from the point of view of cooling water supply. Thus a passive failure (leakage) on train A may result in slightly smaller flowrates on train A and train B (unless the non-LOCA unit crossover valves are isolated). However, since no active failures need be considered, cooling water supply to all train A and B components will still be in excess of minimum requirements. Note that depending on location of the passive failure, flooding considerations may require isolation and shutdown of the failed train. If the RN system is aligned in Single Supply Header Operation, the RN supply and return header crossovers in the Auxiliary Building remain open and the RN trains remain cross-connected.

The discharge header crossover line is normally open to allow water returning from all RN headers to be discharged through the Low Pressure Service Water System (RL). The discharge header crossover valves close upon an emergency low pumphouse pit level in either pit unless the RN system is aligned in Single Supply Header Operation. These signals also align both discharge channels to the Standby Nuclear Service Water Pond. All valves whose functions are shared between units and therefore whose operation is related to the safety of both units are provided with normal and emergency diesel power from Unit 1 and Unit 2.

If a Unit 1 diesel is out of service or down for maintenance, then the shared valves normally powered from that channel are provided with manual switchover to the Unit 2 diesel of corresponding channel. In this manner, any one diesel generator can be down for maintenance and the RN System can still shut the plant down safely assuming a LOCA, blackout, and single failure.

A description of the RN Single Supply Header Operation alignment and the Safety Evaluation for Single Supply Header Operation are presented in Section 9.2.1.7.

A complete RN System single failure analysis is presented in Table 9-4.

9.2.1.4 Testing and Inspection Requirements

All system components are hydrostatically tested prior to station startup and are accessible for periodic inspection during operation. All components, switchovers, starting controls, and the integral systems required for the RN System to perform its safety related functions are tested periodically.

9.2.1.5 Instrumentation Requirements

9.2.1.5.1 General Description

RN System instrumentation and controls are shown on the system flow diagrams (Figure 9-22 through Figure 9-33). Power to the essential, safety related valves, controls, and instrumentation for a particular RN System train are powered from the same electrical power source as the RN pump which normally supplies water to that train. Therefore, loss of one power train would result in the loss of only the instrumentation and controls associated with that particular train. Those valves common to both units which isolate the intake lines in the RN Pumphouse as well as the main discharge crossover and main discharge isolation valves are normally supplied from the corresponding channel of Unit 1 diesels, with a switchover provided to corresponding Unit 2 diesels for the case when a Unit 1 diesel is down for maintenance.

Backup controls are provided at the auxiliary shutdown panel for all the devices required for safe, orderly shutdown in the event of a main control room evacuation.

9.2.1.5.2 Pressure Instrumentation

Pressure transmitters are provided on each RN pump discharge line for displaying pressures at the main control room. Each RN strainer is provided with differential pressure switches to initiate backwash on high differential pressure. Pressure differential indicating switches are connected across the RN Pumphouse lattice screens, and alarm in the main control room on high differential pressure. That channel must then be shut down and the screens cleaned by hand. This will be very infrequent because the intake structures are located at the bottom of the lake and SNSWP, thereby eliminating floating trash. The intake bar screens also are expected to minimize clogging of the RN Pumphouse lattice screens.

Inside the Auxiliary Building, each supply header has pressure indication locally and on the main control board. Each heat exchanger is equipped with a pressure test point at the outlet to monitor tube cleanliness.

The component cooling heat exchangers and control room chiller condensers are provided with local differential pressure indication. Differential pressure indication for the component cooling heat exchangers is also provided on the Operator Aid Computer (OAC).

9.2.1.5.3 Flow Instrumentation

Flow elements are provided on each RN pump discharge which indicate on the main control board, as well as alarm on both high and low setpoints. Local flow indication is provided for setting the design flow through all RN pump motor coolers and upper bearing oil coolers. The manual throttling valves are then locked in place. Flow indication on the main control board is provided for the containment spray heat exchanger outlets, the component cooling heat exchanger outlets, and the diesel generator engine jacket water cooler outlets. These alarm on both high and low setpoints. An alarm on low component cooling system heat exchanger outlet flow occurs only when there is a safety injection signal present. Local flow indication is provided on the component cooling heat exchanger outlets as well as on all heat exchangers whose flow is controlled by a manual throttling valve to aid in setting the design flow and also on all ventilation cooling coil lines to monitor their performance.

Flow indication for the containment spray heat exchangers, component cooling heat exchangers, diesel generator jacket water coolers, and control room chiller condensers is provided on the OAC.

There is a portable flow measuring probe provided for testing to measure RN flow at the long arm discharge points into the SNSWP. This test verifies the performance of the "short leg" pressure drop orifice described in Section 9.2.1.2.4.

9.2.1.5.4 Temperature Instrumentation

RN pump motor bearing and stator temperatures are monitored on the plant computer. Temperature indication is provided for each channel main supply header in the main control room, and temperature test points provided at the outlet of each heat exchanger to check performance. Temperature test points are provided at both the inlet and outlet of the ventilation cooling coils. Local temperature indications are provided at both the inlet and outlet of the Control Room Area Chiller Condensers (YC), on the RN side of the condenser. Temperature of the SNSWP is monitored in the Control Room on the main control board and the OAC (Operator Aid Computer) and alarms on high and high-high temperature setpoint programmed into the

OAC. By technical specification the station must be shut down if average SNSWP temperature exceeds a given value.

All air actuated control valves have travel stops set to provide design flow for safe shutdown heat loads upon loss of instrument air due to station blackout with or without simultaneous LOCA. Instrument air can be restored following a blackout by manually aligning emergency supply of RY/RF to the instrument air compressors and manually loading the compressors on the diesel "blackout bus". This restores air supply for RN as well as all other air actuated control valves.

9.2.1.5.5 Level Instrumentation

Three level instruments are installed in each RN Pumphouse pit behind the lattice screens where the RN pumps take suction. It is this instrumentation which alarms in the control room on low level and emergency low level. When two of the three instruments in either pit detect emergency low level, interlocks realign RN suction and discharge from Lake Wylie to the SNSWP and also perform train isolation. This will provide qualified indication of the occurrence of the loss of the downstream dam.

Level instrumentation provides indication in the control room the levels of Lake Wylie and the SNSWP, which also has positive level markings painted on a pier for visual verification of gage reading.

9.2.1.6 Corrosion, Organic Fouling, and Environmental Qualification

Initially, no provision was made for prevention of long-term corrosion in the RN System. Allowances for such corrosion were made by increasing the wall thickness of the pump pressure boundary, piping, and the heat exchanger shells and tubes in accordance with the applicable codes. Larger pipe sizes than necessary were used for pump adequacy considering scaling. However, due to problems with occlusion, high pressure, drop in piping, macrofouling of heat exchangers, localized pitting, and preferential weld attack, minimizing corrosion in the RN system is important. Minimizing the effects of corrosion in the RN system is accomplished through material replacement, coatings, system configuration changes, system operational changes, periodic maintenance and testing, and chemical addition. As part of the plan to minimize corrosion effects in the RN system, a considerable portion of the system shall be cleaned, inspected, repaired, and coated. These portions include:

- The inside of the 48" diameter intake line from the lake intake structure to the NSW pumphouse
- A significant portion of the inside of the Auxiliary Building return headers
- The inside of the 42" buried RN lake return pipe from isolation valve 1RN843B at Auxiliary Building QQ wall to the RL system boundary valves 1RL054 and 1RL062
- The inside of the 42" & 30" buried RN Supply Headers from the NSW Pumphouse to the Auxiliary Building QQ wall.

The inside of these pipes will be coated with a safety related, high quality coating system. Coating the inside of these pipes mitigates corrosion of the metal materials of construction and maintains the designed integrity of the RN system. The coating system shall be inspected periodically to insure the coating integrity is maintained for the life of the plant.

Unit 1 and 2 Diesel Generator (D/G) 12" RN supply and return buried piping, located between missile protected below ground enclosures outside the D/G building and the supply and SNSWP return headers, has been replaced with corrosion resistant High Density Polyethylene (HDPE) material. Reference 8, approved by the NRC per References 9 and 10, allows use of HDPE in this application.

Asiatic clam control is achieved by a series of design features and operating procedures. Intake structures take suction elevated off the bottom of the lake and SNSWP and at a velocity well below that required by the Environmental Protection Agency for wildlife protection, so large clams are not drawn into the system. A bar screen with openings 4 in. X 4 in. keeps debris from entering the intake lines and a lattice screen with 1 in. X 1 in. openings separates the forebay of the RN Pumphouse from the RN pump suction bay, providing a second level of defense. The water discharging from each RN pump passes through an RN strainer with 1/32 inch openings to strain out dirt and sand particles that could clog control valves with cavitrol trim located throughout the RN System. These screens and strainers will prevent all but the smallest clam larvae from entering the RN piping.

It is understood that Asiatic clam larvae do not permanently attach to pipe walls and grow, but nest in low flow and stagnant places such as valved off pipes and idle heat exchangers and operating heat exchangers heads in front of the tube sheet. Performance monitoring programs to verify adequate flow, flushing of piping and components, and visual inspection of the intake piping and inlet heat exchanger heads during maintenance will provide early detection of any clam infestation of raw water systems. If these monitoring or inspection programs indicate any potential problems, appropriate corrective action will be taken.

Results of performance testing of heat exchangers, assured makeup lines, and supply piping have indicated the need for periodic flushing and/or cleaning on a routine basis to ensure operational readiness. This equipment maintenance issue was further amplified by NRC Generic Letter 89-13, "Service Water System Problems Affecting Safety-Related Equipment," issued on July 18, 1989. Generic Letter 89-13 required licensees to address biofouling issues by instituting the letter recommendations or acceptable substitute actions. In the DPC response provided in the letter from H.B. Tucker to the NRC, dated January 26, 1990, incorporation of the NRC recommendations was documented to include the following actions presented below. A Service Water Program Manual was also created as part of the company's response to serve as a collection, summary and reference point for information necessary to document Generic Letter 89-13 actions and other service water maintenance items.

a. Surveillance and Control

  1) Development of a program to sample and analyze the Catawba intake structures for Asiatic clams.

  2) Inspection every five years to visually inspect all intake structures and pump pits for sediment and corrosion.

  3) Commitments to perform an intake structure cleaning based on the combined results of (1) and (2) above.

b. Biocide Addition

  Due to the piping degradation and fouling problems. Catawba has decided to chemically treat the RN system with a biocide and dispersant. The dispersant will be used to minimize and/or reduce the amount of sediment that settles out in the piping and components served by RN. The biocide will be used to combat the biological fouling within the system. Biocide additions to the RN system may be made at the RN pump structure or upstream of the Component Cooling heat exchangers as necessary to improve equipment reliability. The biocide is not intended to be used for clam control since the flushing and flow testing program have proven to be an equally effective and acceptable alternative method to comply with the macrobiological fouling control requirements of Generic Letter 89-13.

c. Flushing and Flow Testing

Maintaining the flow balance testing elements of the Service Water System Program Manual to identify any degradation due to piping/component obstruction by Asiatic clams.

d. Open-Cycle Systems Performance Characteristics

Maintaining the testing of heat transfer capability of all safety-related heat exchangers cooled by the RN System, as per the guidance of EPRI's Heat Exchanger Performance Monitoring Guidelines for Service Water Systems. Heat exchangers that cannot be tested for heat transfer capability are tested for flow and differential pressure characteristics or are on a regular preventative maintenance schedule for cleaning, or a combination of these, as documented in the Service Water System Program Manual.

e. Inspection and Maintenance Program

1) For open-cycle systems, maintaining the inspection programs using ultrasonic and visual inspection methods. Such procedures are performed periodically and as deemed necessary by heat exchanger performance or system flow balances.

2) Maintaining the periodic cleaning of heat exchangers of excessive accumulation of biofouling agents, corrosion products, and silt. This is performed either on a periodic basis or on an as-needed basis performance tests or system flow balances.

3) Maintaining the service water repair program, which initiates repairs to the RN system as deemed necessary by performance tests, flow balances, U/T inspections, or other means.

4) Internally coated piping will be inspected 18 months following initial application and at three to six year intervals thereafter. The initial Generic Letter 89-13 response, January 26, 1990, letter, stated that no coated piping existed in the RN system. With the implementation of RN pipe coatings, the 89-13 commitment was revised to include coating inspections.

9.2.1.7 RN Single Supply Header Operation Description and Safety Evaluation

Single Supply Header Operation (SSHO) of the RN system is an alignment where one of the two buried RN supply headers from the RN pumphouse to the Auxiliary building is isolated, and all RN cooling water flow to the essential components and diesel generators is directed through the remaining in-service buried RN supply header. The RN system Single Supply Header Operation alignment allows each of the buried supply headers to be removed from service for maintenance and inspection activities, and still maintain cooling water flow to all four essential headers and Diesel Generators.

During RN Single Supply Header Operation, the RN system is aligned with the RN supply header crossovers open and the return header crossovers open, which is similar to the RN alignment during normal operation. However, the redundant buried RN supply header piping is physically isolated. To accomplish this, manual isolation valves in the RN pumphouse are positioned to direct the flow from all four RN pumps to the in-service buried RN supply header, and to isolate flow to the out-of-service RN buried supply header piping. When the RN piping enters the Auxiliary building, each units supply header crossovers are open and direct flow from the in-service RN supply piping to the opposite train essential header supply piping for each unit. Similarly, the in-service supply piping to the Diesel Generators has manual isolation valves which are aligned to isolate the out of service RN supply piping, and to supply flow to both trains of Diesel Generators for each unit.

RN cannot be aligned in the Single Supply header alignment if the RN system is already in RN Single Discharge Header Operation, as described in the CNS Technical Specification 3.7.8.

9.2.1.7.1 RN Single Supply Header Operation and Applicable General Design Criteria

RN Single Supply Header Operation effectively removes a train of redundant supply piping, and the regulatory design basis requirements that relate to equipment failure scenarios must be considered. These requirements originate primarily with 10CFR Part 50, Appendix A, General Design Criteria: GDC 44 (Cooling Water) and GDC 4 (Environmental and dynamic effects design bases).

GDC 44 states that, "Suitable redundancy in components and features, and suitable interconnections, leak detection, and isolation capabilities shall be provided to assure that for onsite electric power system operation (assuming offsite power is not available) and for offsite electric power system operation (assuming onsite power is not available) the system safety function can be accomplished, assuming a single failure." Section 9.2.1.7.2 describes the RN system design basis accident response while the RN system is aligned in Single Supply Header Operation, and Section 9.2.1.7.4 describes passive leakage considerations while the RN system is aligned in SSHO.

GDC 4 requires the evaluation of postulated pipe ruptures during normal operation (or abnormal conditions resulting from the rupture) and the evaluation that structures, systems and components important to safety can withstand the effects of these breaks. Section 9.2.1.7.3 describes RN pipe rupture considerations while the RN system is aligned in Single Supply Header Operation.

Additionally, the requirements of GDC 5, Sharing of Structures, Systems and Components, are addressed. The requirements of GDC 5 can still be met while the RN system is aligned in Single Supply Header Operation. Specifically, no single failure can keep the system from performing its safety function and that two RN pumps will be available to handle a LOCA on one unit and bring the other unit to a safe, cold shutdown.

9.2.1.7.2 RN Design Basis Accident Response While Aligned in SSHO

The RN system response to design-basis events is different when the RN system is aligned in Single Supply Header Operation. When the RN system is aligned for normal operating conditions, and a 2/3 RN pump pit low-low level signal is received, the RN supply header crossover and return header crossover isolation valves will close, resulting in RN train separation. Similarly, when the RN system is aligned for normal operating conditions and there is a Containment Hi-Hi Pressure signal, RN train separation will occur on the accident unit. When the RN system is aligned in Single Supply Header Operation, the RN supply and return header crossover isolation valves are prevented from auto-closing on a 2/3 RN pump pit low-low level signal or a Containment Hi-Hi Pressure signal, and the RN trains remain cross-connected.

If the RN system is aligned for normal operation and a 2/3 low-low RN suction pit level causes a RN suction pit transfer, and one SNSWP suction valve fails to open, the two RN pumps on the affected pit will fail. This is also true for the RN system when it is aligned in Single Supply Header Operation. However, when the RN system is aligned in normal operation, the RN trains separate and the train with the failed RN pumps will have no cooling water. Conversely, when the RN system is aligned in Single Supply Header Operation, the RN supply and return header crossover isolation valves remain open and all four RN essential headers and Diesel Generators continue to be supplied with cooling water flow. The remaining two RN pumps have adequate flow capacity to supply the four essential headers and four Diesel Generators, considering a coincident design-basis event (Loss of Coolant Accident) and a coincident Loss-of-Offsite-Power (LOOP). In aligning for Single Supply Header Operation with one unit shutdown, both trains of NS and CA must be isolated on the shutdown unit to ensure that adequate flow is available for essential components from the remaining two RN Pumps, assuming a loss of one RN pit during pit swap to the SNSWP.

9.2.1.7.3 RN Pipe Rupture Considerations While Aligned in Single Supply Header Operation

Single Supply Header Operation requires the evaluation of the response of the RN system to pipe rupture events. The requirements for evaluation of such events are elaborated in Sections 3.6.1 and 3.6.2 of NUREG 0800, Standard Review Plan (SRP). The RN system is considered to be a moderate energy system and subject to the requirements for postulating breaks of moderate energy piping. The SRP specifies the required through-wall leak size to postulate. In addition, locations are specified at which moderate energy leaks should be postulated. The Catawba Units 1 and 2 licensing basis for pipe rupture complies with the SRP and is contained in the CNS UFSAR. Postulated pipe ruptures on moderate energy piping are evaluated with the plant initially in normal operation. A subsequent failure of an active component is assumed which may hinder the mitigation of the leak. Pipe ruptures are considered the initiating events and concurrent design-basis events are not required to be considered (unless they result from the pipe rupture).

Single Supply Header Operation affects the pipe rupture analysis similar to the way it affects design-basis event single passive failures. For postulated pipe ruptures on the in-service supply header piping, the leakage will have to be tolerated on a long-term basis (i.e. safe shutdown of both units from 100 percent power). Leakage rates from postulated pipe ruptures are governed by the pressure in the pipe and the assumed crack size. The crack size is related to the diameter and wall thickness of the piping (Section 3.6.2.1.2.3 paragraph 3b). The un-isolable RN piping locations (between the Auxiliary Building outside wall and the first isolation valves in the RN system and the Diesel Generator Building outside walls and the first isolation valves in the RN system), required additional design improvements in order to preclude the postulation of a piping break at these locations. Manual isolation valves were added close to the Auxiliary Building wall and Diesel Generator Building walls to minimize the length of piping considered un-isolable. The piping support system was re-designed to preclude the need to postulate intermediate moderate energy cracks by keeping the stresses less than 0.4 (1.2 S_h + S_A; per Section 3.6.2.1.2.3 paragraph 3d). Additionally, the piping at the Auxiliary Building and Diesel Building walls (the stress analysis terminal ends) is included in the Catawba Units' 1 and 2 augmented in-service inspection programs to ensure the integrity of this section of piping. The augmented in-service inspections are noted in Table 3-18, Moderate-Energy Mechanical Piping Systems and the locations of the augmented inspections are described in Table 6-103, Process Lines Subject to Augmented Inservice Inspection.

From the standpoint of flow adequacy, it has been demonstrated by calculation that the RN system can provide adequate flow on a long-term basis to shut down the units concurrent with the above pipe ruptures and an active failure (such as the loss of one RN pump).

When the RN system is in Single Supply Header Operation, in the highly unlikely event that the single RN header has a catastrophic failure resulting in the loss of all RN, procedures exist to safely shutdown the units. This procedure would be utilized in the event of the loss of all RN, regardless of whether the units are in single RN header operation or in dual header operation. The procedure directs operators to maintain reactor coolant pump seal injection using the standby shutdown facility make-up pump so as to preclude a reactor coolant pump seal LOCA. In addition, the procedure instructs operators to use both the fire water system and the drinking water system as an alternative supply of water to safely shutdown both units.

9.2.1.7.4 RN Passive Leakage Considerations While Aligned in SSHO

While the RN system is aligned in SSHO, the maximum credible leakage rate is 50 GPM for a passive failure, (i.e., valve packing leakage). If the leakage is in the un-isolable RN piping locations (between the auxiliary building outside wall and the first isolation valves in the RN and between the diesel generator building outside walls and the first isolation valves in the RN system), the leakage can be tolerated on a continuous basis and RN system pumps can still provide adequate flow to all essential components. The associated rooms' sump pumps have adequate capacity to mitigate the potential flooding in these areas.

The ability to detect leaks in buried RN system piping is dependent on location, depth, surrounding backfill, and size of the leaks. Detected leaks in underground piping are identified when the leak makes its way to the surface. Mitigating actions for piping leaks includes isolating and performing ASME Code repairs on the affected piping.

The ability to detect leaks in above-ground RN system piping in the pump-house and auxiliary and diesel generator buildings can be effectively performed since the piping is accessible and is within visual contact by personnel during plant periodic walk downs by operators. Mitigating actions for piping leaks includes isolating and performing ASME Code repairs on the affected piping.

9.2.1.7.5 RN SSHO Restrictions and Requirements

There is a specific allowed outage time in the station Technical Specifications for RN Single Supply Header Operation, which applies to the buried RN supply header piping. The allowed outage time for all other active and passive components on the RN system still applies when the RN system is aligned in Single Supply Header Operation.

If the RN system is aligned in RN Single Supply Header Operation, aligning the RN system in the one pump analysis is prohibited.

The use of the RN Single Supply Header Operation alignment is restricted to pre-planned maintenance of the RN system buried supply header piping.

In aligning for Single Supply Header Operation with one unit shutdown, both trains of NS and CA must be isolated on the shutdown unit to ensure that adequate flow is available for essential components from the remaining two RN Pumps, assuming a loss of one RN pit during pit swap to the SNSWP.

In order for the RN system to be aligned in Single Supply Header Operation, the WN sump pumps in the Diesel Generator rooms must be operable. Additionally, the Augmented Inservice Inspections described in Table 6-103 must be successfully performed, and to align the RN system in SSHO, all four Diesel Generators and RN pumps must be operable.

RN cannot be aligned in the Single Supply Header alignment if the RN system is already in RN Single Discharge Header Operation, as described in the CNS Technical Specification 3.7.8.

9.2.1.8 RN Single Discharge Header Operation

Single Discharge Header Operation (SDHO) of the RN system is an alignment where one RN train's discharge to the SNSWP, within the Auxiliary Building, is isolated, and the associated RN train in the Auxiliary Building from Unit 1 is aligned to discharge through the RN discharge crossover into the opposite RN train to the SNSWP.

During RN Single Discharge Header Operation, the RN system is aligned to the SNSWP and the RN return header crossover valves are open with power removed, which is similar to the RN alignment during normal operation. However, the redundant buried RN discharge header piping to the SNSWP is physically isolated from the Auxiliary Building by closing the discharge valve and removing power while the in service SNSWP discharge valve to the SNSWP is open with power removed to prevent closing on an automatic signal.

The RN Single Discharge Header Operation alignment allows one of the shared trains of large diameter RN discharge piping in the Auxiliary Building (up to the wall at column line "QQ") to be removed from service for maintenance and inspection activities, and still maintain cooling water discharge flow paths from all four essential headers and Diesel Generators. This alignment does not affect the RN return header piping to the SNSWP that is buried (downstream of valves 1RN58B and 1RN63A). This alignment requires that Unit 2 must be in Mode 5, 6 or No-Mode, Unit 1 is in Modes 1-4, and the RN System is aligned to the SNSWP.

Note that RN cannot be aligned in the Single Discharge Header alignment if the RN system is already in RN Single Supply Header Operation, as described in the CNS Technical Specification 3.7.8 and UFSAR Section 9.2.1.7. Additionally, performing scheduled, planned or discretionary maintenance that renders both RN pumps and/or the associated Diesel Generators inoperable on either train of RN (i.e. draining the RN pump pit) is prohibited while in the Single Discharge Header alignment.

9.2.1.8.1 RN Single Discharge Header Operation and Applicable General Design Criteria

RN Single Discharge Header Operation effectively removes a train of redundant discharge piping, and the regulatory design basis requirements that relate to equipment failure scenarios must be considered. These requirements originate primarily with 10CFR Part 50, Appendix A, General Design Criteria: GDC 44 (Cooling Water) and GDC 4 (Environmental and dynamic effects design bases).

GDC 44 states that, "suitable redundancy in components and features, and suitable interconnections, leak detection, and isolation capabilities shall be provided to assure that for onsite electric power system operation (assuming offsite power is not available) and for offsite electric power system operation (assuming onsite power is not available) the system safety function can be accomplished, assuming a single failure." Section 9.2.1.8.2 describes the RN system design basis accident response while the RN system is aligned in Single Discharge Header Operation, and Section 9.2.1.8.4 describes passive leakage considerations while the RN system is aligned in SDHO.

GDC 4 requires the evaluation of postulated pipe ruptures during normal operation (or abnormal conditions resulting from the rupture) and the evaluation that structures, systems and components important to safety can withstand the effects of these breaks. Section 9.2.1.8.3 describes RN pipe rupture considerations while the RN system is aligned in Single Discharge Header Operation.

Additionally, the requirements of GDC 5, Sharing of Structures, Systems and Components, are addressed. The requirements of GDC 5 can still be met while the RN system is aligned in

Single Discharge Header Operation. Specifically, no single failure can keep the system from performing its safety function and that two RN pumps will be available to handle a LOCA on one unit and bring the other unit to a safe, cold shutdown. However, with the RN system in the Single Discharge Header Operation, it is necessary for Unit 2 to be in Mode 5, 6, or No Mode and Unit 1 will be in a Tech Spec Limiting condition for Operation (LCO) or Tech spec "action statement" and no additional failures are required to be postulated on opposite train equipment.

9.2.1.8.2 RN Design Basis Accident Response While Aligned in SDHO

With only one of the two RN return headers to the SNSWP in service while in the Single Discharge Header Operation, the RN system obviously cannot sustain an additional failure that affects the remaining RN discharge header to the SNSWP. The credible failures that could affect the remaining RN Discharge Header to the SNSWP involve postulated blockages of the flowpath caused by failure of the RN butterfly valves in the active discharge path. To minimize this risk, the RN Single Discharge header alignment has RN "pre-aligned" to the SNSWP (the nuclear safety-related heat sink), and valves in the flow path have been positioned with power removed.

The concept of automatically separating trains in the Single discharge header alignment cannot apply as both trains are connected at the point where the RN piping splits just after entering the Auxiliary Building and on the RN return headers. In the existing configuration the protection provided by separating trains ensures that adequate equipment is operating to perform its design basis functions. This protects against a failure such as a leak or diversion of flow one one train affecting the other train. For design basis events the failures that must be considered are a single active failure or a single passive failure.

However, none of the predicted scenarios will be impacted by RN Single Discharge Header alignment since Unit 1 is in a Tech Spec action statement and no additional failures are required to be postulated on opposite train equipment. For example, with RN Train A in a Tech Spec Limiting Conditiion for Operation (LCO) or Tech spec "action statement," no failures are required to be postulated on Unit 1 Train B equipment or Train B shared equipment. This assumption is described in ANSI/ANS-58.9-1981 Section 4.3, which states "If one train of a redundant safety-related fluid system or its safety-related supporting systems is temporarily rendered inoperable due to short-term maintenance as allowed by the unit technical specifications, a single failure need not be assumed in the other train."

9.2.1.8.3 RN Passive Leakage Considerations While Algined in SDHO

While the RN system is aligned in SDHO, the maximum credible leakage rate is 50 GPM for a passive failure, (i.e., valve packing leakage). If the leakage is in the un-isolable RN piping locations (between the auxiliary building outside wall and the first isolation valves in the RN and between the diesel generator building outside walls and the first isolation valves in the RN system), the leakage can be tolerated on a continuous basis and RN system pumps can still provide adequate flow to all essential components. The associated rooms' sump pumps have adequate capacity to mitigate the potential flooding in these areas.

The ability to detect leaks in buried RN system piping is dependent on location, depth, surrounding backfill, and size of the leaks. Detected leaks in underground piping are identified when the leak makes its way to the surface. Mitigating actions for piping leaks includes isolating and performing ASME Code repairs on the affected piping.

The ability to detect leaks in above-ground RN system piping in the pump-house and auxiliary and diesel generator buildings can be effectively performed since the piping is accessible and is within visual contact by personnel during plant periodic walk downs by operators. Mitigating actions for piping leaks includes isolating and performing ASME Code repairs on the affected piping.

9.2.1.8.4 RN SDHO Restrictions and Requirements

There is a specific allowed outage time in the station Technical Specifications for RN Single Discharge Header Operation, which applies to the RN discharge header piping in the Auxiliary Building. The allowed outage time for all other active and passive components on the RN system still applies when the RN system is aligned in Single Discharge Header Operation.

RN cannot be aligned in the Single Discharge Header alignment if the RN system is already in RN Single Supply Header Operation, as described in Technical Specification 3.7.8. Additionally, performing scheduled, planned or discretionary maintenance that renders both RN pumps and/or the associated Diesel Generators inoperable on either train of RN (i.e. draining the RN pump pit) is prohibited while in the Single Discharge Header Alignment because it will place Unit 1 in a 72 hour action statement.

The use of the RN Single discharge Header Operation alignment is restricted to pre-planned maintenance of the RN system discharge header piping located inside the Auxiliary building upstream of valves 1RN58B and 1RN63A.

9.2.2 Component Cooling System

9.2.2.1 Design Bases

The Component Cooling System (KC) is designed for operation during all phases of plant operation and shutdown. The system serves to:

1. Remove residual and sensible heat from the Reactor Coolant System via the Residual Heat Removal System, during plant shutdown and startup.
2. Cool the letdown flow to the Chemical and Volume Control System during power operation.
3. Cool the spent fuel pool water.
4. Provide cooling to dissipate waste heat from various other primary plant components.
5. Provide cooling to engineered safeguards loads after an accident.

The Component Cooling System serves as an intermediate system and a second boundary between the Reactor Coolant System and the Nuclear Service Water System. This double barrier arrangement reduces the probability of leakage of radioactivity to the environment.

The Component Cooling System design is based on maximum heat sink temperatures (supplied by the Nuclear Service Water System) of 95°F (normal) and 100°F (following a LOCA). During normal operating conditions, the maximum temperature of the component cooling water supplied to the components and reactor coolant pumps is 87°F. However, temperatures in excess of 87°F may occur seasonably due to increased lake temperature during the summer months. Following a LOCA, the component cooling water will exceed 100°F. During a fast unit shutdown in 14 hours the temperature of the component cooling water will approach 120°F. This will occur during the initiation of residual heat removal at the fourth hour of the shutdown.

Active system components considered vital to the cooling function are redundant. Such redundancy of components prohibits a single failure from preventing safe shutdown in any essential system served by the Component Cooling System. Any single passive failure in this system does not prevent the system from performing its design function due to double isolation valves on every crossover between safety trains.

The design provides means for the detection of radioactivity entering the system from the Reactor Coolant System and its associated auxiliary systems, and includes provision for isolation of system components.

9.2.2.2 System Description

The Component Cooling System normally functions as two independent subsystems. One subsystem for Unit 1 and one subsystem for Unit 2. Unit 1 flow diagrams are shown in Figure 9-35 through Figure 9-43. The two subsystems are functionally identical except cooling water supplied to non-essential shared equipment is contained in the Unit 1 subsystem. Crossovers are provided between the two subsystems so that cooling water can be supplied to shared equipment from either unit. Such sharing of components does not degrade the performance or reliability of the essential portion of the Component Cooling System, as crossovers and non-essential shared components are isolated on Engineered Safeguards Actuation Signals. The Component Cooling System consists of eight (four per unit) component cooling pumps, four (two per unit) component cooling heat exchangers, four (two per unit) surge tanks, two (one per unit) drain sumps, four (two per unit) drain sump pumps, and associated valves, piping, and instrumentation.

The Component Cooling System is a closed loop system with equipment receiving cooling flow arranged in parallel circuits. The surge tanks are connected to the suction piping of the component cooling pumps and are located at the highest point in the system in order to facilitate easy filling and venting of the system.

The component cooling pumps and heat exchangers are arranged into two separate trains of equipment in each unit subsystem, with two pumps and one heat exchanger per train. Each surge tank is connected by surge tank riser to each train of component cooling equipment. Each train of component cooling equipment supplies cooling water to a corresponding train of the following redundant engineered safety equipment:

1. Residual heat removal heat exchanger
2. Residual heat removal pump mechanical seal heat exchanger
3. Component cooling pump motor coolers (2 pumps per train)
4. Motor driven auxiliary feedwater pump motor coolers
5. Residual heat removal pump motor coolers
6. Containment spray pump motor coolers
7. Safety injection pump motor coolers
8. Safety injection pump bearing oil cooler
9. Centrifugal charging pump motor coolers
10. Centrifugal charging pump speed reducer oil cooler
11. Centrifugal charging pump bearing oil cooler
12. Auxiliary shutdown panel supply units (RN is assured source to ASPSUs, per NSMs CN-11146, CN-20525).

Any piping connecting the two trains of component cooling equipment is provided with two isolation valves. Where this piping is seldom used, manual isolation valves are provided and are locked closed. Where this piping is often used, motor operated isolation valves, which are actuated to close on an engineered safeguards actuation signal, are provided.

Component cooling water is also provided to the following components which are not essential to safe plant shutdown following a loss of coolant accident or steam break accident:

1. Letdown heat exchanger
2. Sealwater heat exchanger
3. Reciprocating charging pump bearing oil cooler

   Note: Reciprocating charging pump bearing oil coolers were abandoned in place per NSM CN-11392/00 (Unit 1) and NSM CN-21392/00 (Unit 2).
4. Fuel pool cooling pump motor coolers
5. Fuel pool cooling heat exchangers
6. Waste gas compressor package heat exchangers
7. Waste gas hydrogen recombiner packages
8. Recycle evaporator package evaporator condenser
9. Recycle evaporator package distillate cooler
10. Recycle evaporator package vent condenser
11. Waste evaporator package evaporator condenser
12. Waste evaporator package distillate cooler
13. Waste evaporator package vent condenser
14. Excess letdown heat exchanger
15. Reactor coolant drain tank heat exchanger
16. Reactor coolant pump thermal barriers
17. Reactor coolant pump motor lower bearing oil coolers
18. Reactor coolant pump motor upper bearing oil coolers
19. Recycle evaporator concentrate sample cooler
20. Recycle evaporator concentrate heat exchanger
21. Recycle evaporator concentrate pump bearing coolers
22. Waste evaporator concentrate sample cooler
23. Waste evaporator concentrate heat exchanger
24. Waste evaporator concentrate pump bearing coolers
25. Reactor vessel support coolers [Abandoned in place per CD100872 (Unit 1) and CD200950 (Unit 2).]

Cooling water may be supplied to the non-essential equipment from either train of component cooling equipment and, likewise; returned to either train of component cooling equipment. Motor operated isolation valves, which are actuated to close on an engineered safeguards actuation signal, provide separation of non-essential equipment from essential equipment and component cooling equipment train separation during a Loss of Coolant Accident or Steam Break Accident.

A normally closed motor operated valve at the inlet of each residual heat removal heat exchanger is actuated to open on a containment isolation phase "B" signal to assure cooling water supply to these heat exchangers when required during a Loss of Coolant or Steam Break Accident. A continuous supply of component cooling water is provided to the other redundant safety equipment during all modes of plant operation.

On an engineered safety signal both trains of component cooling equipment are actuated and automatically aligned to the appropriate trains of engineered safety equipment. However, only one train of component cooling equipment, i.e., two component cooling pumps and one component cooling heat exchanger, is necessary to supply minimum engineered safety requirements. During normal unit operation one or two pumps and one heat exchanger are required, dependent upon what components are in service and the heat loads which exist at any point in time. Two pumps and one heat exchanger also provide minimum unit cooldown requirements. However, to provide unit cooldown within 20 hours four component cooling pumps and two component cooling heat exchangers are required.

Design flow rates during various unit operating modes are tabulated in Table 9-6. Typical valve lineups for various system operational modes are shown in Table 9-7.

The Nuclear Service Water System (Section 9.2.1) provides an assured source of cooling water to the component cooling heat exchangers. The Component Cooling System serves as an intermediate system and a second boundary between the Reactor Coolant System and the Nuclear Service Water System and assures that any leakage of radioactive fluid into the Component Cooling System from components being cooled is contained within the plant. A radiation monitor is placed at the discharge of each component cooling heat exchanger to detect any radioactive leaks into the Component Cooling System. Each monitor actuates a control room alarm.

The vent lines on the surge tanks are sized large enough to prevent vacuum in the tanks, should cold water from the component cooling drain sump be added to a surge tank at its maximum temperature. Surge tank overflow is directed to the component cooling drain sumps, where it can be pumped to the mixing and settling tank in the Liquid Radwaste System for disposal. On each unit a separate overflow line allows one surge tank to overflow to the surge tank on the opposite train.

Component cooling flow is essential to the operation of the reactor coolant pumps (KC provides cooling water to the RCP thermal barriers and oil coolers). Safety related flow instrumentation is provided on the KC supply header to RCP components to alert the operator of low KC flow. The reactor will be manually tripped if KC flow is lost and cannot be restored within 10 minutes.

The major portion of the Component Cooling System is constructed of carbon steel. Corrosion will be controlled by the addition of corrosion inhibitors to the component cooling water.

Instrumentation is provided in the cooling water lines downstream of the reactor coolant pump thermal barriers to detect high flow resulting from reactor coolant inleakage due to a leaking thermal barrier cooling coil. Upon a high flow signal the motor operated isolation valve in the cooling water discharge line from the thermal barrier automatically closes to isolate the radioactive leak. A check valve in the cooling water line upstream each thermal barrier isolates the supply flow. Component cooling water piping at the inlet and discharge of the thermal barriers is designed to withstand reactor coolant system temperature and pressure. A relief valve in the component cooling piping downstream of the reactor coolant pumps is set to relieve at the design pressure of the component cooling system with a capacity adequate for the maximum rate at which reactor coolant can flow through the thermal barrier break. Discharge from these relief valves is directed to the containment floor and equipment sumps in the Liquid Radwaste System.

Relief valves downstream of heat exchangers other than the reactor coolant pump thermal barriers are discharged into the component cooling drain header. They are sized to relieve the thermal expansion which would occur if the flow through the heat exchanger shell side was isolated and high temperature fluid continued to flow through the tube side.

In the event of a loss of all cooling to NC Pump seals event, the normal alignment of the KC system will support continued natural circulation supply of KC water to the NC Pump thermal barrier heat exchanger tubes. The heat sink provided within the NC pumps by this natural circulation is helpful in reducing the extent of NC pump and pump seal heat up.

9.2.2.3 Components

All the components for this system are located within the controlled environment of the Auxiliary and Reactor Buildings, which are seismic Category I structures that are tornado, missile, and flood protected. Component design data is listed in Table 9-8, and applicable design codes listed in Table 3-4.

All essential components are seismically designed and tested and meet ASME III class 3 codes, except containment isolation valves and reactor coolant pump thermal barrier isolation valves which are ASME III class 2. Essential components which require electrical power receive emergency power from the diesels. All essential components located in one train receive their emergency power from the corresponding train diesel.

9.2.2.3.1 Component Cooling Heat Exchangers

The four component cooling heat exchangers are of shell and straight tube type. Raw river water from the Nuclear Service Water System (Section 9.2.1) is circulated through the straight tubes while component cooling water circulates through the shell side. The heat exchangers are designed to provide the required heat transfer for the various modes of plant operation. One heat exchanger is adequate to supply minimum engineered safety features heat transfer requirements. Shell side material is carbon steel. Tube side material is inhibited admiralty for HXs 1B, 2A and 316SS for HXs1A, 2B.

9.2.2.3.2 Component Cooling Pumps

The eight component cooling pumps are horizontal, centrifugal units. These pumps receive electric power from normal or emergency sources. All four pumps for one unit are started automatically upon receipt of the safety injection signal.

The pumps are designed to operate with the minimum net positive suction head available as provided by the component cooling surge tanks. Normal and engineered safety features system demands are normally adequate to provide pump minimum flow requirements. However, for certain combinations of pump degradation and header alignments, minimum flow lines are also provided to protect the pumps. The minimum flow is 1100 GPM per pump.

Mechanical seals are provided to minimize leakage.

9.2.2.3.3 Component Cooling Surge Tanks

Four surge tanks, two per unit, accommodate expansion, contraction, inleakage, or outleakage of water from the system. One surge tank is aligned to each train of component cooling equipment in order to provide redundancy for a passive failure during a loss of coolant or steam break accident. If an outleakage develops while the trains are cross connected, the trains automatically isolate on low-low level in either surge tank.

On each unit, an overflow line allows water to overflow from one surge tank to the other surge tank. The overflow line originates near the top of each surge tank and does not degrade the required surge tank volume for each train.

9.2.2.3.4 Component Cooling Drain Sump and Pumps

The two component cooling drain sumps, one per unit, and the four component cooling drain sump pumps, two per sump, are located at the lowest point in the system. All equipment drains, low point drains, valve leakoffs, and relief valves (excluding reactor coolant pump thermal barrier relief valves) are piped to the drain sump and then pumped to the appropriate component cooling surge tank, thus minimizing makeup and waste treatment problems associated with chemically treated component cooling water.

9.2.2.3.5 Valves

Electric motor operated valves are provided on all headers to non-essential equipment to isolate and separate the two component cooling trains. Two valves are provided, one per train, to each non-essential header to meet active failure criteria. These valves are provided with normal and emergency power. During normal operation these valves can be opened and closed from the control room, to align the two trains to the non-essential headers. These valves will automatically close on an engineered safeguards actuation signal.

Electric motor operated valves are provided on each header to each residual heat removal heat exchanger. These valves are supplied with normal and emergency power, and can be opened and closed from the control room during normal residual heat removal operations. These valves automatically open on an engineered safeguards actuation signal.

Electric motor operated valves are located in the component cooling lines down stream of each reactor coolant pump thermal barrier. These valves close on high flow caused by a reactor coolant pump thermal barrier leak. The inleaking reactor coolant will then be isolated between the electric motor operated valve and a check valve located in the component cooling line upstream of the reactor coolant pump thermal barrier. The design conditions for these valves and piping between these valves is the same as the Reactor Coolant System.

Electric motor operated valves are provided on each mini flow line to open on low pump flow to protect the pumps. These valves are supplied with both normal and emergency power.

Electric motor operated valves are provided on lines penetrating the containment, to close on an engineered safeguards actuation signal for containment isolation during a loss of coolant accident or steam break accident.

Control valves are provided on cooling lines downstream of most of the major components to control the flow of cooling water through the component. These valves are either controlled by flow instrumentation located in the component cooling line or temperature instrumentation located in the line of the fluid being cooled. These valves are provided with leakoffs to minimize leakage from these valves. On loss of power or instrument air these valves will fail in the open position. Travel stops are provided so that the valve will fail in a set position to provide adequate cooling water and not starve the rest of the system.

Relief valves are provided for overpressurization protection of component cooling lines. These valves are normally located close to a component, and are sized to relieve thermal expansion due to overheating of the cooling water by the component.

A relief valve is located on the return header from the reactor coolant pumps to protect against overpressurization due to a thermal barrier leak and failure of the isolation valve to shut. The valve is sized to relieve the maximum flow of reactor coolant inleakage due to a thermal barrier leak.

9.2.2.3.6 Piping

Component Cooling System piping is carbon steel, except for drain lines from the component cooling drain sump pumps and other lines exposed to the atmosphere which are stainless steel. Welded joints and connections are used except at components which might require removal for maintenance, where flanges are used.

9.2.2.3.7 Backup Cooling for Centrifugal Charging Pump 1A and 2A

In order to improve the total core damage frequency, backup cooling was provided to Centrifugal charging Pump (CCP) 1A per NSM CN-11389/00 and 2A per NSM CN-21389/00. The Probabilistic Risk Assessment (PRA) for Catawba Nuclear Station states that a "Loss of KC" event and a "Loss of RN" event are significant contributors to an NC pump seal LOCA. In addition, the Severe Accident Analysis Group determined that only one train would need the backup cooling. Providing backup cooling for CCP 1B (2B) would result in insignificant core damage frequency improvement.

The backup cooling water to CCP 1A and CCP 2A is supplied by a non-safety-related four inch YD System Header in the Auxiliary Building on the 543' - 00" Elevation. The YD supply ties into the KC System Supply piping to the CCP 1A and 2A Motor Coolers and Pump Bearing and Speed Reducer Oil Coolers. On the KC System return side of these coolers, drain lines are routed from the return lines to the ND/NS Sump on Elevation 522' - 00" in the Auxiliary Building. Since the "Loss of KC" and a "Loss of RN" events are not design basis events, the backup cooling supply and drain lines are not safety-related. The system break from non-safety Class G to QA-1 Class C for the pressure boundary is at the KC System isolation valves in the supply and drain lines.

If the scenario occurs that results in a loss of normal KC System cooling to the CCP 1A (2A), the supply from the YD System will be aligned to provide the cooling water for the CCP 1A (2A) motor coolers and oil coolers. The return lines from the coolers will be aligned to flow to the ND/NS Sump. The flow into the ND/NS Sump will be processed by Radwaste Chemistry. Radwaste Chemistry will process this water through the WL System. In addition, an alternate discharge connection will be provided at the common return on Elevation 543' - 00" to reduce the quantity of YD System water flowing into the ND/NS Sump. The alternate discharge connection would typically not be used until after setting up the return flow into the ND/NS Sump. This is due to the time constraints of setting up the alternate flowpath. This connection may be used to divert the NV Pump YD Backup Cooling discharge flow or part of the flow to the WZ System Auxiliary Building Groundwater Drainage Sump C (preferred) or other location as deemed suitable by Radwaste Chemistry. Catawba Nuclear Station has obtained authorization from the Department of Health and Environment Control (DHEC) to allow the discharge of YD System water into the WZ System Sump C which could potentially discharge directly to Lake Wylie. For the preferred location, a fire hose is connected and routed from the alternate discharge connection to the WZ Sump C. The WZ System flowpath would be as follows: the WZ sump pumps discharge to a yard drain which gravity flows to Yard Drain Collection Sump No. 2 in the WC System which is then processed by the WC System before release to Lake Wylie. However, if Yard Drain Collection Sump No. 2 is receiving large quantities of water from other sources (i.e. heavy rains), this sump will overflow directly to Lake Wylie. This scenario is assumed to last for no more than 24 hours after which the KC System normal cooling supply will be available again.

The "Loss of KC" and "Loss of RN" events are not design basis events. The backup cooling supplied by the YD System is not safety-related and is not relied upon to mitigate any design basis accidents or events. This backup cooling does not affect operability the NV, KC or any other system. If the YD System is taken out of service and cannot supply the backup cooling, there will be no affect on the operability of any NV or KC System component. Operability of the KC System is not dependent on the YD System backup cooling.

9.2.2.4 Safety Evaluation

Most of the equipment, piping, and instrumentation associated with the Component Cooling System is located outside the Containment and, therefore, is available for inspection and maintenance during power operation. Replacement of a pump or heat exchanger can be performed while the other components are in service.

Sufficient cooling capacity is provided to fulfill all system requirements under normal and accident conditions. Adequate safety margins are included in the size and number of components to preclude the possibility of a component malfunction adversely affecting operation of safety features equipment. Active system components considered vital to the operation of the system are redundant. Also, any single passive failure in the system does not prevent the system from performing its design function.

In consideration of single failure criteria, the Component Cooling System contains separate flow paths to the two trains of Engineered Safety Features equipment. Any pipes connecting the separate flow paths contain two isolation valves in series.

The Nuclear Service Water System (Section 9.2.1) provides an assured source of cooling water to the component cooling heat exchangers. The Component Cooling System serves as an intermediate system and a second boundary between the Reactor Coolant System and Nuclear Service Water System and assures that any leakage of radioactive fluid from the components being cooled is contained within the station. Radiation monitors are placed in the discharge lines of the component cooling heat exchangers to detect any radioactive leaks into the Component Cooling System. To minimize the possibility of leakage from piping, valves, and equipment, welded construction is used wherever practical. Further instrumentation to detect both inleakage and outleakage is presented in Section 9.2.2.5. Normal makeup to the system is provided by the Makeup Demineralized Water System. An assured supply of makeup water is available from the Nuclear Service Water System.

A relief valve on the component cooling water return header downstream of the reactor coolant pumps is designed with a capacity adequate for the maximum rate at which reactor coolant can enter the Component Cooling System from a leak in the reactor coolant pump thermal barrier cooling coil. The discharge from these relief valves is directed to the containment floor and equipment sumps. The relief valves on the cooling water lines downstream of other heat exchangers in the system are sized to relieve the thermal expansion occurring if the exchanger shell side is isolated and high temperature fluid continues to flow through the tube side. Discharge from these relief valves is directed to the component cooling drain sump. The set pressure for all relief valves equals the local design pressure of the component cooling piping.

The surge tanks have instrumentation which automatically separates the essential trains of component cooling equipment and isolates flow to the non-essential headers upon low-low level in either surge tank. This, combined with train separation on engineered safety signals, provides redundancy for a single passive failure in the form of outleakage anywhere in the KC System. The KC pumps are able to operate with the surge tanks empty, but the operator manually provides makeup water to the surge tank on low surge tank level. Alarms are provided for high, low, and low-low surge tank levels. On each unit, an overflow line allows water from one surge tank to overflow to the surge tank on the opposite train. This overflow line originates near the top of each surge tank and does not degrade the required surge tank volume for each train.

Since the system does not service any Engineered Safety Feature inside the Containment, Containment isolation valves on the component cooling lines entering and leaving the Containment are automatically closed on Containment isolation signal following a loss of coolant accident, or steam break accident.

Isolation valves on the component cooling header to the reactor coolant pumps do not close until Phase B isolation to allow cooling during a small loss of coolant accident or steam break. All other isolation valves close on Phase A isolation.

Active and passive failure analyses of pumps, heat exchangers, valves and piping are presented in Table 9-9. The safety classes of major system components are listed in Table 3-4.

The Component Cooling System is a moderate-energy piping system, see Section 3.6 regarding the analysis of postulated cracks in these systems.

9.2.2.5 Leakage Provisions

Leakage from the Component Cooling System is minimized as much as possible by extensive use of weld ends, plug valves, packless stem valves, and by the use of mechanical seals on the component cooling pumps. All drains, valve leak-offs, relief valves (excluding reactor coolant pump thermal barrier relief valves) are piped to the component cooling drain sump and pumped to the appropriate component cooling surge tank. This reduces the loss of component cooling water from the system, and the amount of makeup that otherwise would have to be added to the system. A leak in a component cooling line can be detected by a drop in surge tank level, which will actuate a low level alarm in the control room. At low-low surge tank level the trains are isolated to provide redundancy for a single passive failure. The RHRS design, for example, provides two separate and redundant trains of operational capability. Any KC system single failure (i.e., passive failure of KC piping) that would prevent the use of one train of the RHRS will not compromise plant safety since KC train separation would occur at low-low surge tank level. The operational train would continue to remove the decay heat and sensible heat from the RCS and at no time would the reactor core be unprotected. The only consequence would be an extension of the cooldown time. A discussion detailing how the RHRS meets the requirements of General Design Criteria 34 is given in Section 5.4.7.2.5.

9.2.2.5.1 Loop Seals

Loop seals are provided wherever through line gaseous leakage is unacceptable due to fission product gas containment. The following paragraph lists an application and explains how the loop seal design minimizes maintenance.

9.2.2.5.1.1 KC Drain Header Loop Seal

The KC drain header remains open during a small reactor coolant or steam leak inside the containment, when the internal pressure is elevated from 1 to 3 psig. A (non-seismic) loop seal is provided on this drain line where it exits the Reactor Building to prevent the escape of containment-atmosphere gases to the Auxiliary Building. A siphon breaker valve protects this loop seal but automatic makeup is not needed due to minimal though continuous flow. A loop seal fill valve is provided to initially fill the seal loop. Required seal diminsions are given on Figure 9-40.

9.2.2.6 Instrument Applications

9.2.2.6.1 Flow Instrumentation

Flow measurement is located in the inlet lines of the component cooling heat exchangers. Flow rate is given in the control room along with low flow alarm. The valves in the KC pump minimum flow lines open automatically when low flow is detected.

Flow instrumentation is located in all lines providing cooling water to a component. Flow measurement is given either in the control room, on a remote panel, or locally. Flow instrumentation in these lines is also used for low and high flow alarms and for controlling control valves where needed.

Flow is monitored in the KC header serving components on the reactor coolant pumps. Upon low flow, an alarm is given in the control room. The operator must trip the reactor if normal KC flow cannot be reestablished within 10 minutes.

9.2.2.6.2 Level Instrumentation

Surge tank level measurements are used to monitor and control the total amount of water in the system. Should there be leakage into the system, the level will rise and activate a high level alarm. If there is leakage out of the system the level will fall and a low level alarm will be actuated. At low-low level the trains automatically isolate. Level indication is given in the control room.

Component cooling drain sump has automatic sump pump operation that is controlled by high and low level setpoints.

9.2.2.6.3 Pressure Instrumentation

Pressure instrumentation is located in the discharge of each component cooling pump, and in each main discharge header for each train. Pressure indication is given locally and in the control room.

Pressure test points are placed in the suction piping of the component cooling pumps, at the discharge of the component cooling heat exchangers, and in the supply and discharge of all the major heat exchangers served by the system.

9.2.2.6.4 Temperature Instrumentation

Temperature instrumentation is provided in the discharge of the component cooling heat exchangers, reactor coolant pumps upper bearing cooling water discharge and reactor coolant pump thermal barrier discharge. OAC indication of temperature is given along with high temperature alarm.

Temperature test points are placed at the inlet and discharge of the component cooling heat exchangers and at the discharge of all components served by the Component Cooling System where it is practical to do so.

9.2.2.7 Tests and Inspections

System components are hydrostatically tested, and full operational tests are performed before unit operation. Active components of the Component Cooling System are in either continuous or frequent use during normal station operation however additional periodic tests are performed. Containment isolation valves are tested periodically in accordance with Technical Specifications. Periodic visual inspections and preventive maintenance are conducted according to good industrial practice.

9.2.3 Makeup Demineralized Water System

9.2.3.1 Design Bases

The Makeup Demineralized Water System supplies filtered demineralized water to the upper surge tanks for makeup and to other systems throughout the plant that require high quality water. The Makeup Demineralized Water System is shown on Figure 9-44 thru Figure 9-49 and the system component design parameters are given in Table 9-10.

9.2.3.2 System Description

The Makeup Demineralized Water System is supplied by demineralized water from vendor supplied water treatment equipment located in the Water Treatment Building. The two existing makeup demineralizers and polishing demineralizers remain in the flow path from the Water Treatment Building for additional purification and to reduce the concentration of sodium in the YM system.

The resulting demineralized water provides condensate quality water for the following:

1. Unit 1 and Unit 2 condensate makeup to the upper surge tanks
2. Unit 1 and Unit 2 chemical addition tanks
3. Unit 1 and Unit 2 generator stator cooling water makeup
4. Recirculated cooling water storage tank makeup
5. Demineralized water storage tank makeup
6. Vendor supplied de-oxygenation equipment located in the Water Treatment Room for deaerated water makeup to the reactor makeup water storage tanks and for wet layup to the steam generators
7. Auxiliary boiler feedwater
8. Unit 1 and Unit 2 condensate polishing demineralizer alternate supply
9. Deleted per 2015 update
10. CT sink flush water
11. Plant heating glycol batching tank.
12. Steam Generator blowdown demineralizer supply
13. Plant heating, chilled and cooling water system makeup

14. Unit 1 and 2 EMF31 flush
15. Waste Monitor Tank Building supply, including EMF57 flush
16. Unit 1 YV maintenance backfill
17. Condenser circulating water pump oil cooler bearings
18. Main vacuum, makeup demineralizer vacuum deaerator vacuum, makeup demineralizer vacuum deaerator discharge, organic biocide, and vacuum priming pumps (seal water)
19. Hypochlorite generator (chilled water)
20. Service building sump pumps (bearing flush water)
21. Interior Fire Protection System via jockey pumps
22. Auxiliary Building Cooling Water System (Closed Circuit Evaporative Cooler Makeup)
23. Auxiliary boiler blowoff tank
24. Heating water system sample coolers
25. Washdown connections
26. Turbine Building Sump Sample Pump
27. Turbine Building Chilled Water System (YO) Makeup

The demineralized water storage tank supplies demineralized water for the following requirements in the Auxiliary Building, Reactor Buildings, and Turbine Buildings:

1. Decontamination sinks
2. Equipment decontamination tank
3. Hot lab
4. Cold lab
5. Ice condenser glycol mixing and storage tank
6. Various radiation monitors
7. Various demineralizers
8. Mixing and settling tank sludge pumps
9. Solid radwaste flush water header
10. Unit 1 and Unit 2 primary systems sample sinks and Unit 2 NM lab sink.
11. Unit 1 and Unit 2 component cooling surge tanks
12. Unit 1 and Unit 2 BTRS chiller surge tanks
13. Unit 1 and Unit 2 diesel jacket water surge tanks
14. Containment chilled water system compression tank makeup.
15. Environmental Lab
16. Ice making solution mix tank
17. Various battery rooms
18. Unit 1 and Unit 2 Hotwell pump strainers

19. Auxiliary Building cooling water makeup
20. Technical Support Center filter unit
21. Unit 1 and Unit 2 fuel transfer hydraulic power units
22. Liquid Radwaste System loop seal makeup
23. Decontamination spray booth
24. Standby shutdown facility
25. Various respirator washers
26. Unit 1 and Unit 2 Containment valve injection water surge chambers.
27. Contractor radwaste solidification equipment
28. Containment Mechanical equipment building sump pumps (bearing flush water)
29. Post accident liquid and gas sample panels

    Note: On September 11, 2001, the NRC issued Amendments No. 193 and 185 to the Unit 1 and Unit 2 Facility Operating Licenses. These amendments removed the requirements associated with the Post Accident Liquid and Gas Sample Panels.
30. Ultrasonic cleaning tanks
31. Agitated cleaning tank
32. Diesel generator engine starting air compressor aftercoolers (as backup to the drinking water system)
33. Turbine building chilled water system make-up

Demineralized water makeup to the demineralized water storage tank will be supplied from the makeup demineralizers effluent header by two demineralized water storage tank supply pumps. Demineralized water for makeup to the reactor makeup water storage tanks will be supplied by Vendor supplied de-deaeration equipment located in the Water Treatment Room. The permeate storage tank pumps transfer deaerated water to the reactor makeup water storage tank.

9.2.3.3 Safety Evaluation

The Makeup Demineralized Water System is not required for maintenance of plant safety in the event of an accident; therefore, the containment isolation valves and the piping connecting the valves are the only portions of the system which are safety class. There are no safety related implications due to sharing this system between the two units.

9.2.3.4 Instrumentation Application

Sufficient instrumentation is provided to monitor system performance. Alarms are provided for low demineralized water storage and supply tanks level.

The low demineralized water storage tank level alarms in the Control Room. A conductivity monitor is provided on each demineralizer effluent.

9.2.3.5 Tests and Inspections

Prior to startup all piping will be hydrostatically tested and flushed to applicable codes and standards. System operability will be verified by placing the system into operation prior to fuel loading. After startup routine visual inspection of the system components and instrumentation is adequate to verify system operability.

9.2.4 Potable and Sanitary Water Systems

9.2.4.1 Design Bases

Municipal chlorinated water is furnished for the Drinking Water System which is supplied at the required pressure to various drinking water and plumbing fixtures throughout the plant. The Drinking Water System is shown on Figure 9-52. The component design parameters for both systems are given in Table 9-11.

9.2.4.2 System Description

9.2.4.2.1 Filtered Water System

Deleted per 2015 update.

9.2.4.2.2 Drinking Water System

A municipal water system consisting of a water tower, pumps, and chemical treatment equipment provides chlorinated drinking water to the plant. The drinking water system provides cooling water to the diesel generator engine starting air compressor aftercoolers (Section 9.5.6).

The Drinking Water System function for backup cooling water supply to the A train Centrifugal Charging Pumps, upon loss of KC, is described in Section 9.3.4.2.3.1.

The drinking water system provides pump seal water to the vendor supplied deaeration equipment located in the Water Treatment Room.

9.2.4.3 Safety Evaluation

The Drinking Water Systems does not perform any safety function.

9.2.4.4 Instrumentation Application

Sufficient instrumentation is provided to monitor system performance and to control the system automatically or manually under all operating conditions.

9.2.4.5 Tests and Inspections

Prior to startup all piping will be hydrostatically tested and flushed in accordance with applicable codes and standards. Operability of the Drinking Water System will be verified by placing it into operation prior to fuel loading.

9.2.5 Ultimate Heat Sink

9.2.5.1 Design Bases

Two independent sources of nuclear service water are available to provide an adequate supply of cooling water to dissipate waste heat rejected during a unit LOCA plus a unit cooldown. These sources are separated and protected such that failure of one does not induce failure of the other. Lake Wylie is the normal source of nuclear service water. The emergency source is the Standby Nuclear Service Water Pond (SNSWP).

The Nuclear Service Water System is designed to operate properly within a specific temperature range. Calculations are performed to verify that the intake water is within that range, and that there is a sufficient quantity of water to supply the plant for a 30-day period.

9.2.5.2 Description

The Nuclear Service Water System is described in Section 9.2.1. During normal operation Lake Wylie is the source of nuclear service water and also dissipates the waste heat from the discharge. A lake surface elevation of 559.4 ft (169.3 m) or greater is required for operation of the system. If Lake Wylie falls below this elevation the SNSWP can be used to supply water and dissipate the waste heat during shutdown and/or LOCA. The relationship of Lake Wylie, the SNSWP and the Nuclear Service Water System is shown on Figure 9-22, Figure 9-23, and Figure 9-24.

Figure 9-34 shows the location of the SNSWP intake and discharge structures. Figure 9-53 shows the intake and discharge configuration. The pump structure for the NSW system is shown on Figure 2-43. Interconnecting pipe routing is shown on Figure 9-178. At minimum pond elevation of 571 ft (174 m) msl the pond has a surface area of approximately 39 Ac (0.16 km^2), such as shown in Figure 9-54.

Effects of flood waters on the SNSWP are discussed in Section 2.4.8.

9.2.5.3 Design Evaluation

9.2.5.3.1 Analytical Model

For analytical purposes the SNSWP at Catawba is treated as a series of stacked horizontal layers of water. Pond Operation is simulated by removing the bottom slice, adding heat to it and then placing it on top of the stack where it is permitted to cool. Cooling takes place only in the surface layer and at a rate proportional to the water temperature excess above the equilibrium temperature. The heat transfer is simulated by the following equation from Edinger and Geyer (Reference 1):

$$\frac{dT}{dt} = \frac{-K(T-E)}{pCd}$$

where T = water temperature,

K = heat exchange coefficient,

E = equilibrium temperature,

p = water density,

C = Specific heat,

d = depth of the upper slice of water,

and t = length of time cooling takes place.

After cooling, each of the stacked horizontal layers of water is shifted down one layer, retaining their previously defined temperatures. A check is then made for density instabilities which are averaged out if necessary. By use of the computer the entire simulation is repeated hundreds of times. Analytical results, provided in CNC-1150.01-00-0001 "Standby Nuclear Service Water Pond Thermal Analysis during one unit LOCA and one unit shutdown" indicate the maximum achieved intake temperature to the NSW System during an accident condition with extreme meteorology does not exceed 100°F.

The cooling water flow rate for the NSW system used in the computer program assumes all four RN Pumps for the 30 day simulation time at a total flow rate of 30,000 GPM.

Total heat input to the SNSWP from the NSW system is calculated by adding the fixed heat load due to safety related pump and motor coolers, air conditioning equipment, and diesel generator jacket water coolers to the sensible and residual heat loads due to one unit following a LOCA and the second unit due to an immediate cooldown. Residual heat input to the pond is calculated from the Duke Energy calculation CNC-1201.30-00-0015 for the cooldown unit starting 30 hours after trip from rated thermal power plus the LOCA unit, starting immediately. No credit is taken for the ice condenser in the cooldown unit nor for heat transfer in the RN Pumphouse and yard piping, in terms of heat dissipated in the 30 day period following LOCA, thus adding to the conservatism of the analysis. The rate of heat rejection, both residual and sensible for the LOCA unit is determined by summing the containment spray and component cooling heat exchanger heat removal rates as calculated by Duke Energy. After 600 hours, the value is equal to the decay heat curve because all sensible heat has been removed. The decay heat rate from Westinghouse is utilized from 300 hours out to 30 days after LOCA.

The heat input to the SNSWP from the station auxiliary systems is distributed as follows:

1. Heat input from four diesel generators operating at the maximum calculated load for seven days. After seven days offsite power is considered available and no diesel generators are operating.
2. Only heat from one control room air conditioning and pump motors in both units is rejected to the pond during the rest of the shutdown period.
3. For the LOCA unit, fuel pool cooling is restored no sooner than 12 hours after the accident fuel pool cooling to the non-LOCA unit may continue without interruption.

9.2.5.3.2 Meteorology

Meteorological inputs to the Catawba SNSWP computer model consist of dry bulb temperature, dew point temperature, wind speed, exchange coefficient (computed) and the equilibrium temperature (computed). As suggested in Regulatory Guide 1.27, Revision 2, meteorology for the worst historical 7 day and 30 day cooling periods and the worst historical 7 day and 30 day evaporation periods is used.

The "worst cooling condition" is defined as the period in which the equilibrium temperature is the highest. Equilibrium temperature is defined as the water surface temperature at which heat flux into the surface would equal heat flux out. Therefore the historical period with the highest equilibrium temperature will define the period in which the least amount of heat will be lost from a thermal discharge and in which critical return temperatures from the SNSWP would occur. The following equation from Ryan and Harleman (Reference 2) is used to calculate the daily average equilibrium temperatures for the years of record:

$$T_e = \frac{\phi_r + f(w)[BT_d + 0.255T_a] - 1600}{23 + f(w)(B + 0.255)}$$

where

T_e = equilibrium temperature, °F,

ϕ_r = net radiation, $BTU/Ft^2/Day$,

f(w) = wind function, $BTU/Ft^2/Day/mmHG/mph$,

B = gradient of the vapor pressure/temperature curve, mmHg/°F,

T_d = dew point temperature, °F,

T_a = air temperature, °F.

The 7 day and 30 day periods with the highest average equilibrium temperature were used in the Catawba SNSWP simulation. The worst day and the second worst day on record were used to replace days number one and two, respectively, of the worst 30 day period. These two worst days are also repeated as a part of the worst 30 day period.

The 7 day and 30 day "worst evaporation" periods are found using a procedure and computer program similar to those used for the "worst cooling condition." The general expression used to calculate evaporation from a water surface is from Ryan and Harleman (Reference 2):

$$\phi_e = [22.4(\Delta\theta_v)^{1/3} + 14W] \qquad [(e_s - e_z)]$$

where

ϕ_e = evaporative heat flux, $BTU/ft^2/day$,

$\Delta\theta_v$ = virtual temperature difference, °F,

W = wind speed, MPH,

e_s = saturated vapor pressure at the temperature of the water surface, mm Hg,

e_z = vapor pressure of the air at height z, mm Hg.

9.2.5.3.3 Hydraulic Design

The intake for the NSW system is at the bottom of the pond and the discharge is at the surface. The stacked layer concept assumes warm water layers from the surface cannot be pulled into the intake. This is analyzed with an equation from Harleman and Elder (Reference 3).

If a computed depth H, is less than the depth from the bottom of the warm surface water layer to the bottom of the intake, then less than five percent of the intake flow is water pulled down from the surface layer.

$$H = \frac{3}{2}[(Q/B)^2 / g']^{1/3}$$

where

H = depth from bottom of warm surface water layer to bottom of intake,

Q = intake flow, 102.5 CFS,

B = width of intake opening, (37.4 ft.),

g' = $g\Delta d/d$, for Δt = 8°F g' = 0.05 $ft./sec^2$

g = acceleration of gravity, 32.174 ft/sec^2,

d = density of bottom water layer,

Δd = density difference between warm surface and cool bottom water layers

The resulting depth H is approximately 8 ft. The minimum depth of the SNSWP to the intake structure (top of trash rack) is 28 ft, therefore direct recirculation of the surface heated layer is not expected.

There are two discharge structures for the NSW system into the SNSWP. To minimize mixing in these areas the Froude number should be less than one. This will allow the heated discharge water to remain as a surface layer. The Froude number equation is (Reference 2):

$$F = \frac{V}{\left[g \frac{\Delta dh}{d}\right]^{1/2}}$$

where

F = Froude number,

V = Velocity,

h = depth of heater layer.

With a maximum flow of 102.5 cfs at the short arm discharge area, the densimetric Froude number is <0.6.

9.2.5.3.4 Water Supply

The drainage basin for the SNSWP has an area of approximately 410 Ac. Runoff and groundwater flow from the basin are the sources of water for the pond. A typical average drainage basin yield for this area is 1 cfs/mi^2 and is more than adequate to supply the pond.

The full pond elevation for the SNSWP is 574 ft msl, and the minimum level for the pond is 571 ft msl.

During the 30 day LOCA period approximately 46 Acft of water are evaporated, dropping the pond elevation to about 569 ft msl. This is the pond level assumed for the analysis.

Simulating operation of the SNSWP during the "worst evaporation" period indicates about 50 Acft of water would be evaporated.

9.2.5.4 Safety Evaluation

The Catawba Ultimate Heat Sink meets all requirements and recommendations set forth in NRC Regulatory Guide 1.27. The Ultimate Heat Sink is capable of providing cooling for at least 30 days to permit simultaneous safe shutdown and cooldown of both units and to maintain them in a safe shutdown condition. This can be accomplished for a two unit cooldown following loss of Lake Wylie, or a simultaneous LOCA and cooldown following the loss of Lake Wylie.

Sufficient conservatism in pond sizing and analysis has been provided to ensure that a 30-day cooling supply is available at a temperature compatible with design basis temperatures for NSW supplied heat exchangers. A point near the surface of the SNSWP, elevation 568 ft, is monitored in order to conservatively ensure that the assumption in Chapter 6 for the containment peak pressure analysis will be preserved. By selection of the elevation, it is assured by water density differences that the intake to the RN System, located at the bottom, will be bounded by the assumed SNSWP equilibrium temperature of 95°F. To ensure that this initial condition is not exceeded, and to ensure that long term RN temperature does not exceed the 100°F design basis of RN components, the average water temperature must be less than or equal to 95°F at elevation 568 ft in the SNSWP. Long term equipment qualification of safety related components required to mitigate the accident is based on the continuous, maximum RN supply temperature of 100°F. Swapover from Lake Wylie to the SNSWP is required at a temperature of 95.5°F in the RN supply header rather than 95°F because Lake Wylie is not subject to subsequent heatup due to recirculation, as is the SNSWP. Hence the 100°F design basis maximum temperature is not approached while operating from Lake Wylie.

Two points of discharge to the two fingers of the SNSWP ensure equal distribution of heated water over the entire surface of the pond. SNSWP level is monitored and makeup water is provided should the pond level drop to 571.5 ft, which is 2.5 feet below full pond. A low-level alarm, set at elevation 572, signals the need for makeup water, which is provided by aligning the NSW discharge to the SNSWP until it overflows at elevation 574 ft. Should the SNSWP level ever drop to the minimum elevation required for safe shutdown; 571 ft, a low-low level alarm set at 571.5 ft. is actuated and Technical Specifications require immediate makeup or shutdown of the station. This minimum allowable elevation includes one foot of margin to account for evaporation and the use of SNSWP water for assured auxiliary feedwater, assured component cooling makeup, and assured fuel pool makeup for the full 30 days after a postulated accident.

A single supply line is provided from the Lake Wylie intake structure to the RN Pumphouse. Should clogging or failure of this line occur, level instrumentation inside the RN Pumphouse will immediately sense low-low level and align suction and discharge to the SNSWP. Two redundant lines are provided from the SNSWP intake structure to the RN Pumphouse to allow for single failure of one line. Should one line fail, the other is sufficient to provide one channel per unit flow requirements under the most severe operating conditions.

The Lake Wylie and SNSWP intake structures are located far enough from the SNSWP Dam that its postulated collapse would not block both intakes simultaneously. Two lines are provided from the RN Pumphouse to the Auxiliary Building and Diesel Buildings. These are redundant channels which are missile protected and sized sufficiently to provide one channel per unit flow requirements under the most severe operating conditions.

A single normal discharge line is provided which discharges from the RN System to the Low Pressure Service Water System discharge lines to Lake Wylie. Should failure or clogging of this line occur, both supply and return are aligned to the SNSWP. Two redundant lines are provided to discharge from the redundant trains of heat exchangers in both units to the SNSWP. These lines are missile protected and sized sufficiently to provide one channel per unit flow requirements under the most severe operating conditions. Both redundant discharge lines split and discharge to two fingers of the SNSWP to assure equal surface cooling over the entire pond no matter which channel is operating. Discharge structures are missile protected to prevent flow blockage. The flow split of the short leg and long leg of the SNSWP discharge lines is approximately 70% and 30% respectively. To be conservative the thermal performance analysis model for the SNSWP assumes all flow discharges to the short leg discharge. This analysis is conservative relative to the actual values.

Nuclear service water pumps are protected from minimum NPSH (minimum submergence vertical pumps) by safety related and qualified level instrumentation which automatically aligns the proper RN Pumphouse pit valves to switch from Lake Wylie supply to SNSWP supply. The maximum drawdown condition of the SNSWP always exceeds submergence requirements of the RN pumps. A single failure analysis of the various components of the RN System is provided in Table 9-4. The RN System is discussed in Section 9.2.1 and RN System instrumentation detailed in Section 7.4.

9.2.6 Condensate Storage System

Note:

This section of the FSAR contains information on the design bases and design criteria of this system/structure. Additional information that may assist the reader in understanding the system is contained in the design basis document (DBD) for this system/structure.

9.2.6.1 Design Bases

The Condensate Storage System provides a readily available source of deaerated condensate for makeup to the condenser and is the preferred source of auxiliary feedwater for makeup to the steam generators. It also serves to collect and store miscellaneous system drains. The Condensate Storage System is shown on Figure 9-59 thru Figure 9-61 and the system component design parameters are given in Table 9-14.

9.2.6.2 System Description

Makeup to the Condensate Storage System is to the upper surge tank dome from the Makeup Demineralized Water System. The upper surge tank dome drains to the two upper surge tanks. Makeup to the condenser is supplied by gravity flow from the upper surge tanks. The upper surge tanks also provide sealing water for various equipment, and the supply for the auxiliary electric boiler feedwater pumps. Overflow from the upper surge tanks is returned to the condensate storage tank through a 27 foot seal loop which prevents the introduction of air into the upper surge tanks. Valve 1CM363 provides a means for filling and makeup to the seal loop. The condensate storage tank receives the drains from various equipment and holds these drains until they are transferred to the upper surge tank dome by the two full capacity condensate storage tank pumps. The condensate storage tank operates at atmospheric pressure and is vented to the roof. The overflow line from the condensate storage tank has a 3 foot seal loop to prevent steam from the hot drains discharging into the tank from entering the building.

9.2.6.3 Safety Evaluation

The preferred normal source of clean water supply for the auxiliary feedwater pumps is provided by the CA condensate storage tank (42,500 gallons), the main condenser hotwell (170,000 gallons), and the upper surge tanks (85,000 gallons) on each unit. The Condensate Storage System tanks are not safety related, since the assured source of water for the auxiliary feedwater pumps is provided from the Nuclear Service Water System. (Note: CA Condensate Storage Tank is currently isolated due to vortexing concerns)

The water in the Condensate Storage System is not normally radioactive. However, in the event of primary to secondary leakage due to a steam generator tube leak, it is possible for the Condensate Storage System to become radioactively contaminated. A full discussion of the radiological aspects of a primary to secondary leakage including operating concentrations of radioactive contaminants is discussed in Chapter 11.

9.2.6.4 Instrumentation Application

Sufficient instrumentation is provided to monitor system performance. Alarms are provided in the control room for high and low upper surge tank level, high and low condensate storage tank level, and low auxiliary feedwater condensate storage tank level.

9.2.6.5 Tests and Inspections

Prior to startup, all piping will be hydrostatically tested and flushed in accordance with applicable codes and standards. System operability will be verified by placing the system into operation prior to fuel loading.

9.2.7 Refueling Water System

9.2.7.1 Design Bases

The Refueling Water System is designed to provide:

1. a source of borated water at refueling water boron concentration for use during refueling or a postulated loss-of-coolant accident,
2. recirculation of the refueling cavity and fuel transfer canal water for cleanup during refueling, as necessary,
3. recirculation of water in the refueling water storage tank for cleanup following refueling, as necessary, and
4. borated makeup water to the fuel pool
5. an assured source of borated water for makeup of primary loop shrinkage and leakage during an emergency cooldown in the event of a tornado-induced puncture of the Refueling Water Storage Tank (FWST).

9.2.7.2 System Description

A Refueling Water System, as shown in Figure 9-62 is provided for each unit. Operation of the Refueling Water System is described as follows for various modes of system operation.

1. Safety Injection Operation

   The refueling water storage tank provides a source of borated water for the injection mode of operation of the Emergency Core Cooling System.

2. Emergency Cooldown Operation

   The missile-proof wall surrounding the FWST assures that in the case of a tornado-induced missile having punctured the tank that a sufficient quantity of borated water to makeup for primary loop shrinkage and leakage during a cooldown will be retained in the tank.

3. Refueling Cavity Filling and Emptying

   The Refueling Water System provides a secondary means of filling and emptying the refueling cavity, the primary means being provided by the Residual Heat Removal System. The elevation of the refueling water storage tank provides sufficient static head to fill the refueling cavity to approximately 75 percent of its required water level. The refueling water pump is used to complete the filling process. After refueling, the refueling cavity water level is lowered to the top of the reactor vessel by using the Residual Heat Removal System to transfer approximately two-thirds of the water to the refueling water storage tank. The remaining water is transferred by the Refueling Water System. During the filling or emptying operation, water can be bypassed through the Spent Fuel Cooling System demineralizer and filters for cleanup.

4. Refueling Water Cleanup

   The refueling water in the refueling water storage tank and the refueling water cavity is recirculated through the Spent Fuel Cooling System demineralizers and filters for cleanup by using the refueling water pump. The refueling water in the refueling water cavity is recirculated through the Spent Fuel Cooling System Demineralizer and filters or the Boron Recycle System demineralizers and filters for cleanup by using the reactor coolant drain tank pumps.

5. Component Description

   Component safety classifications and design codes are given in Table 3-4 and a summary of principal component design parameters is given in Table 9-15.

   a. Refueling Water Storage Tank

      The refueling water storage tank usable capacity is based on the requirement for filling the refueling cavity to a depth that limits the radiation at the surface of the water to 2.5 mrem/hr during the period when a fuel assembly is transferred over the reactor vessel flange. This function requires more water than is necessary for post-LOCA safe shutdown. The post-LOCA safe shutdown use of the FWST requires the amount of water necessary to supply the centrifugal charging pumps and safety injection pumps, residual heat removal pumps for a period of time (10 minutes or more) sufficient to allow the operator to properly assess the situation and establish the recirculation mode following a LOCA. The suction requirements for two train injection assuming maximum flows due to pump runout are consistent with FWST level setpoints calculation CNC-1552.08-00-0264.

      Deleted Per 2012 Update.

      A twelve inch vent and a six inch vent provide adequate air flow to prevent a vacuum from occurring upon maximum flow injection. The vents extend two feet above the roof of the tank and then terminate in a 180° bend. A screen with ½ in. x ½ in. mesh is provided over the end of both vent lines to keep out birds and debris. The diameter and height of the vent, large screen openings, local heat-tracing, and year around operating temperature of the tank of 70°F are sufficient to preclude vent plugging due to ice and snow.

   b. Refueling Water Pump

      The refueling water pump has the capacity to pump one refueling cavity volume in approximately 24 hours. This flow rate is sufficient to handle any cleanup problem normally encountered. The total dynamic head is determined by the most stringent operating mode, which occurs during the emptying of the refueling cavity by going through the filters and demineralizer of the Spent Fuel Cooling System.

   c. Refueling Water Pump Strainer

      The refueling water pump strainer is provided to protect the refueling water pump from debris that might be dropped in the refueling cavity.

   d. Refueling Water Recirculation Pump

The refueling water recirculation pumps are provided to maintain the water in the pipe header feeding the charging pumps, safety injection pumps, residual heat removal pumps, and the containment spray pump at or above 70°F. This is accomplished by recirculating the volume of water in this header at least once every 2 1/2 hours from the heated refueling water storage tank. This is only required during the coldest winter months.

e. Refueling Water Storage Tank Heaters

Four immersion type heaters are used to maintain the FWST above 70°F to preclude possible damage to the containment vessel due to the inadvertent operation of the Containment Spray System. This is a precaution, as the Containment Pressure Control System effectively prevents inadvertent spray as described in Section 7.6. The heaters each contain three elements but are staged together to achieve more uniform water temperature.

9.2.7.3 Safety Evaluation

The refueling water storage tank provides a source of borated water for use during refueling and a loss-of-coolant accident. The tank Technical Specification minimum contained capacity of 377,537 gallons provides an amount of borated water to assure items 1 through 4 below. The FWST in addition provides sufficient volume to fill the refueling cavity for refueling operations.

1. The volume of borated refueling water needed to increase the boron concentration of initially spilled water to a point that assures no return to criticality with the reactor at cold shutdown and all control rods, except the most reactive rod cluster control assembly, inserted in the core.
2. A volume sufficient to refill the reactor vessel above the nozzles after a loss-of-coolant accident.
3. A sufficient volume of water in the Containment sump to permit the initiation of recirculation.
4. Sufficient volume to allow the station operator adequate time to complete manual valve alignment required to complete switchover from the injection mode following a LOCA to the containment sump recirculation mode. (See Table 6-93)

The only portion of the Refueling Water System shown in Figure 9-62 that is safety related Seismic Category 1, is the refueling water storage tank, RWST missile-proof wall, and associated NRC Quality Class B piping that connects to the ECCS. A failure analysis of the lines from the refueling water storage tank to the safety injection, centrifugal charging, and residual heat removal pumps is provided in Table 6-91 and Table 6-92. The failure of non-seismic Category 1 equipment and piping in the Refueling Water System and interfacing systems does not affect the ability of the Refueling Water System to perform its intended safety related function.

The supply line from the Refueling Water Storage Tank (RWST) is isolated from non-seismic piping associated with the Refueling Water Pump by a series of two normally closed electric motor operated (EMO) seismic category I valves FW1A and FW32B. Similarly, the supply line can be isolated from non-seismic piping associated with the Refueling Water Recirculation pumps by a series of two EMO seismic category I valves FW33A and FW49B, both of which are automatically closed by a safety injection signal. The control room operator is provided with RWST level indication and alarms, as described in Section 6.3.5.4, and will manually close the appropriate valves in the event of a failure of non-seismic piping.

Non-seismic piping which connects to the RWST is not required for safety related functions. The other interfaces of seismic and non-seismic piping occur at penetrations to the containment that are used for refueling. The seismic piping is isolated by normally locked closed isolation valves FW4 and FW13.

The Refueling Water System equipment piping elevations are as follows:

Refueling Water Pump Suction	544' 6 3/8"
Refueling Water Recirculation Pump Suction	523' 0"
RWST 24" Supply Line, Connection B	597' 3 1/4"
RWST Base	594' 6"

The water in the tank is borated to a concentration which assures reactor shutdown by approximately ten percent $\Delta k/k$ when all rod cluster control assemblies are inserted and the reactor is cooled down for refueling. Upon receipt of an Engineered Safety Features signal (S_s or S_t), the centrifugal charging pumps, the safety injection pumps, and the residual heat removal pumps take suction from the tank. Automatic heating is provided to maintain the tank temperature above 70°F. Refueling water recirculation pumps are used to recirculate heated water from the tank through the transport line as necessary to maintain the line water temperature above 70°F.

9.2.7.4 Testing and Inspection Requirements

The Refueling Water System design is verified by pre-operational testing. Testing includes verification of safety-related system flow paths and a verification of electrical heater input and associated control interlocks. The instrumentation associated with the refueling water storage tank is checked pre-operationally and during each refueling.

9.2.7.5 Instrumentation Requirements

Refer to Section 6.3.5.4 for FWST level instrumentation application during Emergency Core Cooling System operation. FWST level indications also aid the operator during the emptying and refilling of the refueling water storage tank during refueling. An overflow line is provided to the waste evaporator feed tank but the operator monitors the slowly rising water level and responds before overflow occurs. The temperature indication is provided to monitor the tank water temperature so that action can be taken if tank water temperature starts approaching the minimum tank water temperature.

All other instrumentation is provided to aid the operation of the system in its various modes.

9.2.8 Conventional Low Pressure Service Water System

9.2.8.1 Design Bases

The Conventional Low Pressure Service Water System is designed to supply lake water for various makeup and cooling functions on the secondary side of the plant. The Conventional Low Pressure Service Water System is shown on Figure 9-63 thru Figure 9-69 and the system component design parameters are given in Table 9-16.

9.2.8.2 System Description

The Conventional Low Pressure Service Water System consists of the following:

1. LPSW pumps
2. LPSW strainers
3. Intake and discharge structures
4. Piping, valves, and instrumentation

The three LPSW pumps are located on the LPSW intake structure on Lake Wylie and discharge to two LPSW strainers. Normally, one strainer will serve each unit, but if one strainer is out of service for any reason, the other strainer is capable of handling LPSW flows up to approximately 60,000 gpm without significantly impacting system operation. Downstream of the strainers, water is supplied to the following equipment:

1. Unit 1 and Unit 2 equipment
    a. Cooling towers makeup
    b. Main turbine lube oil coolers
    c. Generator stator water coolers
    d. Hydrogen coolers
    e. Containment Chillers
    f. Deleted Per 2010 Update
    g. Deleted Per 2007 Update
2. Shared equipment
    a. Recirculated cooling water coolers
    b. Station air compressor aftercoolers
    c. Deleted per 2015 update
    d. Service Building Chillers
    e. Fire protection jockey pumps
    f. Deleted Per 2007 Update
    g. LPSW Intake Screen Backwash System
    h. Deleted Per 2007 Update
    i. Fire Pump A motor bearing cooling water
    j. LPSW pumps motor bearing cooling water
    k. Corrosion test header
    l. Vendor supplied water treatment equipment located in the Water Treatment Building

After removing rejected heat in the above coolers, the LPSW discharge combines with the NSW discharge and is returned to Lake Wylie through two pipes at the discharge structure.

In a station blackout situation, Fire Protection System water would be used for emergency cooling of the E and F Instrument Air Compressors. This water will discharge into the Conventional Low Pressure Service Water System and be returned to the lake.

9.2.8.3 Safety Evaluation

The Conventional Low Pressure Service Water System does not perform any safety function and is therefore not assigned a safety class. Low level radioactive liquid wastes from various tanks in the Liquid Radwaste System will be discharged through radiation monitors to the NSW discharge piping in the Auxiliary Building or directly to the LPSW discharge piping in the Service Building (Monitor Tank Building discharge). The NSW discharge will combine with the LPSW discharge and will be returned to Lake Wylie at the LPSW discharge structure. If additional dilution flow is required to meet radwaste discharge concentration limits, LPSW bypass valves 1RL48, 1RL165, and 1RL166 can be manually opened by the operator (and additional LPSW pumps can be started if required and available) until sufficient discharge flow is obtained (as determined by flow indicators on the LPSW discharge piping). The radiological aspects of discharging low level radioactive liquid wastes including radioactive discharge rates under postulated design conditions are discussed in 11.2 and 11.6.

9.2.8.4 Instrumentation Application

Sufficient instrumentation is provided to monitor system performance. A LPSW pumps high discharge pressure alarm is provided in the control room to indicate low pump flow. A low discharge pressure alarm is also provided to indicate inadequate system pressure.

9.2.8.5 Tests and Inspections

The operating characteristics of the LPSW pumps are established by factory tests. All components were hydrostatically tested prior to initial station startup and most are accessible for periodic inspections during operation or unit shutdowns.

9.2.8.6 Biocide Addition

Due to the piping degradation and fouling problems, Catawba is chemically treating the RL System. The biocide will be added using the Service Water Treatment System or RW System. The affect of the biocide on materials of construction have previously been qualified via the qualification of the RN System and any additional materials in the RL System have been reviewed for acceptability. This biocide is intended for use in reducing the affects of Microbiological Influenced Corrosion (MIC) and biological growth.

9.2.9 References

1. Edinger, J. E. and Geyer, J. C., "Heat Exchange in the Environment," Report No. 2, RP-49 *Cooling Water Studies for Edison Electric Institute*, Johns-Hopkins University, 1965.
2. Ryan, Patrick J. and Donald, R. F. Harleman, *An Analytical and Experimental Study of Transient Cooling Pond Behavior*, Report No. 161, Massachusetts Institute of Technology, 1973.
3. Harleman, D. R. F. and Elder, R. A., "Withdrawal from Two-Layer Stratified Flows," *Journal of the Hydraulics Division*, ASCE, Vol. No. 91, pp. 43-58 1965.
4. Nuclear Regulatory Commission, Letter to All Holders of Operating Licenses or Construction Permits for Nuclear Power Reactors, from Frank J. Miraglia, Jr., August 8, 1988, "Instrument Air Supply System Problems Affecting Safety-Related Equipment (Generic Letter 88-14)."
5. Nuclear Regulatory Commission, Letter to All Holders of Operating Licenses or Construction Permits for Nuclear Power Plants, from James G. Partlow, July 18, 1989, "Service Water System Problems Affecting Safety-Related Equipment (Generic Letter 89-13)."

6. Duke Power Company, Letter from H.B. Tucker to NRC, January 26, 1990, re: Response to Generic Letter 89-13, "Service Water System Problems Affecting Safety-Related Equipment."

7. Duke Power Company, Letter from D.L. Rehn to NRC, October 20, 1993, re: Status of Licensing Issues, (1) Generic Letter 89-13, Service Water Systems; (2) Safety Evaluation for the Steam Generator Tube rupture Analysis; (3) Generic Letter 88-14, Instrument Air.

8. Catawba Nuclear Station, Units 1 and 2, Docket Numbers 50-413 and 50-414, Request for Relief Number 06-CN-003, Use of Polyethylene Materials in Nuclear Safety Related Piping Applications, Dated October 26, 2006.

9. Catawba Nuclear Station, Units 1 and 2, Relief 06-CN-003 Use of Polyethylene Material in Nuclear Service Water Applications (TAC Nos. MD3729 and MD3730), Dated September 12, 2008.

10. Catawba Nuclear Station, Units 1 and 2, Relief 06-CN-003 For Use of Polyethylene Material in Buried Service Water Piping (TAC Nos. ME0234 and ME0235), Dated May 27, 2009.

THIS IS THE LAST PAGE OF THE TEXT SECTION 9.2.

9.3 --Process Auxiliaries

9.3.1 Compressed Air System

9.3.1.1 Design Bases

The Compressed Air System consists of the Instrument Air, Station Air, and Breathing Air Systems. The Instrument Air System supplies clean, oil free, dried air to all air operated instrumentation and valves. The Station Air System supplies compressed air for air operated tools, miscellaneous equipment, and various maintenance purposes. The Breathing Air System supplies clean, oil free, low pressure air to various locations in the Auxiliary Building and in the Containment for breathing protection against airborne contamination while performing certain maintenance and cleaning operations. The Compressed Air Systems are shown on Figure 9-70 thru Figure 9-77, Figure 9-226 thru Figure 9-232, Figure 9-234 thru Figure 9-248, Figure 9-250 thru Figure 9-254, Figure 9-271, and the system component design parameters are given in Table 9-17.

9.3.1.2 System Description

9.3.1.2.1 Instrument Air System

> **Note:**
>
> This section of the FSAR contains information on the design bases and design criteria of this system/structure. Additional information that may assist the reader in understanding the system is contained in the design basis document (DBD) for this system/structure.

The Instrument Air System is primarily comprised of three centrifugal air compressors, three receiver tanks, two dryer assemblies, various valves, filters, and piping to provide quality air to the end use devices. Two of the three centrifugal air compressors operate to supply the normal system requirements for the system. The third centrifugal air compressor is available and typically maintained in an Auto-Start configuration. Two of these centrifugal compressors may be powered by the 4160 VAC Blackout Auxiliary Power System (see Section 9.3.1.3). Additional backup capacity is provided by diesel-driven rotary screw compressors which are maintained available for emergency use. They are limited by manual start capability and are available as interim compressors until the blackout compressors have been restored (see Section 9.3.1.3). The Instrument Air System may also be aligned to provide compressed air to the Station Air System (see Section 9.3.1.2.2), as the additional load on the Instrument Air compressors is minimal.

The centrifugal compressors and their respective intake plenums are located in the basement of the Service Building. This area is free of corrosive contaminants and hazardous gases. Within each compressor, the heated compressed air is cooled and dehumidified before discharging into its respective receiver tank. Downstream of the receiver tanks, air is supplied to the wet header, which supplies the condensate polishing demineralizers, the steam generator blowdown demineralizers, and the dryer assemblies. The dryer assemblies consist of prefilters, desiccant dryers, and afterfilters. Typically, one dryer assembly is maintained in service, although the second dryer assembly may be placed in service due to the limitations of the manual start capability of either dryer assembly. The prefilters, desiccant dryers, and afterfilters maintain the mositure vapor, hydrocarbon, and particulate requirements of the instrument air within the

Quality Standard for instrument Air-ISA-S7.0.01-1996. Downstream of the afterfilters, the instrument air branches into various headers throughout the plant to support appropriately designated Unit 1, Unit 2, and Shared Equipment.

9.3.1.2.2 Station Air System

Station air may be supplied by the Instrument Air centrifugal air compressors or any combination of the two Station Air compressors. When in service, one Station Air compressor typically operates to meet system requirements. The other Station Air compressor is typically maintained in standby service. Downstream of each Station Air compressor, the compressed air flows through an aftercooler and water separator before discharging into a Station Air receiver. The aftercooler cools the compressed air using the Conventional Low Pressure Service Water System (Section 9.2.8) Downstream of the air receivers, the Station Air headers carry station air throughout the plant.

9.3.1.2.3 Breathing Air System

Breathing air is supplied by two Breathing Air compressors. Downstream of each compressor, the compressed air flows through three filters, an aftercooler, and dryer before discharging into a breathing air receiver. The receiver discharge lines join and supply breathing air to various locations in the Auxiliary Building and inside the Containment.

9.3.1.3 Safety Evaluation

The compressed air systems are designed to provide dependable sources of compressed air for all station uses. Sufficient redundancy is provided to give a high degree of reliability to the air supply at all times. Sufficient air receiver capacity is provided to meet system high air demand transients.

Instrument Air Compressor D is supplied from the Station Auxiliary Power System Load Center 2SLXC which allows it to receive electrical power from either unit. Instrument Air Compressors E and F and the associated air dryers can be manually loaded on the Emergency D/G. This provision is made to facilitate shutdown, especially during a Control Room evacuation coincident with a station blackout. The reliable power source for the Instrument Air Compressors E and F in this case is the 4160 VAC Blackout Auxiliary Power System (Section 8.3.1.1.1.4) and the reliable cooling water source is the Fire Protection System (Section 9.5.1).

In the event that the centrifugal air compressors are unable to be returned to service following a loss of power, emergency diesel-driven compressors may be manually started and aligned to provide compressed air to the Instrument Air System. The emergency diesel-driven compressors are designed for short-term emergency support of the Instrument Air System (i.e. until the centrifugal compressors are returned to service). For this reason, the emergency diesel-driven compressors are not intended to meet the Instrument Air System air quality requirements.

Failure of the compressed air systems will not render any safety system equipment or its function inoperable. A loss of instrument air during an accident or station blackout would cause all pneumatically operated valves in the station which are essentially for safe shutdown to fail in the safe position.

A listing of the valves that can be operated from the Auxiliary Shutdown Complex is listed in Section 7.4.7.

9.3.1.4 Instrumentation Application

Sufficient instrumentation is provided to monitor system performance and to control the system automatically or manually under all operating conditions. A self contained backpressure control valve is installed in the crossover header between the Instrument Air and Station Air headers. If the Instrument Air pressure should drop below the valve low pressure setpoint, the control valve will close to terminate air supply to the Station Air System in order to maintain air supply to the Instrument Air System. The control valve will open as the Instrument Air pressure increases.

9.3.1.5 Tests and Inspections

The Instrument Air system is fully tested and inspected in accordance with appropriate recommendations of Regulatory Guide 1.80 prior to initial operation as described in Chapter 14. The air at the discharge of the air dryers is continuously monitored for local verification of an acceptable dew point. The air at the filter discharge is tested periodically for hydrocarbons and particulate contamination. Air samples are taken at selected remote locations of the Instrument Air System and checked for hydrocarbons, particulate matter, and dewpoint as recommended in Regulatory Guide 1.80 and in accordance with ISA-S7.0.01-1996. Adequate operating performance monitoring assures system integrity.

The NRC issued Generic Letter 88-14, "Instrument Air Supply System Problems Affecting Safety-Related Equipment," on August 8, 1988 (Reference 1). The purpose of Generic Letter 88-14 was to request for Catawba Nuclear Station an Instrument Air System design review of NUREG-1275 and verification of the following:

1. Verification by test that actual instrument air quality is consistent with the manufacturer's recommendations for individual components served.
2. Verification that maintenance practices, emergency procedures, and training are adequate to ensure that safety-related equipment will function as intended on loss of instrument air.
3. Verification that the design of the entire Instrument Air System, including air or other pneumatic accumulators, is in accordance with its intended function, including verification by test that air-operated safety-related components will perform as expected in accordance with all design-basis events, including a loss of the normal Instrument Air System. This design verification should include an analysis of current air-operated component failure positions to verify that they are correct for assuring required safety functions.

Responses detailing these verifications, along with descriptions of the Instrument Air Program, and design and programmatic enhancements necessary for maintaining proper instrument air quality were submitted to the NRC, beginning with the letter from H.B. Tucker to the NRC, dated February 10, 1989 (Reference 2), and concluding with the letter from D.L. Rehn to the NRC, dated January 12, 1995 (Reference 3), which detailed Generic Letter 88-14 action item closeout.

9.3.2 Process Sampling and Post-Accident Sampling Systems

9.3.2.1 Design Bases

9.3.2.1.1 Process Sampling Systems

The process sampling systems are designed to obtain samples from the various process systems of each of the two units. The process sampling systems are divided into two systems, the Nuclear Sampling System, and the Conventional Sampling System. The Nuclear Sampling

System contains all primary samples and steam generator blowdown and upper shell samples for sampling for primary to secondary tube leaks. The Conventional Sampling System contains all secondary side samples. Other local grab samples are taken but are not considered as part of these two systems. Adequate safety features are provided to protect laboratory personnel and prevent the spread of contamination of primary samples from the sample room. These systems have no emergency function. During a loss of coolant accident, samples originating inside the Containment are isolated at the containment wall. Fission product release will be kept within limits stated in 10 CFR 20 by limiting sample system discharges for all operational modes and anticipated malfunctions or failures.

The General Office Radiation Protection Group has evaluated the benefits of Zinc, both natural zinc and depleted zinc, when added to the NC System. This initiative is being made in an effort to reduce the overall NC system crud inventory and result in long-term personnel dose savings. To inject the zinc, a new chemical addition point has been added to the NM System on Unit 1 per Design Change CD-100320 and on Unit 2 per Design Change CD-200483. Catawba Station Chemistry has determined the optimum location for injecting zinc which is between valves 1(2)NM119 and 1(2)NM120. The flow path for injection will be through 1(2)NM119 and then via the NM System return header to the VCT. The installation and operation of a chemical injection skid, injection of chemicals, and removal of the skid will be controlled by an approved chemistry procedure.

9.3.2.1.2 Post-Accident Sampling System

The postaccident sampling system (PASS) is designed in compliance with the criteria in NUREG-0737, Item II.B.3. This system provides the capability to obtain and quantitatively analyze reactor coolant and containment atmosphere samples without radiation exposure to any individual exceeding 5 rems to the whole body or 75 rems to the extremities (GDC 19) during and following an accident in which there is core degradation. Materials to be analyzed and quantified include certain radionuclides that are indicators of severity of core damage (such as noble gases, isotopes of iodine and cesium, and nonvolatile isotopes), hydrogen in the containment atmosphere and total dissolved gases or hydrogen, boron, and chloride in reactor coolant samples in accordance with the requirements of NUREG 0737, Item II.B.3.

However, on September 11, 2001, the NRC issued Amendments No. 193 and 185 to the Unit 1 and Unit 2 Facility Operating Licenses, respectively. These amendments removed the requirements associated with post accident sampling from the plant Technical Specifications. The NRC concluded that the information provided by the post accident sampling is either unnecessary, or is effectively provided by other indications of process parameters or measurement of radiation levels.

In the license amendment request (LAR), CNS committed to maintaining the capability to obtain and analyze highly radioactive samples of reactor coolant, the containment sump, and containment atmosphere for the recovery phase of an accident. These contingency plans are contained in Chemistry and Radiation Protection procedures and they do not rely on any function of the post accident containment sample (PACS) panel or the post accident liquid sample (PALS) panel. It is also noted that this commitment to maintain such sampling capability is not associated with any design function which is required to mitigate the consequences of a design basis event. Therefore, this sampling capability is maintained in a non-nuclear safety related manner.

The LAR also committed to providing the capability for classifying fuel damage events at the Alert level threshold for radioactivity levels equal to or greater than 300 micro-curies/ml dose equivalent iodine. Emergency Plan procedures perform this function without the use of the PACS or PALS panels.

The final LAR commitment was to provide the capability to monitor radioactive iodines which have been released to offsite environments. This capability is outlined in the CNS Emergency Plan and applicable emergency procedures. Again, the PACS and PALS panels are not required to meet this commitment.

Temporary Mod CD200396 disabled the Unit 2 Post Accident Liquid Sample Panel by cutting and capping the ½" NM sample line upstream of valve 2NM294. The flow path downstream of 2NM294 is no longer available. NC hot leg A and C liquid samples are not accessible through the PALS Panel. NC A and C hot leg liquid sampling is accomplished using NM sample hood existing procedures. Temporary MOD CD200396 was made permanent by CD201232.

9.3.2.2 System Description

9.3.2.2.1 Nuclear Sampling System

A Nuclear Sampling System, as shown on Figure 9-78 through Figure 9-82 is provided for each unit. The system provides representative samples for laboratory analyses which are used for guidance in the operation of various primary and secondary systems. Typical information obtained includes reactor coolant boron and chloride concentrations, fission product concentration, hydrogen and oxygen content, fission gas content, corrosion product concentration, and chemical additive concentration. A sample room is provided for each unit.

The General Office Radiation Protection Group has evaluated the benefits of Zinc, both natural zinc and depleted zinc, when added to the NC System. This initiative is being made in an effort to reduce the overall NC system crud inventory and result in long-term personnel dose savings. To inject the zinc, a new chemical addition point has been added to the NM System on Unit 1 per Design Change CD-100320 and on Unit 2 per Design Change CD-200483. Catawba Station Chemistry has determined the optimum location for injecting zinc which is between valves 1(2)NM119 and 1(2)NM120. The flow path for injection will be through 1(2)NM119 and then via the NM System return header to the VCT. The installation and operation of a chemical injection skid, injection of chemicals, and removal of the skid will be controlled by an approved chemistry procedure.

Sample lines originating within the Containment are provided with remote, motor-operated Containment isolation valves, located both inside and outside the Containment, which are closed automatically by a Containment isolation signal in the event of a LOCA. In addition, a manual valve is located close to each sample source, and manually operated valves for flow control and isolation are located in the sample room. The isolation valves used for containment isolation of the process sampling lines are electric motor operated and therefore fail "as is." These valves are used in groups for each penetration with the isolation valves inside containment supplied by one train of safety related power while the valve outside containment receives power from the other train of safety related power. Both interior and exterior valves receive an appropriate automatic signal to close. Isolation of these lines is thus assured even with assumption of a single failure. This meets the intent of GDC 60 in Appendix A to 10CFR 50.

Sample lines originating outside the Containment are provided with a manually or air operated valve close to the source of the sample, with the exception of the residual heat removal loops which are provided with a remote, motor-operated valve. All remotely operated valves are controlled from the sample room.

All sample lines are located so a sample is taken from a free flowing stream or directly from a component so that a representative sample is taken. Purge lines are provided through which sample fluids may flow until sufficient volume has passed to permit collection of a representative sample. Sufficient flow is directed to the sample sink to purge the remainder of the sample line prior to taking a sample. All sample lines containing reactor grade water are purged to the volume control tank in the Chemical Volume Control System, the volume control tank gas space is purged to the Waste Gas System, and all other sample lines are purged to one of the waste evaporator feed tank sumps in the Liquid Radwaste System.

Normally, water discharged from the Containment floor and equipment sumps and the incore instrument sumps is processed and monitored in the Liquid Radwaste System. Following an accident, water in the containment recirculation sump can be sampled from the discharge side of the residual heat removal pumps by the Nuclear Sampling System.

All sample lines are provided with a local sample valve in the sample room sink. The sample sink is located in a hooded enclosure which is equipped with an exhaust ventilator. The work area around the sink and enclosure is large enough for sample collection and storage of radiation monitoring equipment.

Shielding is provided where required for personnel protection (refer to Section 12.1). Local instrumentation is provided to permit manual control of sampling operations and to assure that the samples are at suitable temperature and pressures before diverting flow to the sample sink.

Sample heat exchangers are provided to cool samples from the reactor coolant loops, residual heat removal loops, pressurizer steam and liquid spaces, and the steam generator blowdown lines. A delay coil is provided for decay of short-lived radionuclides present in the reactor coolant loop samples. NOTE: The delay coil has been abandoned in place per EC 112660 (U-1) and EC 112663 (U-2) based on ALARA dose considerations. In the sample room manually controlled valves are provided to reduce pressure. Sample vessels are provided to obtain degassed reactor coolant liquid and dissolved gas samples for laboratory analysis. An automated sampling system is provided for both units. A sample panel is located in each NM Sample Room containing on-line sample analytical equipment along with tubing and solenoid valves sufficient to route selected samples for automated sampling. Sample selection and analysis for each lab can be controlled locally via a dedicated workstation.

A Hot Leg Particle Sample Panel has been added in the NM Sample Lab PALS Room to sample Unit 1 NC System corrosion products in support of the long term investigation of reactor core Axial Offset Anomalies. The panel is installed in the existing NC Loop A/C NM sample line and constant flow will be maintained through the panel to allow taking representative samples and support the continued operation of the NM System Automated Sample Panel located down stream. The panel uses YN system cooling water, routes waste primary water to WEFT Sump A, and allows grab samples at Primary Sample Panel 1B Sink.

A gaseous sample from the volume control tank in the chemical and volume control system is collected in a sample vessel.

The steam generator blowdown sample lines are taken off the blowdown lines as close to the steam generator as practical in order to provide representative samples and satisfactory radioactivity control. The steam generator upper shell sample lines are taken directly off the steam generator. They are tied, along with the blowdown sample lines, into common steam generator sample lines to the sample room. The sample line flow from each steam generator is cooled by a sample heat exchanger. Downstream of the sample heat exchanger each sample line separates into 3 paths. One path connects all four sample lines together for manual sampling at the primary sample sink. Another path connects all four sample lines together and directs the flow through a radiation monitor. The flow from the radiation monitor is normally isolated from the steam generators and will be aligned to the steam generator once the condenser off-gas radiation monitor alarms. This alignment is performed to determine which steam generator is potentially faulted and then trends the primary to secondary leak. The discharge from the steam generator blowdown monitor is directed to the condensate storage tank of the Condensate Storage System. Individual lines are provided for each steam generator sample header, directing flow to the conventional sampling panel.

Each line contains an air operated isolation valve which will automatically close on a signal from the Condensate Steam Air Ejector radiation monitor. Containment isolation valves are provided in each of the steam generator sample lines and are arranged so that the operator may select sample flow from the upper shell and/or the blowdown line of each steam generator. These valves close automatically on the safety injection signal. The ability to obtain a manual sample in the primary sample sink for identifying the responsible steam generator following a radiation monitor alarm is provided.

The principal components of the system are the sample heat exchangers, delay coil, sample vessels and the sample sink. NOTE: The delay coil has been abandoned in place per EC 112660 (U-1) and EC 112663 (U-2) based on ALARA dose considerations. Component safety classifications and codes are listed in Table 3-4. Component design is as follows:

Sample Heat Exchangers

Sample heat exchangers are provided to cool samples originating from the pressurizer, the reactor coolant loops, the residual heat removal loops and the steam generator blowdown sample lines. The samples flow through the tube side and water from the Auxiliary Building Cooling System (YN) circulates through the shell side. In January 2011 a tube leak was confirmed in the 1B Reactor Coolant Hot Leg Sample Head Exchanger. This leak allowed Reactor Coolant to enter the YN system. In spite of efforts to decontaminate the YN system, low levels of contamination remain. Therefore, the YN System is being operated as a contaminated system.

Delay Coil

NOTE: The delay coil has been abandoned in place per EC 112660 (U-1) and EC 112663 (U-2) based on ALARA dose considerations.

A delay coil, consisting of coiled tubing, is provided in the high pressure sample line from the reactor coolant loops. The delay coil has sufficient length to provide at least a 40 second sample transit time within the Containment. An additional 20 seconds transit time is provided from the Containment to the sample sink. The delay allows for decay of the short lived isotope N16 to a level that permits normal access to the sample room.

Sample Vessels

Sample vessels are provided in the sample lines from the pressurizer, the reactor coolant loops and the volume control tank to obtain liquid and gas samples for laboratory analysis.

Sample Sink

Two sample sinks are provided in each sample room. One sink includes all the samples which require heat exchangers or sample vessels plus the accumulator sample lines. The second sink includes all the other sample lines. Both sinks drain to the waste feed tank of the Liquid Radwaste System.

The sinks are located in a hooded enclosure which is supplied with a continuously running exhaust fan. The fan discharges to the unit vent. The enclosure is penetrated by the sample lines, and a demineralized water line for each sink. Manual valves, for sample lines discharge isolation and flow control, are mounted on panels above each sink.

Each sample is listed in Table 9-18 giving the sampled system, sample location, and system design temperature and pressure. All sample lines originating inside the containment are safety class 2 through the containment to the outside isolation valve. From the outside isolation to the sample sink the piping is non nuclear safety, but is adequately shielded. Sample lines originating at the reactor coolant lines are safety class 2. A 0.236 id connection is required to change from safety class 1 to safety class 2. Sample lines originating at the pressurizer are safety class 1 until a flow restrictor transition piece where the piping becomes safety class 2. All sample lines originating outside the containment are the same safety class until the root valve or closed isolation valve where the piping class changes to non nuclear safety. All piping safety class boundaries meet the ANS1 N18.2 Code.

9.3.2.2.2 Conventional Sampling System

The Conventional Sampling System, as shown on Figure 9-83 through Figure 9-87 and Figure 9-259, Figure 9-260, and Figure 9-263 is designed to allow random grab samples and/or continuous monitoring of the essential water chemistry parameters in the secondary side of the nuclear station. This system is divided into four major parts; the Conventional systems sample panels, the polishing demineralizer water analysis sample panels, the treated water area sample panel, and the Electrochemical Potential (ECP) Monitor System and Feedwater Corrosion Monitor Sample Cooling Heat Exchanger (Unit 1).

9.3.2.2.2.1 Conventional Systems Sample Panels

The conventional systems sample panels are in the conventional sampling lab. The piping layout for these panels are shown on Figure 9-83, Figure 9-84, Figure 9-86, Figure 9-259, Figure 9-260 and Figure 9-263. There is one conventional systems sample panel per unit, which contains the following samples:

1. S. G. "A" Blowdown Sample
2. S. G. "B" Blowdown Sample
3. S. G. "C" Blowdown Sample
4. S. G. "D" Blowdown Sample
5. Final Feedwater Sample
6. Hotwell Pump Discharge Sample
7. Polish Demineralizer Main Effluent Sample
8. Heater Drain C1 H. P. Sample
9. Heater Drain C2 H. P. Sample
10. Upper Surge Tank Sample
11. Main Steam Sample A
12. Main Steam Sample B
13. Main Steam Sample C
14. Main Steam Sample D
15. Makeup Demineralized Water Effluent Sample

16. Moisture Separator Reheaters Drain Tank (A, B, C & D)
17. First Stage Reheater Drain Tank (A, B, C & D)
18. Second Stage Reheater Drain Tank (A, B, C & D)
19. Low Pressure Turbine Crossover (A/B, C/D)
20. Steam Generator Blowdown Demineralizer Effluent
21. Steam Generator Blowdown Demineralizer Influent

All of the above samples pass through equipment necessary to reduce temperature and pressure of the samples so they can be utilized as grab samples and/or used in automatic analyzers. This equipment includes rough and final cooling heat exchangers, equipped with isolation valves, and self-contained pressure regulator valves and relief valves. The amount of pressure and temperature reduction required for each sample varies depending on the samples initial inlet conditions and on the type of analysis a sample requires. Samples which enter the sample panel at a high temperature are cooled to 110°F by the rough cooling heat exchangers. The rough cooling heat exchangers receive cooling water from the Recirculating Cooling Water System. Samples which are provided with both grab sampling capability and automatic analyzer capability pass through the self-contained pressure regulators which reduce sample line pressure to 10 psig. Relief valves are on the analyzer lines to insure a safe pressure if the self-contained pressure regulators cannot maintain pressure below the design pressure of 25 psig. This insures that downstream flow through downstream analyzers are not overpressurized. All sample water flowing to analyzers next flows through final cooling heat exchangers that cool sample water to a standard 77°F water temperature. Final Cooling Heat Exchangers from both units receive cooling water from the Final Cooling Water Loop which utilizes the Computer Chilled Water System. Refer to Table 9-19 for the temperature and pressure conditioning requirements of each sample.

All samples on the conventional systems panel maintain a continuous flow to the analyzers and therefore do not require purge time prior to taking a sample.

All sample panels drain to the Unit 1 turbine sump.

Table 9-20 shows the types of analyzers that are provided for each sample in the Conventional Sampling Lab.

The final cooling water loop supplies water to the final cooling heat exchangers. The conventional sampling final cooling pump supplies 127 GPM of cooling water to a parallel circuit which splits the cooling water through the final cooling heat exchangers. The cooling water is collected at the outlet of the heat exchangers and recirculated back to the final cooling pump. This recirculated water is cooled by chilled water from the Computer Room Chilled Water System. A portion of the warm water which flows from the final cooling heat exchangers is discharged back into the Computer Room Chilled Water System. The temperature at the inlet of the final cooling heat exchangers is controlled by the amount of chilled water which is admitted into the cooling loop by the sample final cooling water temperature control valve. This control valve is located on the return line to the Computer Room Chilled Water System, from the final cooling water loop. The final cooling water loop serves both units. This sharing in no way affects the safety or integrity of the station since this system is not safety related.

The automatic or semi-automatic features of this sampling system are as follows:

1. Self-contained pressure regulators maintain a 10 psig pressure on sample lines flowing to analyzers.

2. The final cooling water temperature control valve regulates chilled water flow in and out of the final cooling water loop. This valve is controlled by the temperature of the cooling water entering the final cooling heat exchangers.
3. Samples from the Steam Generator Blowdown Systems are isolated from the Conventional Sampling Lab if the sample temperature exceeds 200°F or if a high amount of radiation is detected in the condensate steam air ejector off-gas.

9.3.2.2.2.2 Polishing Demineralizer Water Analysis Sample Panels

There is one Polishing Demineralizer Water Analysis Sample Panel per unit. These panels are located in the Conventional Sampling Lab of the Service Building and are shown on Figure 9-85. Each panel houses equipment to monitor the polish demineralizer water quality. The following samples are utilized in this panel:

1. Polish Demineralizer Main Influent Sample
2. Polish Demineralizer Vessel "A" Effluent Sample
3. Polish Demineralizer Vessel "B" Effluent Sample
4. Polish Demineralizer Vessel "C" Effluent Sample
5. Polish Demineralizer Vessel "D" Effluent Sample
6. Polish Demineralizer Vessel "E" Effluent Sample
7. Polish Demineralizer Main Effluent Sample

Each sample line in this panel is equipped with a needle valve, which is used to isolate the sample flow from the sampling panel, and a self-contained pressure regulator which maintains constant downstream pressure. Downstream of each pressure regulator, the sample lines split into a grab sampling line and an analyzer line. The grab sample line contains relief valves to insure sampler safety and needle valves to open and shut the sample line. The analyzer lines are equipped with cation conductivity analyzers, which have testing ports. Flow from the grab sample lines and analyzers flow into the sample sink provided with the panel, which in turn flows into the unit 1 Turbine Building sump.

Table 9-20 shows the type of analyzers that are provided for each sample in the Conventional Sampling Lab.

The operation of the Polish Demineralizer Water Analysis Sample Panels is manual. Adequate purge time must be allowed for each sample, to insure that representative samples are obtained.

9.3.2.2.2.3 Treated Water Area Sample Panel

The Treated Water Area Sample Panel is located in the Conventional Sampling Lab. There is one panel for both units, which houses grab sample points from the Drinking Water System, and the Recirculated Cooling Water System. The following samples are located in the sample panel:

1. Raw Water Sample
2. Recirculating Cooling Water Sample
3. Deleted per 2015 update
4. Deleted per 2015 update

5. Deleted per 2015 update
6. Deleted per 2015 update
7. Deleted per 2015 update
8. Deleted per 2015 update
9. Deleted per 2015 update

These samples drain, when a needle valve is opened, into a sample sink which is incorporated in the panel. This sink then drains into the Service Building Sump.

Operation of the grab samples on the Treated Water Area Sample Panel is manual. Grab sample lines must be purged to obtain a representative sample.

9.3.2.2.2.4 Electrochemical Potential Monitor System and Feedwater Corrosion Monitor Sample Cooling Heat Exchanger (Unit 1)

The Electrochemical Potential (ECP) Monitor System takes a sample from the Final Feedwater portion of the Feedwater (CF) System. The sample is transported through tubing to the ECP Monitor located in the Turbine Building. Isolation valves are provided to isolate the monitor during maintenance or at other times when it is not in use. The monitor itself consists of a stainless steel autoclave, inlet and outlet isolation valves, a flow element with pressure transmitter, ECP electrodes in the autoclave, and local electronics with display. This system is used on an as needed basis and is not utilized routinely.

The ECP monitor is located in close proximity to the feedwater line tie-in to assure that the actual sample is at or very near actual feedwater temperature and pressure. The sample flow is returned to the Condensate (CM) System via a connection downstream of the "C" LP heaters. Throttle valves and a relief valve are provided in the monitor discharge line. Isolation valves are provided at the supply (CF) and discharge (CM) tie-ins of the sample line.

The ECP monitor is transportable for use on either Unit 1 or Unit 2. It is powered from a 110 volt source.

The Feedwater Corrosion Monitor Sample Cooling Heat Exchanger allows chemistry the flexibility to connect sampling equipment for corrosion product sampling of Steam Generator Feedwater (CF). This sampling equipment can be used in meeting the UFSAR Section 10.3.5.2 Secondary Side Chemistry requirement to assure that water purity remains within specified limits.

9.3.2.2.3 Post-Accident Liquid Sampling System

The Post-Accident Liquid Sample System consists of a sample panel that houses the tubing, valving, instrumentation and system components. The system is controlled and monitored remotely from the sample control panel.

On September 11, 2001, the NRC issued Amendments No. 193 and 185 to the Unit 1 and Unit 2 Facility Operating Licenses. These amendments removed the requirements associated with the PASS Panels from the plant Technical Specification. The NRC has concluded that the information provided by the PASS Panels is either unnecessary or is effectively provided by other indications of process parameters or measurement of radiaiton levels. See Section 9.3.2.1.2 for discussion of commitments made in order to eliminate the use of the PASS system.

Although the requirements to maintain the PASS system have been removed, the system has not been abandoned. The following description of the operation and design of the system are still valid even though the system is not required to be operable for any post accident analysis. The system is schematically illustrated in Figures 9-201, 9-202, and 9-203 and details of the control and sample panels are discussed below.

9.3.2.2.3.1 Control Panel

1. All outputs from the control panel are 115 VAC, 1.5A.
2. To keep the radiation exposure as low as reasonably possible, the control panel is located approximately 40 cabling feet away from the sampling panel in a separate room.
3. Instrumentation is provided to measure the pH, temperature, and sample flow of the cooling water and sample, and pressure in critical points in the sample panel.

9.3.2.2.3.2 Sample Panel

1. Reactor coolant is brought into the sample panel through a cooler, which brings the sample temperature below 212°F, and a 500 ml sample is trapped at system pressure.
2. The sample trap is depressurized by opening a valve between the trapped area and an evacuated volume. The depressurized sample is then de-gassed using one of two methods: nitrogen stripping or total gas method.
3. pH measurements are then made on the full strength sample.
4. 5 ml, 1 ml, or 1 μ1 of the full strength sample is trapped for retrieval by the operator.
5. Approximately 20 ml of the gas is trapped for retrieval by the operator.
6. Before retrieving the samples the sample panel is flushed of any excess sample.
7. The sample panel sump collects any liquids which may leak in the sample panel. During normal operation, all liquids for Unit 1 are returned to the Waste Evaporator Feed Tank Sump A. For Unit 2, all liquids are returned to the Waste Evaporator Feed Tank Sump B. During post-accident operation, liquids for both units may be diverted to the VCT.

The PALS is designed to handle two (NC, ND or containment sump) sampling points. Each sampling point will have its own inlet valve and demineralized water flush valve, which are external to the sample panel. These external valves must be able to handle the highest system pressure that will be seen by the panel.

The motive force for the sample is supplied by the pressure of the system being sampled or by pumps which are external to the sample panels.

Flow through the sampling system is controlled by a high pressure regulator and needle valve. In the event of failure of the high pressure regulator or the needle valve flow through the system is throttled by the sample cooler.

9.3.2.2.3.3 System Operation and Measurements

Isotopic analysis is run on a trapped volume of sample from the PALS panel. The individual isotopes are identified at the station counting room from that sample.

Hydrogen levels in the containment atmosphere can be determined by the hydrogen monitor located in the auxiliary building (see FSAR Section 1.8.1, NUREG 0737, Item II.F.1 and FSAR Table 1-11).

Dissolved gases are vacuum and nitrogen stripped from a trapped liquid sample. Capabilities to analyze the gases of the sample are completed at the station chemistry lab or calculated by using PALS calculated hydrogen method (Ideal Gas Law and Henry's Law).

Chloride and boron analysis are performed on a diluted sample at the station chemistry lab.

Ph is performed on an undiluted sample at the PALS panel. Capabilities of pulling an undiluted sample in case the instrument is inoperable can be accomplished.

9.3.2.3 Safety Evaluation

All sample lines have the required indicators, pressure throttling valves, heat exchangers, etc., to ensure plant operator safety when collecting samples. The two sampling systems serve no emergency function. All sample lines which penetrate the Containment are isolated on Containment isolation signal. Also, all samples have the ability to be isolated manually at the sample source or just prior to entering the panels in the Conventional Sampling Lab.

The Nuclear Sampling System has the following special safety features due to handling primary loop samples:

1. Sample lines from the reactor coolant hot legs contain a delay coil to provide a decay time for N-16. NOTE: The delay coil has been abandoned in place per EC 112660 (U-1) and EC 112663 (U-2) based on ALARA dose considerations.
2. Adequate shielding is provided to protect personnel when taking a sample.
3. Exhaust hoods are provided for each sample sink to ensure that leakage of any gases will be exhausted from the sample room.
4. Sample sinks are provided to collect all spillage and are drained to the waste evaporator feed tank sump A of the Liquid Radwaste System.
5. An automated sampling panel is provided to allow automated sampling of various primary side systems.

The routing of high pressure and temperature sample lines outside the reactor containment is not considered hazardous because of the limited flow capacity.

9.3.2.4 Tests and Inspections

The systems are fully tested and inspected before initial operation. Adequate operating performance monitoring assures system integrity. Tests of sampling systems used for post-accident sampling of radioactive fluids are adequate to verify that flow paths are available with adequate holdup times to allow sampling, and that normal sampling methods will work.

9.3.2.5 Instrumentation Application

Adequate temperature and pressure indication are provided for taking manual samples. (No provisions are made for taking manual samples from the ECP Monitor System.)

Radiation monitors are provided for continuous monitoring of the reactor coolant hot legs and condenser off-gas. Radiation monitoring capabilities are available on the steam generator blowdown however this monitor is manually valved in following the condenser off-gas monitor going into the alarm.

An automated sample panel is provided containing necessary tubing and solenoid valves to select and route primary side samples for analysis. Control of sample selection and control of analytical equipment is accomplished via dedicated workstation located in each NM Sample Room. Analysis results are also displayed on these terminals.

9.3.3 Equipment and Floor Drainage System

9.3.3.1 Design Bases

Section 11.2, Liquid Radwaste System (WL) contains a discussion of the eight subsystems provided to collect, control, process, handle, store, and dispose of liquid radioactive waste generated as a result of normal operation, including anticipated operational occurrences. This includes potential leakage from safety systems. Section 11.2.2.7.2.2, paragraph 2, describes means to detect excessive unidentified leakage inside containment. Excessive leakage in the Auxiliary Building, as discussed in Section 11.2.2.7.2.3, is sensed by WL System tank and sump level instrumentation. The Equipment and Floor Drainage System does not exist separately, but is considered the means of segregation and collection for the WL System. Equipment and floor drain headers are routed to the various tanks of the WL System in a manner designed to minimize the liquid and gaseous radioactive releases. Frequent reference should be made to Section 11.2 for a more thorough discussion of the radwaste segregation philosophy and design.

9.3.3.2 System Description

The Equipment and Floor Drainage System is included in the discussion of the Liquid Radwaste System, Section 11.2. Flow diagrams showing portions of the Equipment and Floor Drainage System are Figure 11-1, Figure 11-2, Figure 11-3, Figure 11-8, Figure 11-11, Figure 11-12, Figure 11-13, and Figure 11-14. The flushing supply connections necessary to flush reactor coolant from various plant components are shown as Figure 9-103 of the Boron Recycle System. The Equipment and Floor Drainage System piping is embedded in the floor where possible. The various areas of the Equipment and Floor Drainage System are described below.

Waste Drain Tank Drains

Components that contain water with entrained fission product gases are flushed out with water from the reactor makeup water storage tank into the waste drain tank. Three component volumes of flush water are considered sufficient to provide a clean component. Demineralizers are flushed prior to sluicing to prevent gaseous release from the spent resin storage tanks. All other components are drained to the waste evaporator feed tank after flushing prior to maintenance.

Waste Evaporator Feed Tank Drains

All equipment that contains tritium or other radioactive elements is drained either directly to the waste evaporator feed tank or indirectly to this tank via the waste evaporator feed tank sumps.

Laundry and Hot Shower Tank Drains

The drains from the laundry, showers, and sinks that may contain radioactive wastes are piped to the laundry and hot shower tank.

Floor Drain Tank Drains

For a thorough discussion of the segregation and collection processes for Auxiliary Building "clean" and "radioactive" area drains, see Section 11.2.2.1.5. Reactor Building floor drains are normally routed to the floor drain tank.

Reactor Coolant Drain Tank Drains

For a description of the components draining to this tank and the hydrogen overpressure maintained see Section 11.2.2.1.1.

Ventilation Unit Condensate Drain Tank Drains

Condensation from all the containment ventilation units is collected from their respective drain pans. A header system is is provided to route this condensate out of the containment to the ventilation unit condensate drain tanks. See Section 11.2.2.1.7 for a description of the treatment of this tank's contents.

Steam Generator Drain Tank Drains

Drain lines are provided off the low point of each steam generator blowdown line for quick drainage of the contents whether they are non-radioactive, or radioactively contaminated due to tube leakage. Refer to Section 11.2.2.1.8 for a description of this function.

Auxiliary Building Ventilation Unit Condensate Drains

The condensation off of all the various cooling coils in the Auxiliary Building are routed to the clean area sumps (floor drain sumps C and D). For further description see Section 11.2.2.2.9.6.

Auxiliary Building Air Handling Filter Train Drains

All air handling filter trains are required to have internal sprinkler systems for fire protection and adequate drainage to take sprinkler head flow. Should the sprinklers discharge, the drainage water could wash radioactive contaminants off the filter elements so drainage is routed to the floor drain tank for treatment. See Section 11.2.2.2.9.4 for further description.

Decontamination Area Drains

The various ultrasonic cleaners and turbulator drains in the decontamination area are routed to the mixing and settling tank, where acids are neutralized prior to further treatment. See Section 11.2.2.1.6 for further description. The soaking trough is too large to drain to the mixing and settling tank so it is routed to the floor drain tank for treatment.

Diesel Generator Building Floor Drains

Each diesel generator area drains to a diesel generator sump system as described in section 9.5.9.

9.3.3.3 Safety Evaluation

Drains are sized large enough to facilitate draining of equipment in a reasonable amount of time but small enough to limit drainage from overflowing downstream processes. Sump sizes and sump pump capacities, discussed in Sections 11.2.2.2.4 and 11.2.2.2.5, are compatible to eliminate undesirable sump pump cycling operation. Two independent means are provided to empty all sumps except the incore instrumentation room sump and Upper Head Injection Building sump, neither of which are expected to receive leakage during normal operation. Sump pump capacities are sized large enough to handle a credible rupture or the maximum expected flow rate into their respective sumps.

All piping capable of flooding components needed for safe shutdown and accident mitigation is designed to seismic Category I. This minimizes the potential for flooding safety related components. Good operating practice dictates that system operation be either terminated or quickly switched over to the redundant channel and the leaking component or header isolated. This minimizes the quantity of water available for flooding safety related equipment. Excessive leakage in the Reactor Building and Auxiliary Building is discussed in Sections 11.2.2.7.2.2 and 11.2.2.7.2.3 respectively.

The containment spray and residual heat removal pump room sump, described in Section 11.2.2.2.4.3, is served by four safety related sump pumps described in Section 11.2.2.2.5.6. This sump is shared between units but the pumps are powered by normal and emergency diesel power from channels 1A, 1B, 2A, and 2B respectively. The pumps are set to come on at various levels in the NS and ND pump room sump and together can handle nearly 500 GPM of inleakage. Should this still not be sufficient, the 522 ft. level can safely hold up to 218,000 gallons of water before the level reaches safety related pump motors or essential electrical equipment. This is sufficient room volume and sump pump capacity to hold or divert the water contained in the refueling water storage tank, the largest single tank available for flooding consideration.

Flood design considerations are discussed in Section 2.4.2.2. Critical station areas are not flooded by a probable maximum flood.

The Equipment and Floor Drainage System has been carefully and rigorously designed to accomplish the necessary segregation of liquid wastes as required by the Liquid Radwaste System.

Double isolation valves with a telltale to check through line leakage are used on all piped-up equipment drains where leakage is crucial. Component drains not piped to the WL System or Component Cooling Drain sump have a single valve and pipe cap to eliminate drippage.

9.3.3.4 Tests and Inspections

The system is tested and inspected to applicable codes before initial operation. Adequate operating performance monitoring assures system integrity.

9.3.3.5 Instrumentation Application

Sumps and sump pumps have adequate instrumentation to start and stop pumps and monitor performance, as well as alternate redundant pumps to assure equal wear. Flow integrators are used on sump pump discharge lines, sample purge lines, and at various points in equipment flush and drain headers to monitor flows, establish normal limits, and thereby detect excessive through line leakage. Instrumentation is shown on the flow diagrams referenced in Section 9.3.3.2.

9.3.4 Chemical and Volume Control System

9.3.4.1 Design Bases

The Chemical and Volume Control System, is designed to provide the following services to the Reactor Coolant System.

1. Maintenance of predetermined water level in the pressurizer, i.e. maintain required water inventory in the Reactor Coolant System.
2. Maintenance of seal water injection flow to the reactor coolant pumps.
3. Control of reactor coolant water chemistry conditions, activity level, soluble chemical neutron absorber concentration and makeup.
4. Emergency core cooling (safety injection).
5. Provide conditions for filling, draining, and hydrostatic testing in the Reactor Coolant System.

9.3.4.1.1 Maintenance of Reactor Coolant Inventory

The Chemical and Volume Control System maintains the coolant inventory in the Reactor Coolant System within the allowable pressurizer level range for all normal modes of operation including startup from cold shutdown, full power operation and plant cooldown. (See Table 9-21 for letdown and charging flow rates). This system also has sufficient makeup capacity to maintain the minimum required inventory in the event of minor Reactor Coolant System leaks. (See Technical Specifications for a discussion of maximum allowable Reactor Coolant System leakage).

9.3.4.1.2 Maintenance of Seal Water Injection

The Chemical and Volume Control System is able to continuously supply filtered water to each reactor coolant pump seal, as required by the reactor coolant pump design.

9.3.4.1.3 Reactor Coolant Purification and Chemistry

The Chemical and Volume Control System removes fission and activation products, in ionic form or as particles, and corrosion products from the reactor coolant during operation of the reactor. In removing fission and activation products the Chemical and Volume Control System provides access to those process lines carrying reactor coolant during operation and reduces activity releases due to leaks. The Chemical and Volume Control System also removes excess lithium from the reactor coolant, keeping the lithium concentration within the desired limits of pH control.

The Chemical and Volume Control System provides a means for adding chemicals to the Reactor Coolant System, controlling the pH of the coolant during initial startup and subsequent operation, scavenging oxygen from the coolant during startup, and controlling the oxygen level of the reactor coolant due to radiolysis during all operation subsequent to startup. The Chemical and Volume Control System is capable of maintaining the oxygen content and pH of the reactor coolant within limits specified in Table 5-9 during all operation subsequent to startup.

9.3.4.1.4 Reactivity Control

The Chemical and Volume Control System regulates the concentration of chemical neutron absorber (boron) in the reactor coolant to control reactivity changes resulting from the change in reactor coolant temperature between cold shutdown and hot full-power operation, burnup of fuel and burnable poisons, buildup of fission products in the fuel, and xenon transients.

Reactor Makeup Control

1. The Chemical and Volume Control System is capable of borating the Reactor Coolant System through either one of three flow paths: (a) through blender to VCT, (b) through blender to charging pump, and (c) directly to charging pumps.
2. The amount of boric acid stored in the Chemical and Volume Control System always exceeds that amount required to borate the Reactor Coolant System to cold shutdown concentration assuming that the control assembly with the highest reactivity worth is stuck in its fully withdrawn position. This amount of boric acid also exceeds the amount required to bring the reactor to hot shutdown and to compensate for subsequent xenon decay.

9.3.4.1.5 Emergency Core Cooling

The centrifugal charging pumps in the Chemical and Volume Control System serve as the high-head safety injection pumps in the Emergency Core Cooling System. Other than the centrifugal charging pumps and associated piping and valves, the Chemical and Volume Control System is not required to function during a loss-of-coolant accident. During a loss-of-coolant accident, the Chemical and Volume Control System is isolated except for the centrifugal charging pumps and the piping in the safety injection and seal injection path.

9.3.4.1.6 Hydrostatic Testing of the Reactor Coolant System

The Chemical and Volume Control System is capable of supplying water at the maximum test pressure specified to verify the integrity of the Reactor Coolant System.

9.3.4.2 System Description

The Chemical and Volume Control System is shown in Figure 9-89 through Figure 9-97 with system design parameters listed in Table 9-21. The Chemical and Volume Control System consists of two subsystems: the charging, letdown and seal water system, and the chemical control, purification and makeup system.

9.3.4.2.1 Charging, Letdown and Seal Water System

The charging and letdown functions of the Chemical and Volume Control System are employed to maintain a predetermined water level in the Reactor Coolant System pressurizer, thus maintaining proper reactor coolant inventory during all phases of unit operation. This is achieved by means of a continuous feed and bleed process during which the feed rate is automatically controlled based on pressurizer water level. The bleed rate can be chosen to suit various unit operational requirements by selecting the proper combination of letdown controls, which consists of a control valve and two orifices in the letdown flow path.

Reactor coolant is discharged to the Chemical and Volume Control System from a reactor coolant loop cold leg; it then flows through the shell side of the regenerative heat exchanger where its temperature is reduced by heat transfer to the charging flow passing through the tubes. The coolant then experiences a large pressure reduction as it passes through the letdown controls and flows through the tube side of the letdown heat exchanger where its temperature is further reduced to the operating temperature of the mixed bed demineralizers (115°F). Downstream of the letdown heat exchanger a second pressure reduction occurs. This second pressure reduction is performed by the low pressure letdown valve, which maintains upstream pressure thus preventing flashing downstream of the letdown orifices.

The coolant then flows through one of the mixed bed demineralizers. The flow may then pass through the cation bed demineralizer which is used intermittently when additional purification of the reactor coolant is required. The cation bed demineralizer flow is limited to normal letdown flow or less.

The coolant then flows through one of the reactor coolant filters. The flow then enters the volume control tank via a diversion valve and finally a spray nozzle in the gas space of the tank. During reactor coolant boration and dilution operations, especially during load follow, part or all of the letdown flow heading for the volume control tank may be directed to the Boron Recycle System via the diversion valve. Hydrogen (from the Hydrogen Bulk Storage System) is continuously supplied to the volume control tank where it mixes with fission gases which are stripped from the reactor coolant in the gas space. The contaminated hydrogen is vented back to the Waste Gas System. The partial pressure of the hydrogen gas mixture in the volume control tank determines the concentration of hydrogen dissolved in the reactor coolant for control of oxygen produced by radiolysis of water in the core.

Two centrifugal charging pumps are provided to take suction from the volume control tank and return the purified reactor coolant to the Reactor Coolant System through the charging line. Charging flow is handled by either of the charging pumps. The charging flow splits into two paths which provide reactor coolant pump seal injection and Reactor Coolant System charging. The bulk of the charging flow is pumped back to the Reactor Coolant System through the tube side of the regenerative heat exchanger raising the charging flow to a temperature approaching the reactor coolant temperature. The flow is then injected into a cold leg of the Reactor Coolant System. Two charging paths are provided from a point downstream of the regenerative heat exchanger for rapid boration of the system. A flow path is also provided from the regenerative heat exchanger outlet to the pressurizer spray line. A motor operated valve in the spray line is available to provide auxiliary spray to the vapor space of the pressurizer. A line from the RHR System also supplies pressurizer spray. This line was added in order to handle a temperature transient which exists at the pressurizer nozzle. Pressurizer spray under normal operation is supplied by the RHR System. This provides a means of cooling the pressurizer near the end of unit cooldown, when the reactor coolant pumps, which normally provide the driving head for the pressurizer spray, are not operating.

A portion of the charging flow is directed to the reactor coolant pumps (nominally 8 gpm per pump) through a seal water injection filter. The flow is directed downward to a point between the pump shaft bearing and the thermal barrier cooling coil. Here the flow splits and a portion (nominally 5 gpm per pump) enters the Reactor Coolant System through the labyrinth seals and thermal barrier. The remainder of the flow is directed upward along the pump shaft, cooling the lower bearing, and to the number 1 seal leakoff. The number 1 seal leakoff flow discharges to a common manifold, exits from the containment, and then passes through the seal water return filter and the seal water heat exchanger to the volume control tank. A very small portion of the seal flow leaks through to the number 2 seal. A number 3 seal provides a final barrier to leakage to Containment atmosphere. The number 2 and 3 seal leakoff flows are discharged to the reactor coolant drain tank in the Liquid Radwaste System.

A standpipe is provided to assure a backpressure of at least 7 feet of water on the number 3 seal and warn of excessive number 2 seal leakage. The first outlet from the standpipe has an orifice to permit normal number 2 seal leakage to flow to the reactor coolant drain tank; excessive number 2 leakage results in a rise in standpipe level and eventual overflow to the reactor coolant drain tank via a second overflow connection.

An alternate letdown path from the Reactor Coolant System is provided in the event that the normal letdown path is inoperable. Reactor coolant can be discharged from a cold leg to flow through the tube side of the excess letdown heat exchanger where it is cooled by component cooling water. Downstream of the heat exchanger a remote-manual control valve controls the letdown flow. The flow normally joins the number 1 seal discharge manifold and passes through the seal water return filter and heat exchanger to the VCT. The flow can also be directed to the reactor coolant drain tank. When the normal letdown line is not available, the normal purification path is also not in operation. Therefore, this alternate condition would allow continued power operation for a limited period of time, dependent on Reactor Coolant System chemistry and activity. The excess letdown flow path is also used to provide additional letdown capability during the final stages of unit heatup. This path removes some of the excess reactor coolant due to expansion of the system as a result of the Reactor Coolant System temperature increase. In this case, the excess letdown is diverted to the reactor coolant drain tank.

Surges in Reactor Coolant System inventory due to load changes are accommodated for the most part in the pressurizer. The volume control tank provides surge capacity for reactor coolant expansion not accommodated by the pressurizer. If the water level in the volume control tank exceeds the normal operating range, a proportional controller modulates a three way valve downstream of the reactor coolant filter to divert a portion of the letdown to the Boron Recycle System. If the high-level limit in the volume control tank is reached, an alarm is actuated in the control room and the letdown flow is completely diverted to the Boron Recycle System.

The Boron Recycle System receives and processes reactor coolant effluent for reuse of the boric acid and purified water. The system decontaminates the effluent by means of demineralization and gas stripping, and uses evaporation to separate and recover the boric acid and reactor makeup water.

Low level in the volume control tank initiates makeup from the reactor makeup control system. If the reactor makeup control system does not supply sufficient makeup to keep the volume control tank level from falling to a lower level, a low alarm is actuated. Manual action may correct the situation or, if the level continues to decrease, an emergency low level signal from the two level channels causes the suction of the charging pumps to be transferred to the refueling water storage tank.

9.3.4.2.2 Chemical Control, Purification and Makeup System

The water chemistry, chemical shim and makeup requirements of the reactor coolant system are such that the following functions must be provided:

1. Means of addition and removal of pH control chemicals for startup and normal operation.
2. Control of oxygen concentration following venting and that due to radiolysis in the core region during normal operation.
3. Means of purification to remove corrosion and fission products.
4. Means of addition and removal of soluble chemical neutron absorber and makeup water at concentration and rates compatible with all phases of plant operation including emergency situations.

9.3.4.2.2.1 pH Control

The pH control chemical employed is lithium hydroxide (Li^7 OH). This chemical is chosen for its compatibility with the materials and water chemistry of borated water/stainless steel/zirconium/Inconel systems. In addition, lithium-7 is produced in the core region due to irradiation of the dissolved boron in the coolant.

The concentration of lithium-7 in the Reactor Coolant System is maintained in the range specified for pH control per the coordinated boron/lithium program. If the concentration exceeds this range, as it may during the early stages of core life, the cation bed demineralizer is employed in the letdown line in series operation with a mixed bed demineralizer. Since the amount of lithium to be removed is small and its buildup can be readily calculated, the flow through the cation bed demineralizer is not required to be full letdown flow. If the concentration of lithium-7 is below the specified limits, lithium hydroxide can be introduced into the Reactor Coolant System via the charging flow. The solution is prepared in the laboratory and poured into the chemical mixing tank. Reactor makeup water is then used to flush the solution to the suction manifold of the charging pumps.

9.3.4.2.2.2 Oxygen Control

During reactor startup from the cold condition, hydrazine is employed as an oxygen scavenging agent. The hydrazine solution is introduced into the Reactor Coolant System in the same manner as described above for the pH control agent.

Dissolved hydrogen is employed to control and scavenge oxygen produced due to radiolysis of water in the core region. Sufficient pressure of hydrogen gas mixture is maintained in the volume control tank such that the specified equilibrium concentration of hydrogen is maintained in the reactor coolant.

Hydrogen is supplied from the hydrogen bulk storage system and a pressure control valve maintains a minimum pressure in the vapor space of the volume control tank. This valve can be adjusted to provide the correct equilibrium hydrogen concentration (>=15 cc/kg hydrogen at STP for reactor criticality and 25-50 cc/kg hydrogen at STP for normal operation).

9.3.4.2.2.3 Reactor Coolant Purification

Mixed bed demineralizers and a cation bed demineralizer are provided in the letdown line to provide cleanup of the letdown flow. The demineralizers remove ionic corrosion products and fission products. One mixed bed demineralizer is in continuous service and can be supplemented intermittently by the cation bed demineralizer, if necessary, for additional purification. The cation resin removes principally cesium and lithium isotopes from the purification flow. The second mixed bed demineralizer serves as a standby unit for use if the operating demineralizer becomes exhausted during operation. In mode 5, 6, or no mode, the maximum allowable letdown flow from the RHRS into the Chemical and Volume Control System is 185 GPM. Each mixed-bed demineralizer is sized to accept maximum letdown flow of 120 GPM.

A further cleanup feature is provided for use during cold shutdown and residual heat removal. A remote operated valve admits a bypass flow from the Residual Heat Removal System (RHRS) into the letdown line upstream of the letdown heat exchanger. The flow passes through the heat exchanger, through one or both mixed bed demineralizers and the reactor coolant filter to the volume control tank. The fluid is then returned to the Reactor Coolant System via the normal charging route.

Filters are provided at various locations to ensure filtration of particulate and resin fines and to protect the seals on the reactor coolant pumps.

Fission gases are removed from the reactor coolant by continuous or intermittent purging of the volume control tank to the Waste Gas System.

9.3.4.2.2.4 Reactor Makeup Control System

The soluble neutron absorber (boric acid) concentration is controlled by the Reactor Makeup Control System. The Reactor Makeup Control System is also used to maintain proper reactor coolant inventory. In addition, for emergency boration and makeup, the capability exists to provide refueling water or 4 weight percent boric acid directly to the suction of the charging pump.

The Reactor Makeup Control System provides a manually pre-selected makeup composition to the charging pump suction header or to the volume control tank. The makeup control functions are those of maintaining desired operating fluid inventory in the volume control tank and adjusting reactor coolant boron concentration for reactivity control. Reactor makeup water and boric acid solution (4 weight percent) are blended together at the reactor coolant boron concentration for use as makeup to maintain volume control tank inventory or they can be used separately to change the reactor coolant boron concentration.

The boric acid is stored in two boric acid tanks. Two boric acid transfer pumps per tank are provided with one pump normally aligned for service and the second pump in reserve. On a demand signal by the reactor makeup controller, the pump starts and delivers boric acid to the suction header of the charging pumps. The pump can also be used to recirculate the boric acid tank fluid.

All portions of the Chemical and Volume Control System which normally contain concentrated boric acid solution (4 weight percent boric acid) are required to be located within a heated area in order to maintain solution temperature at > 65°F. If a portion of the system which normally contains concentrated boric acid solution is not located in a heated area, it is provided with some other means (e.g. heat tracing) to maintain solution temperature at > 65°F. The Boric Acid Pump and Tank Rooms are surveyed during winter, at cold shutdown and during refueling to assure that the required boric acid solution temperature is > 65°F.

The reactor makeup water pumps, taking suction from the reactor makeup water storage tank, are employed for various makeup and flushing operations throughout the systems. One of these pumps starts on demand from the reactor makeup controller and provides flow to the suction header of the charging pumps or the volume control tank.

During reactor operation, changes are made in the reactor coolant boron concentration for the following conditions:

1. Reactor startup - boron concentration must be decreased from shutdown concentration to achieve criticality.
2. Load follow - boron concentration must be either increased or decreased to compensate for the xenon transient following a change in load.
3. Fuel burnup - boron concentration must be decreased to compensate for fuel burnup and the buildup of fission products in the fuel.
4. Cold shutdown - boron concentration must be increased to the cold shutdown concentration.

The Reactor Makeup Control System can be set up for the following modes of operation:

9.3.4.2.2.4.1 Automatic Makeup

The "automatic makeup" mode of operation of the Reactor Makeup Control System provides blended boric acid solution, preset to match the boron concentration in the Reactor Coolant System. Automatic makeup compensates for minor leakage of reactor coolant without causing significant changes in the reactor coolant boron concentration.

Under normal plant operating conditions, the mode selector switch is set in the "automatic makeup" position. This switch position establishes a preset control signal to the total makeup flow controller and established positions for the makeup stop valves for automatic makeup. The boric acid flow controller is set to blend to the same concentration of borated water as contained in the Reactor Coolant System. A preset low level signal from the volume control tank level controller causes the automatic makeup control action to start a reactor makeup water pump, start a boric acid transfer pump, open the makeup stop valve to the charging pump suction, and position the boric acid flow control valve and the reactor makeup water flow control valve. The flow controllers then blend the makeup stream according to the preset concentration. Makeup addition to the charging pump suction header causes the water level in the volume control tank to rise. At a preset high level point, the makeup is stopped. This operation may be terminated manually at any time.

If the automatic makeup fails or is not aligned for operation and the tank level continues to decrease, a low level alarm is actuated. Manual action may correct the situation or, if the level continues to decrease, an emergency low level signal opens the stop valves in the refueling water supply line to the charging pumps, and closes the stop valves in the volume control tank outlet line.

9.3.4.2.2.4.2 Dilution

The "dilute" mode of operation permits the addition of a pre-selected quantity of reactor makeup water at a pre-selected flow rate to the Reactor Coolant System. The operator sets the mode selector switch to "dilute", the reactor makeup water flow controller set point to the desired flow rate, the reactor makeup water batch integrator to the desired quantity and initiates system start. This opens the reactor makeup water control valve to the volume control tank and starts a reactor makeup water pump which delivers water to the volume control tank. The makeup water is injected through the volume control tank spray nozzle and through the tank to the charging pump suction header. Excessive rise of the volume control tank water level is prevented by automatic actuation (by the tank level controller) of a three-way diversion valve which routes the reactor coolant letdown flow to the recycle holdup tanks. When the preset quantity of water has been added, the batch integrator causes the pump to stop and the control valve to close. This operation may be terminated manually at any time by actuating makeup stop.

9.3.4.2.2.4.3 Alternate Dilution

The "alternate dilute" mode of operation is similar to the dilute mode except a portion of the dilution water flows directly to the charging pump suction and a portion flows into the volume control tank via the spray nozzle and then flows to the charging pump suction. This decreases the delay in dilution the Reactor Coolant System caused by directing dilution water to the volume control tank.

9.3.4.2.2.4.4 Boration

The "borate" mode of operation permits the addition of a pre-selected quantity of concentrated boric acid solution at a pre-selected flow rate to the Reactor Coolant System. The operator sets the mode selection switch to "borate", the concentrated boric acid flow controller setpoint to the desired flow rate, the concentrated boric acid batch integrator to the desired quantity, and initiates system start. This opens the makeup stop valve to the charging pumps suction, positions the boric acid flow control valve, and starts the selected boric acid transfer pump, which delivers a 4 weight percent boric acid solution to the charging pumps suction header. The total quantity added in most cases is so small that it has only a minor effect on the volume control tank level. When the preset quantity of concentrated boric acid solution is added, the batch integrator causes makeup to stop. Also, the operation may be terminated manually at any time.

9.3.4.2.2.4.5 Manual

The "manual" mode of operation permits the addition of a pre-selected quantity and blend of boric acid solution to the refueling water storage tank, to the recycle holdup tanks in the Boron Recycle System, or to some other location via a temporary connection. While in the manual mode of operation, automatic makeup to the Reactor Coolant System is precluded. The discharge flow path must be prepared by opening manual valves in the desired path.

The operator sets the mode selector switch to "manual", the boric acid and total makeup flow controllers to the desired flow rates, the boric acid and total makeup batch integrators to the desired quantities, and actuates the makeup start switch.

The start switch actuates the boric acid flow control valve and the reactor makeup water flow control valve and starts the pre-selected reactor makeup water pump and boric acid transfer pump.

When the preset quantities of boric acid and reactor makeup water have been added, the batch integrators cause makeup to stop. This operation may be stopped manually by actuating the makeup stop switch.

If either batch integrator is satisfied before the other has recorded its required total, the pump and valve associated with the integrator which has been satisfied will terminate flow. The flow controlled by the other integrator will continue until that integrator is satisfied. In the manual mode, the boric acid flow is terminated first to prevent piping systems from remaining filled with 4 weight percent boric acid solution.

The quantities of boric acid and reactor makeup water injected are totalized by the batch counters and the flow rates are recorded on strip recorders. Deviation alarms sound for both boric acid and reactor makeup water if flow rates deviate from setpoints.

9.3.4.2.3 Component Description

A summary of principal Chemical and Volume Control System component design parameters is given in Table 9-22, and safety classifications and design codes are given in Table 3-4.

All Chemical and Volume Control System piping that handles radioactive liquid is austenitic stainless steel. All piping joints and connections are welded, except where flanged connections are required to facilitate equipment removal for maintenance and hydrostatic testing.

9.3.4.2.3.1 Charging Pumps

Two charging pumps are provided to inject coolant into the Reactor Coolant System. These pumps are of the single speed, horizontal, centrifugal type. All parts in contact with the reactor coolant are fabricated of austenitic stainless steel or other material of adequate corrosion resistance. The centrifugal charging pump seal leakoff is contained in seal leakoff troughs that are connected to an equipment drains piping assembly in each pump room. The reciprocating pump stuffing box is provided with leakoffs to collect the leakage. The reciprocating pump design prevents lubricating oil from contaminating the charging flow. There is a minimum flow recirculation line to protect the centrifugal charging pumps from a closed discharge valve condition.

Charging flow rate is determined from a pressurizer level signal. When operating a centrifugal charging pump, the flow paths remain the same but charging flow control is accomplished by a modulating valve on the discharge side of the centrifugal pumps. The centrifugal charging pumps also serve as high head safety injection pumps in the Emergency Core Cooling System.

Reciprocating Charging Pump No. 1 was abandoned in place per NSM CN-11392/00. Reciprocating Charging Pump No. 2 was abandoned in place per NSM CN-21392/00. In order to improve the total core damage frequency, backup cooling was provided to Centrifugal Charging Pump (CCP) 1A per NSM CN-11389/00 and 2A per NSM CN-21389/00. The Probabilistic Risk Assessment (PRA) for Catawba Nuclear Station that a "Loss of KC" event and a "Loss of RN" event are significant contributors to an NC pump seal LOCA. In addition, the Severe Accident Analysis Group determined that only one train would need the backup cooling. Providing backup cooling for CCP 1B (2B) would result in insignificant core damage frequency improvement.

The backup cooling water to CCP 1A (2A) is supplied by a non-safety-related four inch YD System Header in the Auxiliary Building on the 543' - 00" Elevation. The YD supply ties into the KC System Supply piping to the CCP 1A and 2A Motor Coolers and Pump Bearing and Speed Reducer Oil Coolers. On the KC System return side of these coolers, drain lines are routed from the return lines to the ND/NS Sump on Elevation 522' - 00" in the Auxiliary Building. Since the "Loss of KC" and a "Loss of RN" events are not design basis events, the backup cooling supply and drain lines are not safety-related. The system break from non-safety Class G to QA-1 Class C for the pressure boundary is at the KC System isolation valves in the supply and drain lines.

If the scenario occurs that results in a loss of normal KC System cooling to the CCP 1A (2A), the supply from the YD System will be aligned to provide the cooling water for the CCP 1A (2A) motor coolers and oil coolers. The return lines from the coolers will be aligned to flow to the ND/NS Sump. The flow into the ND/NS Sump will be processed by Radwaste Chemistry. Radwaste Chemistry will process this water through the WL System. In addition, an alternate discharge connection will be provided at the common return on Elevation 543' - 00" to reduce the quantity of YD System water flowing into the ND/NS Sump. The alternate discharge connection would typically not be used until after setting up the return flow into the ND/NS Sump. This is due to the time constraints of setting up the alternate flowpath. This connection may be used to divert the NV Pump YD Backup Cooling discharge flow or part of the flow to the WZ System Auxiliary Building Groundwater Drainage Sump C (preferred) or other location as deemed suitable by Radwaste Chemistry. Catawba Nuclear Station has obtained authorization from the Department of Health and Environmental Control (DHEC) to allow the discharge of YD System water into the WZ System Sump C which could potentially discharge directly to Lake Wylie. For the preferred location, a fire hose is connected and routed from the alternate discharge connection to the WZ Sump C. The WZ System flowpath would be as follows: the WZ sump pumps discharge to a yard drain which gravity flows to Yard Drain Collection Sump No. 2 in the WC System which is then processed by the WC System before release to Lake Wylie. However, if Yard Drain Collection Sump No. 2 is receiving large quantities of water from other sources (i.e. heavy rains), this sump will overflow directly to Lake Wylie. This scenario is assumed to last for no more than 24 hours after which the KC System normal cooling supply will be available again.

The "Loss of KC" and "Loss of RN" events are not design basis events. The backup cooling supplied by the YD System is not safety-related and is not relied upon to mitigate any design basis accidents or events. Operability of the NV System is not dependent on the YD System backup cooling.

9.3.4.2.3.2 Boric Acid Transfer Pumps

Four shared boric acid transfer pumps are provided with two pumps normally aligned to serve each unit. On each unit, one pump is normally aligned to supply boric acid to the boric acid blender, while the second serves as a standby. Manual or automatic initiation of the reactor coolant makeup system starts a pump to provide normal makeup of boric acid solution through the boric acid blender. Emergency boration, supplying 4 weight percent boric acid solution directly to the suction of the charging pumps, can be accomplished by manually starting either pump. The transfer pumps also function to transfer boric acid solution from the batching tank to the boric acid tanks.

The pumps are located in a heated area to prevent crystallization of the boric acid solution. All parts in contact with the solution are of austenitic stainless steel.

9.3.4.2.3.2.1 Boric Acid Recirculation Pumps

Two boric acid recirculation pumps are provided, one for each boric acid tank. The pump will take suction from the tank overflow and return (4 wt %) boric acid to the tank drain, 135° from the tank overflow. This pump will provide approximately 120 gpm of boric acid recirculation for tank mixing required to obtain a representative sample of boric acid concentration. The pumps are manually operated in a heated area to prevent crystalization of the boric acid solution.

9.3.4.2.3.3 Regenerative Heat Exchanger

The regenerative heat exchanger is designed to recover heat from the letdown flow by reheating the charging flow, which reduces thermal shock on the charging penetrations into the reactor coolant loop piping.

The letdown stream flows through the shell of the regenerative heat exchanger and the charging stream flows through the tubes. The unit is constructed of austenitic stainless steel, and is of all welded construction.

The temperatures of both outlet streams from the heat exchanger are monitored with indication given in the Control Room. A high temperature alarm is given on the main control board if the temperature of the letdown stream exceeds desired limits.

9.3.4.2.3.4 Letdown Heat Exchanger

The letdown heat exchanger cools the letdown stream to the operating temperature of the mixed bed demineralizers. Letdown flows through the tube side of the exchanger while component cooling water flows through the shell side. All surfaces in contact with the reactor coolant are austenitic stainless steel, and the shell is carbon steel.

The low pressure letdown valve, located downstream of the heat exchanger, maintains the pressure of the letdown flow in a range sufficiently high to prevent two phase flow. Pressure indication and high pressure alarm are provided on the main control board.

The letdown temperature control indicates and controls the temperature of the letdown flow exiting from the letdown heat exchanger. The temperature sensor, which is part of the Chemical and Volume Control System, provides input to the controller in the Component Cooling System. The exit temperature is controlled by regulating the component cooling water flow through the letdown heat exchanger by using the control valve located in the component cooling water discharge line. Temperature indication is provided on the main control board. If the outlet temperature from the heat exchanger is excessive, a high temperature alarm is actuated and a temperature controlled valve diverts the letdown directly to the volume control tank.

9.3.4.2.3.5 Excess Letdown Heat Exchanger

The excess letdown heat exchanger cools reactor coolant letdown flow. The excess letdown heat exchanger can be employed either when normal letdown is temporarily out of service to maintain the reactor in operation or it can be used to supplement maximum letdown during the final stages of heatup. The letdown flows through the tube side of the unit and component cooling water is circulated through the shell. All surfaces in contact with reactor coolant are austenitic stainless steel and the shell is carbon steel. All tube joints are welded.

A temperature detector measures temperature of excess letdown downstream of the excess letdown heat exchanger. Temperature indication and high temperature alarm are provided on the main control board.

A pressure sensor indicates the pressure of the excess letdown flow downstream of the excess letdown heat exchanger and excess letdown control valve. Pressure indication is provided on the main control board.

9.3.4.2.3.6 Seal Water Heat Exchanger

The seal water heat exchanger is designed to cool fluid from three sources: reactor coolant pump #1 seal water returning to the Chemical and Volume Control System, reactor coolant discharged from the excess letdown heat exchanger, and centrifugal charging pump bypass flow. Reactor coolant flows through the tube side of the heat exchanger and component cooling water is circulated through the shell. The design flow rate is equal to the sum of the excess letdown flow, maximum design reactor coolant pump seal leakage, and bypass flow from one centrifugal charging pump. The unit is designed to cool the above flow to the temperature normally maintained in the volume control tank. All surfaces in contact with reactor coolant are austenitic stainless steel and the shell is carbon steel.

9.3.4.2.3.7 Volume Control Tank

The volume control tank provides surge capacity for part of the reactor coolant expansion volume not accommodated by the pressurizer. When the level in the tank reaches the high level setpoint, the remainder of the expansion volume is accommodated by diversion of the letdown stream to the Boron Recycle System. It also provides a means for introducing hydrogen into the coolant to maintain the required equilibrium concentration of 25-50 cc/kg hydrogen at STP for normal operation and is used for degassing the reactor coolant. It also serves as a head tank for the charging pumps.

A spray nozzle located inside the tank on the letdown line nozzle provides liquid-to-gas contact between the incoming fluid and the hydrogen atmosphere in the tank.

A remotely operated vent valve, discharging to the Waste Gas System permits continuous or intermittent removal of gaseous fission products which are stripped from the reactor coolant and collected in this tank. Relief protection, gas space sampling, and nitrogen purge connections are also provided. The tank also accepts the seal water return flow from the reactor coolant pumps.

Volume control tank pressure and temperature are monitored with indication given in the Control Room. Alarm is given in the Control Room for high and low pressure conditions and for high temperature.

Two level channels govern the water inventory in the volume control tank. These channels provide local and remote level indication, level alarms, level control, makeup control, and emergency makeup control.

If the volume control tank level rises above the normal operating range, one channel provides an analog signal to the proportional controller which modulates the three-way valve downstream of the reactor coolant filter to maintain the volume control tank level within the normal operating band. The three-way valve can split letdown flow so that a portion goes to the Boron Recycle System and a portion to the volume control tank. The controller would operate in this fashion during a dilution operation when reactor makeup water is being fed to the volume control tank from the reactor makeup control system.

If the modulating function of the channel fails and the volume control tank level continues to rise, the high level alarm alerts the operator to the malfunction and the letdown flow can be manually diverted to the holdup tanks. If no action is taken by the operator and the tank level continues to rise, the full letdown flow is automatically diverted.

During normal power operation, a low level in the volume control tank initiates automatic makeup which injects a pre-selected blend of boric acid and water into the charging pump suction header. When the volume control tank is restored to normal, automatic makeup stops.

If the automatic makeup fails or is not aligned for operation and the tank level continues to decrease, a low level alarm is actuated. Manual action may correct the situation or, if the level continues to decrese, an emergency low level signal from both channels opens the stop valves in the refueling water supply line and closes the stop valves in the volume control tank outlet line.

The VCT level control system and the control of the Catawba charging pumps suction has a design of the fuctional logic that is basically the same as the generic case reported by Westinghouse (Reference Westinghouse Letter NS TMA-2451, dated May 21, 1981, from T. M. Anderson (W) to V. Stello (NRC). The hardware design of the Catawba VCT level control system is safety grade equipment as in the generic design. In the event of a VCT level control system failure timely operator action will negate the consequences scenario and positively address the identified concern. The plant is equipped with numerous alarms which would be actuated at various times in the event so as to alert the operator to this situation. Station procedures were evaluated to assure that appropriate instructions are provided to the operator to assure an adequate water supply to the charging pumps in the event of a VCT level control system failure.

9.3.4.2.3.8 Boric Acid Tanks

Two boric acid tanks are shared by the two units. During normal operation, one tank supplies boric acid solution for each unit. Each tank is designed to store sufficient boric acid solution for a cold shutdown from full power operation immediately following refueling with the most reactive control rod not inserted, plus operating margins.

The concentration of boric acid solution in storage is maintained between 4 and 4.4 percent by weight. Periodic manual sampling and corrective action, if necessary, assures that these limits are maintained. Therefore, measured amounts of boric acid solution can be delivered to the reactor coolant to control the concentration.

A temperature sensor provides temperature measurement of each tank's contents. Temperature indication is provided as well as high and low temperature alarms which are indicated on the main control board.

Two level detectors indicate the level in each boric acid tank. Level indication with high, low, low-low, and empty level alarms is provided on the main control board. The high level alarm is associated with imminent overflow and the low level alarm is set to alarm prior to dropping below the Selected Licensee Commitments value for MODES 1 through 4. The low-low level alarm is set to alarm prior to dropping below the Selected Licensee Commitments value for MODES 5 and 6, while the empty level is associated with minimum useable volume and boric acid transfer pump protection.

Specific setpoints consider the minimum useable volume including allowances for instrument error, level tap location, tank outlet elevation, vortexing and tank tolerance. An additional margin is provided for reasonable operator response time prior to exceeding Selected Licensee Commitments volumes required. The setpoints resulting from the considerations as described above provide adequate protection while allowing as large as possible working volume to lengthen the time between batching boric acid crystal.

9.3.4.2.3.9 Batching Tank

The batching tank is used for mixing a makeup supply of boric acid solution for transfer to the boric acid tanks. The tank may also be used for solution storage. A boric acid batching tank pump is used to transfer the batching tanks contents to the boric acid tanks.

A local sampling point is provided for verifying the solution concentration prior to transferring it out of the tank. The tank is provided with an agitator to improve mixing during batching operations and a steam jacket for heating the boric acid solution.

9.3.4.2.3.10 Chemical Mixing Tank

The primary use of the chemical mixing tank is in the preparation of caustic solutions for pH control and hydrazine solution for oxygen scavenging.

9.3.4.2.3.11 Mixed Bed Demineralizers

Two flushable mixed bed demineralizers assist in maintaining reactor coolant purity. A lithium-form cation resin and hydroxyl-form anion resin are charged into the demineralizers. The anion resin is converted to the borate form during operation. Both types of resin remove fission and corrosion products. Hydrogen form cation resin can also be charged into the demineralizer, instead of lithium form resin. The hydrogen form resin is converted to the lithium form on-line.

The resin bed is designed to provide a decontamination factor of ten for most fission products (exceptions are cesium, yttrium, and molybdenum).

Each demineralizer has sufficient capacity for approximately one core cycle with one percent defective fuel rods. One demineralizer serves as a standby unit for use if the operating demineralizer becomes exhausted during operation. It can also be used for lithium control. If used for this purpose, the cation resin in the standby demineralizer remains in the hydrogen form.

A temperature sensor measures temperature of the letdown flow downstream of the letdown heat exchanger and controls the letdown flow to the mixed bed demineralizers by means of a three-way valve. If the letdown temperature exceeds the allowable resin operating temperature, (approximately 140°F), the flow automatically bypasses the demineralizers. Temperature indication and high alarm are provided on the main control board. The air operated three-way valve failure mode directs flow to the volume control tank.

Deleted paragraph(s) per 2003 update.

9.3.4.2.3.12 Cation Bed Demineralizers

A flushable cation resin bed in the hydrogen form is located downstream of the mixed bed demineralizers and is used intermittently to control the concentration of excess of Li^7 which builds up in the coolant from the B^{10} (n, α) Li^7 reaction. The demineralizer also has sufficient capacity to maintain the cesium-137 concentration in the coolant below 1.0 μCi/cc with 1 percent defective fuel. The resin bed is designed to reduce the concentration of ionic isotopes, particularly cesium, yttrium, and molybdenum by a minimum factor of 10.

Because of the possibility of loss of resin through the inlet of this demineralizer during the process in which resin is removed, a resin strainer has been installed in the inlet piping. The inlet strainer on Unit 2 has been removed.

The cation bed demineralizer has sufficient capacity for approximately one core cycle with one percent defective fuel rods.

9.3.4.2.3.13 Reactor Coolant Filters

Two reactor coolant filters are located on the letdown line. One filter is located upstream of the mixed bed demineralizers, and the second is located upstream of the volume control tank. The filters collect resin fines and particulates from the letdown stream. The design flow capacity of each filter is greater than the maximum purification flow rate.

One local differential pressure indicator is provided for each reactor coolant filter.

9.3.4.2.3.14 Seal Water Injection Filters

Two seal water injection filters are located in parallel in a common line to the reactor coolant pump seals; they collect particulate matter that could be harmful to the seal faces. Each filter is sized to accept flow in excess of the normal seal water flow requirements.

A differential pressure indicator monitors the pressure drop across each seal water injection filter and gives local indication with high differential pressure alarm on the main control board.

9.3.4.2.3.15 Seal Water Return Filter

The filter collects particulates from the reactor coolant pump seal water return and from the excess letdown flow. The filter is designed to pass flow in excess of the sum of the excess letdown flow and the maximum design leakage from the reactor coolant pump seals.

A local differential pressure indicator is provided.

9.3.4.2.3.16 Boric Acid Filter

The boric acid filter collects particulates from the boric acid solution and reactor makeup water for the reactor coolant makeup circuit. The blender consists of a conventional pipe-tee fitted with a perforated tube insert. The blender decreases the pipe length required to homogenize the mixture for taking representative local sample. A sample point is provided in the piping just downstream of the blender.

9.3.4.2.3.17 Letdown Controls

Two letdown orifices and a control valve are arranged in parallel and serve to reduce the pressure of the letdown stream to a value compatible with the letdown heat exchanger design. One of the orifices and the control valve are sized such that either can pass normal letdown flow; the other orifice can pass less than the normal letdown flow. One or both standby letdown controls may be used with the normally operating control valve in order to increase letdown flow such as during reactor heatup operations and maximum purification. This arrangement also provides a full standby capacity for control of letdown flow. The letdown controls are placed in and taken out of service by remote manual operation of their respective isolation valves.

A flow monitor provides indication in the control room of the letdown flow rate and high alarm to indicate unusually high flow.

A low pressure letdown controller controls the pressure downstream of the letdown heat exchanger to prevent flashing of the letdown liquid. Pressure indication and high pressure alarm are provided on the main control board.

9.3.4.2.3.18 Valves

Valves that perform a modulating function are equipped with a stuffing box containing two sets of packing and an intermediate leakoff connection. Valves are normally installed such that, when closed, the high pressure is not on the packing. Basic material of construction is stainless steel for all valves which handle radioactive liquid or boric acid solutions.

Isolation valves are provided for all lines entering the reactor Containment. These valves are discussed in detail in Section 6.2.4.

Relief valves are provided for the following lines and components that might be pressurized above design pressure by improper operation or component malfunction:

1. Charging Line Downstream of Regenerative Heat Exchanger

   If the charging side of the regenerative heat exchanger is isolated while the hot letdown flow continues at its maximum rate, the volumetric expansion of coolant on the charging side of the heat exchanger is relieved to the Reactor Coolant System through a spring loaded check valve. The spring in the valve is designed to permit the check valve to open in the event that the differential pressure exceeds the design pressure differential.

2. Letdown Line Downstream of Letdown Orifices

   The pressure relief valve downstream of the letdown orifices protects the low pressure piping and the letdown heat exchanger from overpressure when the low pressure piping is isolated. The capacity of the relief valve exceeds the maximum flow rate through all letdown orifices. The valve set pressure is equal to the design pressure of the letdown heat exchanger tube side.

3. Letdown Line Downstream of Low Pressure Letdown Valve

   The pressure relief valve downstream of the low pressure letdown valve protects the low pressure piping, demineralizers, and filter from overpressure when this section of the system is isolated. The overpressure may result from leakage through the low pressure letdown valve. The capacity of the relief valve exceeds the maximum flow rate through all letdown orifices. The valve set pressure is equal to the design pressure of the demineralizers.

4. Volume Control Tank

   The relief valve on the volume control tank permits the tank to be designed for a lower pressure than the upstream equipment. This valve has a capacity greater than the summation of the following items: maximum letdown, maximum seal water return, excess letdown and nominal flow from one reactor makeup water pump. The valve set pressure equals the design pressure of the volume control tank.

5. Charging Pump Suction

   A relief valve on the charging pump suction header relieves pressure that may build up if the suction line isolation valves are closed or if the system is overpressurized. The valve set pressure is equal to the design pressure of the associated piping and equipment.

6. Seal Water Return Line (Inside Containment)

This relief valve is designed to relieve overpressurization in the seal water return piping inside the Containment if the motor-operated isolation valve is closed. The valve is designed to relieve the total leakoff flow from the No. 1 seals of the reactor coolant pumps plus the design excess letdown flow. The valve is set to relieve at the design pressure of the piping.

7. Seal Water Return Line (Charging Pumps Bypass Flow)

   This relief valve protects the seal water heat exchanger and its associated piping from overpressurization. If either of the isolation valves for the heat exchanger are closed and if the bypass line is closed, the piping could be overpressurized by the bypass flow from the centrifugal charging pumps.

   The valve is sized to handle the full bypass flow with all centrifugal pumps running. The valve is set to relieve at the design pressure of the heat exchanger.

8. Positive Displacement Charging Pump Discharge

   The pressure relief valve on the positive displacement charging pump discharge line relieves the rated pumping capacity if the pump is started with the discharge isolation valve closed. The set pressure of the valve is equal to the design pressure of the pump discharge piping.

   Note: Positive Displacement Pump No. 1 was abandoned in place per NSM CN-11392/00. Reciprocating Charging Pump No. 2 was abandoned in place per NSM CN-21392/00.

9. Steam Line to Batching Tank

   The relief valve on the steam line to the batching tank protects the low pressure piping and batching tank heating jacket from overpressure when the condensate return line is isolated. The capacity of the relief valve equals the maximum expected steam inlet flow. The set pressure equals the design pressure of the heating jacket.

9.3.4.2.3.19 Piping

All Chemical and Volume Control System piping handling radioactive liquid is austenitic stainless steel. All piping joints and connections are welded, except where flanged connections are required to facilitate equipment removal for maintenance and hydrostatic testing.

9.3.4.2.4 System Operation

9.3.4.2.4.1 Reactor Startup

Reactor startup is defined as the operations which bring the reactor from cold shutdown to normal operating temperature and pressure.

It is assumed that:

1. Normal residual heat removal is in progress,
2. Reactor Coolant System boron concentration is at the cold shutdown concentration,
3. Reactor makeup control subsystem is set to provide makeup at the cold shutdown concentration,
4. Reactor Coolant System is either water solid or drained to minimum level for the purpose of refueling or maintenance. If the Reactor Coolant System is water solid, system pressure is

controlled by letdown through the Residual Heat Removal System and through the low pressure letdown valve in the letdown line, and

5. The charging and letdown lines of the Chemical and Volume Control System are filled with coolant at the cold shutdown boron concentration. The letdown orifice isolation valves are closed.

If the Reactor Coolant System requires filling and venting, the procedure is as follows:

1. One charging pump is started, which provides blended flow from the reactor makeup control system at the cold shutdown boron concentration,
2. The vents on the head of the reactor vessel and pressurizer are opened, then
3. The Reactor Coolant System is filled and the vents closed.

The system pressure is raised by using the charging pump and controlled by the low pressure letdown valve. When the system pressure is adequate for operation of the reactor coolant pumps, seal water flow to the pumps is established and the pumps are operated and vented sequentially until all gases are cleared from the system. Final venting takes place at the pressurizer.

Once filling and venting operations are completed, charging and letdown flows are established. System alignments are completed to facilitate Pressurizer steam bubble information from either a drained-down or water-solid condition. Heating of the Reactor Coolant System is accomplished by using the desired combination of Pressurizer heaters and/or reactor Coolant Pumps. Pressurizer steam space temperature and Reactor Coolant wide range pressure instrumentation assist the Control Room with indication of steam bubble formation within the Pressurizer. System pressure is controlled using a letdown flowpath, a Pressurizer Spray flowpath, and the Pressurizer heaters. Residual Heat Removal is isolated from the Reactor Coolant System when it is no longer needed for heat removal, auxiliary spray, system letdown, etc.

The reactor coolant boron concentration is now reduced either by operating the reactor makeup control system in the "dilute" mode or by operating the Boron Thermal Regeneration System in the boron storage mode, and when the resin beds are saturated, washing off the beds to the Boron Recycle System. The reactor coolant boron concentration is corrected to the point where the control rods may be withdrawn and criticality achieved. Nuclear heatup may then proceed with corresponding manual adjustment of the reactor coolant boron concentration to balance the temperature coefficient effects and maintain the control rods within their operating range. During heatup, the appropriate combination of letdown controls is used to provide necessary letdown flow.

Prior to or during the heating process, the Chemical and Volume Control System is employed to obtain the correct chemical properties in the Reactor Coolant System. The reactor makeup control subsystem of the Chemical and Volume Control System is operated on a continuing basis to assure correct control rod position. Chemicals are added through the chemical mixing tank as required to control reactor coolant chemistry such as pH and dissolved oxygen content. Hydrogen overpressure is established in the volume control tank to assure the appropriate hydrogen concentration in the reactor coolant.

9.3.4.2.4.2 Power Generation and Hot Shutdown Operation

1. Base Load

At a constant power level, the rates of charging and letdown are dictated by the requirements for seal water to the reactor coolant pumps and the normal purification of the Reactor Coolant System. One charging pump is employed and charging flow is controlled automatically from pressurizer level. The only adjustments in boron concentration necessary are those to compensate for core burnup. These adjustments are made at infrequent intervals to maintain the control groups within their allowable limits.

Rapid variations in power demand are accommodated automatically by control rod movement. If variations in power level occur, and the new power level is sustained for long periods, some adjustment in boron concentration may be necessary to maintain the control groups within their maneuvering band.

During normal operation, normal letdown flow is maintained and one mixed bed demineralizer is in service. Reactor coolant samples are taken periodically to check boron concentration, water quality, pH and activity level. The charging flow through the discharge header flow control valve to the Reactor Coolant System is controlled automatically by the pressurizer level control signal.

2. Load Follow

A power reduction initially causes a xenon buildup followed by xenon decay to a new, lower equilibrium value. The reverse occurs if the power level increases; initially, the xenon level decreases and then it increases to a new and higher equilibrium value associated with the amount of the power level change.

The reactor makeup control subsystem may also be used to vary the boron concentration in the reactor coolant.

The most important information available to the station operator, enabling him to determine whether dilution or boration of the Reactor Coolant System is necessary, is the position of the control rods within the maneuvering band. If, for example, the control rods are moving down into the core, and are approaching the bottom of the maneuvering band, the operator must borate the reactor coolant to bring the rods outward. If not, the control rods may move into the core beyond the shutdown limit. However, if the rods are moving out of the core, the operator dilutes the reactor coolant to keep the rods from moving above the top of the maneuvering band. Keeping the control rods within the maneuvering band assures the capability of immediate return to full power. However, violation of the upper limit of the maneuvering band is not safety related and is allowed. With the control rods above the top of the maneuvering band the reactor cannot return to full power immediately; it can return to some intermediate power level immediately and then reach full power at some rate determined by the xenon burnout transient.

During periods of unit loading, the reactor coolant expands as its temperature rises. The pressurizer absorbs most of this expansion as the level controller raises the level setpoint to the increased level associated with the new power level. The remainder of the excess coolant is letdown and stored in the volume control tank. During this period, the flow through the letdown orifice remains constant and the charging flow is reduced by the pressurizer level control signal, resulting in an increased temperature at the regenerative heat exchanger outlet. The temperature controller downstream from the letdown heat exchanger increases the component cooling water flow to maintain the desired letdown temperature.

During periods of unit unloading, the charging flow increases to make up for the coolant contraction not accommodated by the programmed reduction in pressurizer level.

3. Hot Shutdown

   If required, for periods of maintenance, or following spurious reactor trips, the reactor can be held subcritical, but with the capability to return to full power within the period of time it takes to withdraw control rods. During this hot shutdown period, temperature is maintained at no-load Tavg by initially dumping steam to remove core residual heat, or at later stages, by running reactor coolant pumps to maintain system temperature.

   Following shutdown, xenon buildup occurs and increases the degree of shutdown; i.e., initially, with initial xenon concentration and all control rods inserted, the core is maintained at a minimum of 1 percent $^{\Delta}$k/k subcritical. The effect of xenon buildup is to increase this value to a maximum of about 4 percent $^{\Delta}$k/k at about eight hours following shutdown. If hot shutdown is maintained past this point, xenon decay results in a decrease in degree of shutdown. Since the value of the initial xenon concentration is about 3 percent $^{\Delta}$k/k (assuming that an equilibrium concentration had been reached during operation), boration of the reactor coolant is necessary to counteract the xenon decay and maintain shutdown.

   If rapid recovery is required, dilution of the system may be performed to counteract this xenon buildup. However, after the xenon concentration reaches a peak, boration must be performed to maintain the reactor subcritical as the xenon decays out.

9.3.4.2.4.3 Reactor Shutdown

Reactor shutdown is defined as the operations which bring the reactor to cold shutdown.

Before initiating a cold shutdown, the Reactor Coolant System hydrogen concentration is reduced by replacing the volume control tank hydrogen atmosphere with nitrogen and by continuous purging to the Waste Processing System.

Before cooldown and depressurization of the reactor unit is initiated, the reactor coolant boron concentration is increased to the required shutdown margin boron concentration for the target cooldown temperature. The operator sets the reactor makeup control system to "borate", selects the volume of concentrated boric acid solution necessary to perform the boration, selects the desired flow rate and actuates makeup start. After the boration is completed and reactor coolant samples verify that the concentration is correct, the operator resets the reactor makeup control system for leakage makeup and system contraction at the shutdown reactor coolant boron concentration.

Contraction of the coolant during cooldown of the Reactor Coolant System results in actuation of the pressurizer level control to maintain normal pressurizer water level. The charging flow is increased, relative to letdown flow, and results in a decreasing volume control tank level. The volume control tank level controller automatically initiates makeup to maintain the inventory.

After the Residual Heat Removal System is placed in service and the reactor coolant pumps are shut down, further cooling of the pressurizer liquid is accomplished by charging through the auxiliary spray line from the Residual Heat Removal System. Coincident with unit cooldown, a portion of the reactor coolant flow is diverted from the Residual Heat Removal System to the Chemical and Volume Control System for cleanup. Demineralization of ionic radioactive impurities and stripping of fission gases reduce the reactor coolant activity level sufficiently to permit personnel access for refueling or maintenance operations.

9.3.4.3 Safety Evaluation

The classification of structures, components and systems is presented in Section 3.2. A further discussion on seismic design categories is given in Section 3.7. Conformance with NRC

General Design Criteria for the plant systems, components and structures are important to safety as presented in Section 3.1.

9.3.4.3.1 Reactivity Control

Any time that the plant is at power, the quantity of boric acid retained and ready for injection always exceeds that quantity required for the normal cold shutdown assuming that the control assembly of greatest worth is in its fully withdrawn position. This quantity always exceeds the quantity of boric acid required to bring the reactor to hot shutdown and to compensate for subsequent xenon decay. An adequate quantity of boric acid is also available in the refueling water storage tank to achieve cold shutdown.

When the reactor is subcritical; i.e., during cold or hot shutdown, refueling and approach to criticality, the neutron source multiplication is continuously monitored and indicated. Any appreciable increase in the neutron source multiplication, including that caused by the maximum physical boron dilution rate, is slow enough to give ample time to start a corrective action to prevent the core from becoming critical (the boron dilution accident is discussed in Section 15.4.6). The rate of boration, with a single boric acid transfer pump operating, is sufficient to take the reactor from full power operation to 1 percent shutdown in the hot condition, with no rods inserted, in less than 90 minutes. In less than 90 additional minutes, enough boric acid can be injected to compensate for xenon decay, although xenon decay below the equilibrium operating level will not begin until approximately 25 hours after shutdown. Additional boric acid is employed if it is desired to bring the reactor to cold shutdown conditions.

Two separate and independent flow paths are available for reactor coolant boration; i.e., the charging line and the reactor coolant pump seal injection line. A single failure does not result in the inability to borate the Reactor Coolant System.

If the normal charging line is not available, charging to the Reactor Coolant System is continued via reactor coolant pump seal injection, by the standby makeup pump, at the rate of approximately 6.5 gpm to each reactor coolant pump.

Subsequent to the initial transient at a maximum seal leak off of 5 gpm (each reactor coolant pump), a nominal 1.5 gpm of boric acid water (each reactor coolant pump) is injected into the reactor coolant system. At the charging rate of 6 gpm (1.5 gpm to each reactor coolant pump), approximately 12 hours are required to add enough boric acid solution to counteract xenon decay, although xenon decay below the full power equilibrium operating level will not begin until approximately 25 hours after the reactor is shutdown. The initial transient associated with loss of seal injection coincident with loss of thermal barrier forced cooling has been analyzed demonstrating successful transition to steady state event mitigation.

As backup to the normal boric acid supply, the operator can align the refueling water storage tank outlet to the suction of the charging pumps.

Inoperability of a single component does not impair ability to meet boron injection requirements.

9.3.4.3.2 Reactor Coolant Purification

The Chemical and Volume Control System is capable of reducing the concentration of ionic isotopes in the purification stream as required in the design basis. This is accomplished by passing the letdown flow through one of the mixed bed demineralizers which removes ionic isotopes, except those of cesium, molybdenum and yttrium, with a minimum decontamination factor of 10. Through occasional use of the cation bed demineralizer the concentration of cesium can be maintained below 1.0 μCi/cc, assuming one percent defective fuel cladding. The cation bed demineralizer is capable of passing the maximum purification letdown flow, though only a portion of this capacity is normally utilized. Each mixed bed demineralizer is capable of processing the maximum purification letdown flow rate. If the normally operating mixed bed demineralizer's resin has become exhausted, the second demineralizer can be placed in service. Each demineralizer is designed, however, to operate for one core cycle with one percent defective fuel.

A further cleanup feature is provided for use during residual heat removal operations. A remote-operated valve admits a bypass flow from the RHRS into the letdown line at a point upstream of the letdown heat exchanger. The flow passes through the heat exchanger and then passes through one or both of the mixed bed demineralizers and the reactor coolant filter to the volume control tank. The fluid is then returned to the Reactor Coolant System via the normal charging route.

The maximum temperature that will be allowed for the mixed bed and cation bed demineralizers is approximately 140°F. If the temperature of the letdown stream approaches this level, the flow will be automatically diverted so as to bypass the demineralizers. If the letdown is not diverted, the only consequence would be a decrease in ion removal capability. Ion removal capability starts to decrease when the temperature of the resin goes above approximately 140°F for anion resin or above approximately 250°F for cation resin. The resins do not lose their exchange capability immediately. Ion exchange still takes place (at a faster rate) when temperature is increased. However, with increasing temperature, the resin loses some of its ion exchange sites along with the ions that are held at the lost sites. The ions lost from the sites may be reexchanged farther down the bed. The number of sites lost is a function of the temperature reached in the bed and of the time the bed remains at the high temperature. Capability for ion exchange will not be lost until a significant portion of the exchange sites are lost from the resin.

There would be no safety problem associated with over-heating of the demineralizer resins. The only effect on reactor operating conditions would be the possibility of an increase in the reactor coolant activity level. If the activity level in the reactor coolant were to exceed the limit given in the technical specifications, reactor operation would be restricted as required by the Technical Specifications.

9.3.4.3.3 Seal Water Injection

Flow to the reactor coolant pump seals is assured since there are three charging pumps, any one of which is capable of supplying the normal charging line flow plus the nominal seal water flow. For a fire in any postulated fire zone that would have the capability of disabling normal seal water flow, flow is still assured to the reactor coolant pump seals through the standby makeup pump. The standby makeup pump is powered by the SSF. (See Figure 9-97).

9.3.4.3.4 Hydrostatic Testing of the Reactor Coolant System

Hydrostatic testing of the Reactor Coolant System will be per the requirements of ASME Boiler and Pressure Vessel Code (Case N-498-1).

The centrifugal charging pumps are capable of providing the IWB 5000 ASME XI required pressure for performing the hydrostatic testing of the Reactor Coolant system.

9.3.4.3.5 Leakage Provisions

Chemical Volume and Control System components, valves, and piping which see radioactive service are designed to limit leakage to the atmosphere. The following are preventive means which are provided to limit radioactive leakage to the environment.

1. All packed valves which are larger than 2 inches and which are designated for radioactive service are provided with a stuffing box and lantern leakoff connections.
2. All control (modulating) and three-way valves are either provided with stuffing box and leakoff connections or are totally enclosed.
3. Welding of all piping joints and connections except where flanged connections are provided to facilitate maintenance and hydrostatic testing.

The volume control tank provides an inferential measurement of leakage from the Chemical and Volume Control System as well as the Reactor Coolant System. The amount of leakage can be inferred from the amount of makeup added by the reactor makeup control system.

During normal operation, the hydrogen and fission gases in the volume control Tank are continuously or intermittently purged to the Waste Gas System to limit the release of radioactive gases through leakage by maintaining the radioactive gas level in the reactor coolant several times lower than the equilibrium level. Also, provided are two mixed-bed demineralizers which maintain reactor coolant purity, thus reducing the radioactivity level of the Reactor Coolant System water.

9.3.4.3.6 Ability to Meet the Safeguards Function

A failure analysis of the portion of the Chemical Volume and Control System (used as part of the Emergency Core Cooling System) is included as part of the Emergency Core Cooling System failure analysis presented in Table 6-91.

9.3.4.3.7 Heat Tracing

Heat tracing requirements for boric acid solutions depends mainly on the solution concentration. For this plant the concentration of boric acid ranges from 10 ppm to 4 wt percent boric acid. Electrical heat tracing is not required on any Chemical and Volume Control System components which contain 4 wt. percent boric acid, providing these components are located in a room maintained at 65°F or higher. Redundant room heaters are provided to assure room temperature does not go below 65°F.The 65°F temperature is derived from Boric acid tank boron concentration (7000 ppm) solubility temperature of 55°F plus 10°F margin to assure solubility. Boric acid tank and boric acid transfer pump rooms are heated. Thermostat settings typically maintain the areas above 75°F and, therefore, the contents typically above 75°F.

Piping from the boric acid transfer pump to the boric acid blender and the charging pumps suction is heated via redundant heat tracing. The amount of piping not heat traced is minimal, and is located downstream of normally closed boron injection path isolation valves NV240 and NV234 where the small lines enter the larger, pump section header. A temperature survey was taken with minimal heat loads in service in the Unit 1 boron injection flowpath areas of the Auxiliary Building during 1EOC4 shutdown.

HISTORICAL INFORMATION IN ITALICS BELOW NOT REQUIRED TO BE REVISED

Actual winter conditions were additionally adjusted to simulate 10°F design outdoor air temperature. Survey results indicate that a normal general area temperature of approximately 75°F is maintained by normal heat loads (lighting, etc.) with worst case temperatures no lower than 65°F.

Since dilution of 7000 ppm boron solution at the blender or charging pump suction would decrease the minimum solubility, and heat added to the room by charging pump operation would aid in maintaining solubility, heat tracing downstream of valves NV240 and NV234 is not required.

The proper operation of the heat tracing as displayed on the heat tracing panelboard ensures that boron solubility is properly maintained in all plant modes, including operation, cold shutdown, and refueling. Refer to Section 9.3.4.2 for more information.

9.3.4.3.8 Abnormal Operation

The Chemical and Volume Control System is capable of making up for a small Reactor Coolant System leak of up to approximately 130 gpm using one centrifugal charging pump and still maintaining seal injection flow to the reactor coolant pumps. This also allows for a minimum Reactor Coolant System cooldown contraction. This is accomplished with the letdown isolated.

9.3.4.3.9 Failure Modes and Effects Analysis

A Failure Modes and Effects Analysis of the Chemical and Volume Control System is provided as Table 9-23.

9.3.4.4 Tests and Inspections

As part of plant operation, periodic tests, surveillance inspections and instrument calibrations are made to monitor equipment condition and performance. Most components are in use regularly; therefore, assurance of the availability and performance of the systems and equipment is provided by control room and/or local indication.

Technical Specifications have been established concerning surveillance of the Chemical and Volume Control System.

Please refer to 14.1 for further information on initial tests and inspections.

9.3.4.5 Instrumentation Application

Process control instrumentation is provided to acquire data concerning key parameters about the Chemical and Volume Control System. The location of the instrumentation is shown on Figure 9-89 through Figure 9-97. This instrumentation is described in Section 7.4.4.

The instrumentation furnishes input signals for monitoring and/or alarming purposes. Indications and/or alarms are provided for the following parameters:

1. Temperature
2. Pressure
3. Flow
4. Water level

The instrumentation also supplies input signals for control purposes. Some specific control functions are:

1. Letdown flow is diverted to the volume control tank upon high temperature indication upstream of the mixed bed demineralizers.
2. Pressure upstream of the letdown heat exchanger is controlled to prevent flashing of the letdown liquid.
3. Charging flow rate is controlled during charging pump operation.
4. Water level is controlled in the volume control tank.
5. Temperature of the boric acid solution in the batching tank is maintained.

6. Reactor makeup is controlled.

9.3.5 Boron Recycle System

The Boron Recycle System (NB) receives and recycles reactor coolant effluent for reuse of the boric acid and makeup water. The system decontaminates the effluent by means of demineralization and gas stripping, and uses evaporation to separate and recover the boric acid and makeup water. The Boron Recycle System is shared by both units.

9.3.5.1 Design Basis

9.3.5.1.1 Collection Requirements

The Boron Recycle System collects and processes effluent which can be readily reused as makeup to the Reactor Coolant System. The recycle holdup tanks, basically, accept deaerated, tritiated, borated radioactive letdown, drains, and valve stem leakoffs.

The italicized text below is HISTORICAL INFORMATION, NOT REQUIRED TO BE REVISED.

The Boron Recycle System is designed to collect, via the letdown line in the Chemical and Volume Control System, the excess reactor coolant that results from the following plant operations during one core cycle (approximately one year) for each of the two units.

1. *Dilution for core burnup from approximately 1200 ppm boron at the beginning of a core cycle to approximately 100 ppm near the end of a core cycle.*
2. *Hot shutdowns and startups: four hot shutdowns are assumed to take place during a core cycle.*
3. *Cold shutdowns and startups: three cold shutdowns are assumed to take place during a core cycle.*
4. *Refueling shutdown and startup.*

The Boron Recycle System also collects water from the following sources:

1. Reactor Coolant Drain Tank (liquid radwaste system) - collects leakoff type drains from equipment inside the containment.
2. Volume control tank pressure relief valve (Chemical and Volume Control System) - provides a volume that can contain the radioactive water and gas which can be processed and recycled.
3. Boric acid blender (Chemical and Volume Control System) - provides a means of changing the boron concentration in the recycle holdup tanks prior to returning liquid back to the Reactor Coolant System following drainage from this system.
4. Recycle Monitor Tanks (Liquid Radwaste System) - Provides flexibility for recycling water from the Liquid Radwaste System.
5. Fuel pool cooling pumps (Spent Fuel Cooling System) - provides a means of storing the fuel transfer canal water in case maintenance is required on the transfer equipment.
6. Valve leakoffs and equipment drains - the recycle holdup tanks collect deaerated, tritiated water from valve leakoffs and equipment drains.
7. Gas Decay Drain Pump (Waste Gas System) - provides a collection point for condensate from the gas system and for reactor makeup water used for gas decay tank maintenance.

8. Sampling system automation panel (Nuclear Sampling System) - provides means to process and recycle the boron from the primary side liquid samples sent to the automated sampling panel.

9.3.5.1.2 Capacity Requirement

The Boron Recycle System is designed to process the total volume of water collected during a core cycle as well as short term surges. The design surge is that produced by a cold shutdown and subsequent startup for both units during the latter part of a core cycle or by a refueling shutdown and start up.

9.3.5.1.3 Purification Requirement

The water collected by the Boron Recycle System contains dissolved gases, boric acid, and suspended solids. Based on reactor operations with one percent of the rated core thermal power being generated by fuel elements with defective cladding, the Boron Recycle System, in conjunction with Chemical and Volume Control System purification, is designed to provide sufficient cleanup of the water to satisfy the chemistry requirements of the recycled reactor makeup water and 4 weight percent boric acid solution.

The maximum radioactivity concentration buildup in the Boron Recycle System components is based on operation of the reactor at its engineered safeguards design rating with defective fuel rods generating one percent of the rated core thermal power. For each component, the shielding design considers the maximum buildup on an isotopic basis including only those isotopes which are present in significant amounts. Filtration, demineralization, and gas stripping are the means by which the activity concentrations are controlled.

9.3.5.2 System Description

The Boron Recycle System is shown on Figure 9-98 through Figure 9-105. When water is directed to the Boron Recycle System, the flow passes first through the recycle evaporator feed demineralizers and filters and then into the recycle holdup tanks. The recycle evaporator feed pumps can be used to transfer liquid from one recycle holdup tank to the other if desired. When sufficient borated water is accumulated to warrant evaporator operation, the recycle evaporator feed pumps take suction from the selected recycle holdup tank. The fluid then flows through the recycle evaporator package. Here, hydrogen, nitrogen, and residual fission gases are removed in the stripping column before the liquid enters the evaporator shell. These gases are directed to the Waste Gas System.

During evaporator operation, distillate from the evaporator flows continuously to one of the reactor makeup storage tanks. Also located in this flow path are the recycle evaporator condensate demineralizer and the recycle evaporator condensate filter. A radiation monitor continuously checks the evaporator distillate for high activity, and a conductivity monitor continuously checks the evaporator distillate for high conductivity. On high radiation or high conductivity a three-way diversion valve is tripped in order to return the distillate to the recycle holdup tanks.

The distillate from the evaporator can also be accumulated in one of the recycle monitor tanks of the Liquid Radwaste System for analysis if desired.

From there the distillate can be pumped to either the reactor makeup storage tank, recycle evaporator feed demineralizer, or disposed of through the Liquid Radwaste System.

One evaporator concentrates pump continuously recirculates evaporator bottoms. A portion of this flow passes through a densitometer which senses boric acid concentration. At a preselected setpoint, usually 4 weight %, this densitometer opens the concentrates discharge valve, normally allowing concentrates to flow through the concentrates heat exchanger to the boric acid tanks in the Chemical and Volume Control System through the recycle evaporator concentrates filter. If, for some reason, these concentrates cannot be discharged to the boric acid tanks, they can be diverted to the recycle holdup tanks, the Liquid Radwaste System, or the Solid Radwaste System.

Redundant pumps are installed in the evaporator to increase reliability. The concentrates pumps have bearing coolers and a concentrates sample cooler is installed upstream of the densitometer to preclude flashing downstream.

Connections are provided so that, if necessary, the recycle evaporator can be used as a waste evaporator (and vice versa).

Thermal insulation is provided on system valves, piping, and equipment for personnel protection and to prevent heat losses. Where necessary, antisweat insulation is provided. Materials are compatible with use on stainless steel (low chloride).

Electrical heat tracing is required on the recycle evaporator even though redundant electrical heating units are provided in the room in which it is located. Electrical heat tracing is provided on the concentrates piping which leaves the room to insure that the boric acid does not precipitate. The heat tracing is designed to maintain solution temperature above the solubility temperature of the maximum expected boron concentration.

Heat tracing is also provided on the outdoor piping associated with the reactor makeup water storage tanks to prevent freezing of the water in these lines under cold, static conditions.

9.3.5.2.1 Component Descriptions

A summary of principal component data is given in Table 9-24 and the code requirements given in Section 3.2.

9.3.5.2.1.1 Recycle Evaporator Feed Pumps

Two centrifugal, canned pumps supply feed to the recycle evaporator package from the recycle holdup tanks. The pumps can be used to transfer liquid from one holdup tank to the other, to the spent fuel pool of either unit, or to the charging pumps of either unit for transfer into the respective unit's Reactor Coolant System. The pumps can be used to recirculate water from the recycle holdup tanks through the recycle evaporator feed demineralizers for additional cleanup if desired. All wetted surfaces are constructed of austenitic stainless steel.

9.3.5.2.1.2 Recycle Holdup Tanks

Two recycle holdup tanks provide storage of radioactive fluid which is discharged from the Reactor Coolant System during startup, shutdown, load changes and boron dilution. The sizing criteria for the tanks is based on the design surge cold shutdown and startup. The tanks are constructed of austenitic stainless steel.

Each tank has a diaphragm which prevents air from dissolving in the water and prevents the hydrogen and fission gases in the water from mixing with the air. The volume in the tank above the diaphragm is continuously ventilated to the Auxiliary Building Ventilation System. The ventilation rate provides the capability for safe reduction of hydrogen concentration in the recycle holdup tank above diaphragm space to 3 percent within 10 minutes following an assumed diaphragm disintegration. The volume of gas below the diaphragm is vented to the Waste Gas System.

9.3.5.2.1.3 Recycle Evaporator Reagent Tank

This tank provides a means of adding chemicals to the evaporator, for purposes such as normal chemical and anti-foaming agent addition when the evaporator is used as a waste evaporator. The tank is constructed of austenitic stainless steel.

9.3.5.2.1.4 Recycle Evaporator Feed Demineralizers

Two flushable mixed resin bed demineralizers are used to remove anions and cations from the water entering the Recycle Holdup Tanks. The demineralizers are aligned in parallel. The total capacity of the resin is sufficient for one equilibrium core cycle, assuming load-follow operation and one percent fuel defects. Each bed will accept maximum unit letdown flow. The vessels are constructed of austenitic stainless steel.

9.3.5.2.1.5 Recycle Evaporator Condensate Demineralizer

A flushable, anion demineralizer is provided as a polishing demineralizer for distillate from the recycle evaporator. Although the bed may become saturated with boron at the normally low concentration (<10 ppm) leaving the evaporator, it still removes boron if the concentration increases because of an evaporator upset. The demineralizer also provides a means for cleanup of the reactor makeup water storage tank contents by continuous recirculation.

9.3.5.2.1.6 Recycle Evaporator Feed Filters

Two cage assembly type recycle evaporator feed filters are aligned in parallel to collect resin fines and particulate matter 5 microns or larger from water entering the recycle holdup tanks. Each filter is designed to accept maximum letdown flow.

9.3.5.2.1.7 Recycle Evaporator Condensate Filter

The cage assembly type recycle evaporator condensate filter is designed to filter the recycle evaporator condensate, prior to storage in the reactor makeup water storage tank. This originally supplied filter was designed for maximum condensate flow, and retained particles 25 microns or larger. Several different filter cartridge sizes are approved for use which provide filtration down to 0.1 micron.

9.3.5.2.1.8 Recycle Evaporator Concentrates Filter

The recycle evaporator concentrate filter is a cage assembly type. It will filter 4 wt. percent boric acid at the design rate of the evaporator concentrates pump, as it is transferred to the boric acid tanks (Chemical and Volume Control System). The filter retains particles 25 microns and larger.

9.3.5.2.1.9 Recycle Evaporator Package

The recycle evaporator package consists of an evaporator, absorption tower, evaporator condenser, distillate cooler, feed preheater, stripping column, vent condenser, two eductors, two concentrate pumps, two distillate pumps, valves, piping, and instrumentation. The recycle evaporator package removes hydrogen, fission gases, and any other gases from the evaporator feed. The condensate produced is of reactor makeup grade, and the concentrate is 4 wt. percent boric acid.

The borated water from the recycle holdup tanks flows into the package to the feed preheater. The preheater heats the feed stream, using process steam. The steam flow is controlled by temperature instrumentation at the feed exit of the preheaters. The preheated feed flows into the stripping column where hydrogen, fission gases, and any other gases are stripped from the borated water. The stripping medium is a portion of the evaporator overheads (steam) which enters the bottom of the packaged stripping column. The stripped gases and an equilibrium quantity of stripping steam leave the top of the stripping column and flow to the vent condenser which cools the gases and condenses the major portion of the stripping steam. The Component Cooling System provides the source of cooling water. The gases are vented via the vent header to the Waste Gas System and the liquid condensate is returned to the stripping column by means of an eductor in the feed line. The stripping column is designed to provide a decontamination factor of 10^5 for all gases in the feed. The evaporator concentrates the borated liquid to 4 wt. percent boric acid. The evaporator bottoms are continuously recirculated by the boric acid concentrate pumps. A portion of this flows through a densitometer which monitors the concentration of boric acid. At the preselected setpoint the densitometer opens the concentrates discharge valve and concentrate is pumped through the recycle evaporator concentrates heat exchanger to the boric acid tanks in the Chemical and Volume Control System. The concentrates discharge valve is automatically closed on low evaporator level or when low concentration is detected by the densitometer. Nitrogen is added during complete evaporator pumpdown to assure that adequate NPSH is maintained to the operating concentrates pumps. To insure that concentrates and distillate streams are within specifications, samples are periodically taken via sample cylinders provided.

The major portion of vapors leaving the evaporator flow through the absorption tower and then are condensed in the evaporator condenser. The distillate is pumped through a distillate cooler and out of the unit at a maximum of 120° F. A portion of the distillate is recycled to the absorption tower to serve as the absorption medium.

The evaporator condenser and distillate cooler are serviced by component cooling water.

The solids-separating efficiency between the distillate and the bottoms in the evaporator is designed for 10^5. All equipment in the unit in contact with the process fluids is constructed of austenitic stainless steel.

9.3.5.2.1.10 Reactor Makeup Water Storage Tanks

Two reactor makeup water storage tanks (one per unit) supply reactor grade makeup water for the station. Each tank is sized to supply the water requirements for one unit during a cold shutdown followed by a startup from cold conditions assuming these events occur late in cycle life when Reactor Coolant System boron concentration is below 200 ppm. A minimum quantity of water is available at all times to effect a cold shutdown. If, after a cold shutdown and startup have been accomplished, it becomes necessary to perform an additional cold shutdown, the quantity of water required can be drawn again from the reactor makeup water storage tank which was replenished by the recycle evaporator during the time of the first cold shutdown. In addition, water may be transferred between the two tanks by utilizing connections at the inlet to the recycle evaporator condensate demineralizer and at the discharge of the recycle evaporator condensate filter.

In addition to the makeup requirements outlined above, the reactor makeup water storage tanks provide flush water to various radioactive equipment and piping throughout the station.

Each tank is fitted with a flexible diaphragm in order to maintain the specified reactor makeup water requirements for oxygen. Construction is of stainless steel lined carbon steel.

9.3.5.2.1.11 Reactor Makeup Water Pumps

There are two reactor makeup pumps per unit. Each pump is designed to have sufficient capacity to cool the contents of the pressurizer relief tank from 200°F to ambient in approximately 1 hour following a pressurizer safety valve discharge. This requires a flow of 150 gpm at a total head sufficient to overcome the pressurizer relief tank internal pressure (50 psig when safety valve is discharging), plus a 10.7 psi drop across the pressurizer relief tank spray nozzles, in addition to line losses and valve losses.

Each pump is also capable of delivering up to a maximum of 120 gpm to the boric acid blender in the Chemical and Volume Control System against a pressure of 60 psig at the blender. A discharge connection is provided as an auxiliary makeup water supply to the spent fuel pool. A line is also provided to allow recirculation back to the reactor makeup water tanks.

The pumps are centrifugal pumps manufactured of stainless steel. The reactor makeup water storage tanks serve as head tanks for these pumps. The pumps are operated automatically by the reactor makeup control system (Chemical and Volume Control System) to provide makeup water to the boric acid blender. Flow to the pressurizer relief tank and the spent fuel pool is provided by manual operation.

9.3.5.2.1.12 Recycle Holdup Tank/WasteDrain Tank Eductor Skid

The recycle holdup tank vent eductor skid is used periodically (about once every other month) to pull gases from under the recycle holdup tank diaphragm. The motive force is provided by the waste gas compressor and the RHT/WDT eductor skid.

9.3.5.2.1.13 Recycle Evaporator Condensate Return Unit

The condensate return unit collects condensed steam from the recycle evaporator package feed preheater and evaporator and returns the condensate to the Condensate System. The unit consists of a 100 gallon receiver, two 25 gpm pumps, valves, piping, instrumentation, and automatic controls.

9.3.5.2.1.14 Valves

The basic material of construction for all valves is stainless steel. All valves are welded to the piping, except the three-way and relief valves, and butterfly valves which are flanged. All three-way valves are provided with a stuffing box and lantern leakoff connection. The relief valve upstream of the recycle evaporator feed demineralizers protects the piping which feeds these demineralizers. It relieves at 150 psig and will pass the maximum plant letdown flow.

9.3.5.2.1.15 Piping

All Boron Recycle System piping that handles radioactive liquid is austenitic stainless steel. All piping joints and connections are welded, except where flanged connections are required to facilitate equipment removal for maintenance and hydrostatic testing.

9.3.5.2.1.16 Reactor Makeup Water Filter

The reactor makeup water filter is designed to provide further filtration of the reactor makeup water. The filter can be aligned for continuous filtration during reactor water makeup or recirculated through the filter back to the reactor makeup water storage tank as part of a purification loop.

9.3.5.2.2 System Operation

The Boron Recycle System is manually operated with the exception of a few automatic protection functions. These automatic functions protect the recycle evaporator feed demineralizers from a high inlet temperature and high pressure drop, prevent a high vacuum from being drawn on the recycle holdup tank diaphragm, prevent high activity, or high conductivity, recycle evaporator condensate from being sent to the reactor makeup water storage tank, and prevent the recycle evaporator feed pumps from cavitation when the recycle holdup tank level becomes too low. The Boron Recycle System has sufficient instrumentation readouts and alarms to provide the operator information to insure proper system operation.

9.3.5.2.2.1 Evaporation

Water is accumulated in the recycle holdup tank until sufficient quantity exists to warrant an evaporator startup. Prior to startup of the evaporator, the contents of the recycle holdup tank is analyzed and, if necessary, the contents recirculated through the recycle evaporator feed demineralizers. The flow can be discharged back to the recycle holdup tank or to the evaporator. The evaporator is then operated to produce an aqueous solution of 4 wt. percent boric acid as bottoms.

During the operation of the evaporator, distillate is continuously sent to one of the reactor makeup water storage tanks (via the recycle evaporator condensate demineralizer as necessary). The distillate is monitored for high activity, or high conductivity and is automatically diverted to the recycle evaporator feed for reprocessing on high radiation or conductivity.

Evaporator bottoms are analyzed periodically to ensure they are within specifications. If specifications are met, the evaporator bottoms are pumped to the boric acid tanks (Chemical and Volume Control System) for re-use; otherwise, it can be returned to the recycle holdup tanks via the recycle evaporator feed demineralizers for reevaporation or, if desired, the concentrated boric acid can be sent to the Solid or Liquid Radwaste Systems for processing or disposal.

9.3.5.2.2.2 Recycle Holdup Tank Venting

Because hydrogen is dissolved in the reactor coolant at 2 atmospheres of pressure, a portion of the hydrogen along with fission gases will come out of solution in the recycle holdup tank under the diaphragm. Periodically, the hydrogen and fission gases should be vented to the Waste Gas System. The recycle holdup tank should be vented after accepting approximately 200,000 gallons from the letdown line, the reactor coolant drain tank, and the Waste Gas System drain. The recycle holdup tank should also be vented before and after a Reactor Coolant System loop drain or a drain from the Spent Fuel Cooling System.

The total integrated flow of hydrogen-bearing water to the recycle holdup tanks is monitored to indicate when a sufficient amount of water has passed to the recycle holdup tanks to require venting of the accumulated gases.

9.3.5.2.2.3 Maintenance Drains

When large amounts of water must be drained from the Reactor Coolant System or the spent fuel pool (or fuel transfer canal) to the Boron Recycle System, a recycle holdup tank is drained of water and vented to the Waste Gas System. Large amounts of water can then be stored in this holdup tank until maintenance is completed and, after checking the chemistry, returned. After returning the water, the recycle holdup tank is again vented to the Waste Gas System where it may be directed to a shutdown gas decay tank to prevent accumulation of air or nitrogen in the high activity gas decay tanks.

9.3.5.2.2.4 Reactor Makeup Water Cleanup

If the reactor makeup water requires purification, it can be recirculated through the recycle evaporator condensate demineralizer until its chemistry is within specifications. If further processing is necessary, water from the reactor makeup water storage tank is directed through the recycle evaporator condensate demineralizer and into the recycle holdup tank prior to reprocessing.

In addition to the above, reactor makeup water can be aligned to the reactor makeup water filter for continuous filtration during reactor water makeup or recirculated through the filter back to the reactor makeup water storage tank as part of a purification loop.

9.3.5.2.2.5 Waste Processing With the Recycle Evaporator

Connections are provided so that the recycle evaporator can be used as a waste evaporator (and vice versa). These consist of a feed connection from the waste evaporator feed tank, a condensate connection to the recycle monitor tank, a concentrate connection to the drumming room, and an evaporator vent connection to the plant vent. Therefore, the recycle evaporator can perform the function of the waste evaporator.

After using the recycle evaporator to process water from the Liquid Waste System, it must be thoroughly cleaned out. During initial recycle processing, the condensate should be directed to the recycle monitor tank for analysis prior to recycling to the reactor makeup water storage tank. Depending upon the purity of the evaporator bottoms, the concentrated boric acid can be recycled to the boric acid tanks or can be drummed.

9.3.5.3 Safety Evaluation

Malfunctions in the Boron Recycle System do not affect the safety of station operations. The Boron Recycle System is designed to tolerate equipment faults with critical functions being met by the use of two pieces of equipment so that the failure of one does, at most, reduce the capacity of the Boron Recycle System but not completely shut it down. Because of the large surge capacity of the Boron Recycle System, the non-availability of the recycle evaporator can be tolerated for periods of time.

All piping and components handling radioactive fluids are designed, fabricated, and inspected according to applicable code requirements and a listing is provided in Table 3-4. The use of packless stem plug valves and welded piping joints minimizes leaks.

9.3.5.4 Tests and Inspections

The Boron Recycle System is functionally tested to verify the ability of the system to receive and recycle excess reactor coolant. The Boron Recycle System is in intermittent use through normal reactor operation. Periodic visual inspection and preventive maintenance are conducted using normal industry practice.

The NRC issued IE Bulletin 89-02, "Stress Corrosion Cracking of High-Hardness Type 410 Stainless Steel Internal Preloaded Bolting in Anchor Darling Model S350W Swing Check Valves or Valves of Similar Design," on July 19, 1989, requesting that licensees identify, disassemble and inspect certain types of swing check valves which may contain Type 410 stainless steel (SS) bolting material. The bulletin further requested that if the Type 410 SS bolting material was of sufficiently high hardness that it was susceptible to stress corrosion cracking or (SCC), or had failed, appropriate actions should be taken. In preparing the DPC response to this bulletin, one valve (swing check valve 1NB-800) was identified with sufficient similarities to the Anchor Darling Model S350W swing check valve to warrant inspection. However, as is explained in the DPC response to IE Bulletin 89-02, 1NB-800 is not capable of being isolated for disassembly unless both Catawba Nuclear Station Units 1 and 2 are shutdown and defueled (letter from H.B. Tucker to NRC, dated May 23, 1990). Further response and justification for deferral of inspecting the valve internals was provided in the letter from M.S. Tuckman to the NRC, dated February 28, 1991. The NRC issued a Safety Evaluation Report (SER) for IE Bulletin 89-02 on August 16, 1991, which concluded, based on the DPC responses, that valve 1NB-800 remained functional and that inspection could be deferred until an opportunity arose for inspection (i.e., both Catawba units defueled). During the interim period, however, the SER recommended that periodic verification of valve integrity by nonintrusive means be employed.

9.3.5.5 Instrumentation Application

The instrumentation available for the Boron Recycle System is discussed below. Alarms are provided as noted. There is also a common alarm on the Main Control Board which indicates any alarms on the Boron Recycle System panel.

9.3.5.5.1 Temperature

Instrumentation is provided to measure the temperature of the inlet flow to the recycle evaporator feed demineralizers and to control bypass valves. If the inlet temperature becomes too high, the instrumentation aligns the three way valve to bypass the demineralizers. Local temperature indication and a high temperature alarm on the Boron Recycle System panel are provided by this instrumentation.

Instrumentation is provided to measure the temperature of the water in each of the reactor makeup storage tanks. A low temperature alarm is signalled if the water temperature drops to 38°F or less.

9.3.5.5.2 Pressure

Instrumentation is provided to measure the pressure differential across the recycle evaporator feed demineralizers and to control the same valve as discussed above (but independently of the temperature control). If the pressure drop through the demineralizers is too high, this instrumentation aligns the valve to divert flow directly to the recycle evaporator feed filters. Local pressure indication and a high alarm on the Boron Recycle System panel are provided by this instrumentation.

Instrumentation is provided to measure the pressure differential across each recycle evaporator feed filter, the recycle evaporator concentrates filter, and the recycle evaporator condensate filter. Local indication of the pressure in each inlet and outlet line is provided.

Instrumentation is provided to measure and give local indication of the discharge pressures of each recycle evaporator feed pump, and each reactor makeup water pump.

Instrumentation is provided to measure the pressure in the recycle holdup tank vent line and to control the shutoff valve in the vent line. This instrumentation is used during holdup tank vent operations. When the pressure in this line becomes too low, the valve is closed to protect the holdup tank diaphragm from an excessive differential pressure across it. Local pressure indication and a low pressure alarm on the Boron Recycle System panel are provided.

Instrumentation is provided to measure and give local indication of the pressure of the Reactor Makeup Water Storage Tank.

Instrumentation is provided to measure the pressure differential across the reactor makeup filter. Local and Operator Aid Computer (OAC) indication is provided by this instrumentation.

9.3.5.5.3 Flow

Instrumentation is provided to monitor the total integrated flow received by the Boron Recycle System from the letdown line (Chemical and Volume Control System) and the reactor coolant drain tank (Liquid Waste Recycle System).

Indication of integrated flow and high alarm are given on the Boron Recycle System panel. Actuation of the high alarm indicates that the integrated flow has reached a value at which the volume of gases (hydrogen and fission gases) which have come out of solution should be vented from the recycle holdup tank.

Instrumentation is provided which gives local indication of the recycle holdup tank vent purge flow.

Instrumentation is provided to give local indication and record the feed flow to the recycle evaporator package.

Instrumentation is provided to give local indication of the reactor makeup water pump flow.

9.3.5.5.4 Level

Instrumentation is provided to give an indication of the water level of each recycle holdup tank. Both high level and low level alarms are provided by this instrumentation at the Boron Recycle System panel. Recycle evaporator feed pump A will shut off on low level in Tank A, and recycle evaporator feed pump B will shut off on low level in Tank B to protect the pumps.

Instrumentation is provided to give control room indication of the water level of each reactor makeup water storage tank. High and low level alarms are provided. On low level indication, this system will shut off the reactor makeup water pumps to protect the pumps.

9.3.5.5.5 Radiation

This instrumentation provides radiation control panel indication of the radiation level of the recycle evaporator condensate. Upon a high radiation level, this system will activate this three-way valve to divert flow back to the recycle evaporator feed demineralizers. This instrumentation also has a high radiation level alarm, located on both the Boron Recycle System control panel, and the main control board.

9.3.5.5.6 Conductivity

Instrumentation is provided to give indication of the conductivity of the recycle evaporator condensate. When high conductivity is detected this instrumentation will align the three way valve to divert flow back to the recycle evaporator feed demineralizers and alarm.

9.3.5.5.7 Density

An indicating densitometer is provided in the evaporator concentrates recirculation path. When boric acid concentration reaches the predetermined setpoint the concentrates discharge valve opens. When the monitor senses low concentration the discharge valve automatically closes.

9.3.6 Boron Thermal Regeneration System

HISTORICAL INFORMATION NOT REQUIRED TO BE REVISED

The Boron Thermal Regeneration System (NR) varies the Reactor Coolant System boron concentration to compensate for xenon transients and other reactivity changes which occur when the reactor power level is changed.

***Note:** The supply and return lines from the NV to the NR System have been cut and capped, effectively rendering this system inoperable. Changes in Boron concentration are controlled only by the NV System.*

9.3.6.1 Design Basis

The Boron Thermal Regeneration System is designed to accommodate the changes in boron concentration required by the design load cycle without requiring makeup for either boration or dilution.

9.3.6.2 System Description

During normal operation of the Chemical and Volume Control System, the letdown flow from the Reactor Coolant System passes through the regenerative heat exchanger, the letdown heat exchanger, the first of two reactor coolant filters, a mixed bed demineralizer, the second reactor coolant filter and the volume control tank. The charging pumps then take suction from the volume control tank and return the purified reactor coolant to the Reactor Coolant System.

An alternate letdown path is provided which allows part or all of the letdown flow to pass through the Boron Thermal Regeneration System (shown in Figure 9-106 and Figure 9-107) when boron concentration changes are made to follow unit load. The letdown flow is directed to the Boron Thermal Regeneration System from a point downstream of the mixed bed demineralizers. After processing by the Boron Thermal Regeneration System, the flow is returned to the Chemical and Volume Control System at a point upstream of the second reactor coolant filter.

Storage and release of boron during load follow operation is determined by the temperature of the fluid entering the thermal regeneration demineralizers. A group of heat exchangers and chiller units are employed to provide the desired fluid temperatures at the demineralizer inlet for either storage or release operation of the system.

The flow path through the Boron Thermal Regeneration System is different for boron storage and release operations. During boron storage, the letdown stream enters the moderating heat exchanger and from there it passes through the letdown chiller heat exchanger. These two heat exchangers cool the letdown stream prior to its entering the demineralizers. The letdown reheat heat exchanger is valved out on the tube side and performs no function during boron storage operations. The temperature of the letdown stream at the point of entry to the demineralizers is controlled automatically by the temperature control valve which controls the shell side flow to the letdown chiller heat exchanger. After passing through the demineralizers, the letdown enters the moderating heat exchanger shell side, where it is heated by the incoming letdown stream before going to the volume control tank.

Therefore, for boron storage, a decrease in the boric acid concentration in the reactor coolant is accomplished by sending the letdown flow at relatively low temperatures to the thermal regeneration demineralizers. The resin, which was depleted of boron at high temperature during a prior boron release operation, is now capable of storing boric acid from the low temperature letdown stream. Reactor coolant with a decreased concentration of boric acid leaves the demineralizers and is directed to the Chemical and Volume Control System.

During the boron release operation, the letdown stream enters the moderating heat exchanger tube side, bypasses the letdown chiller heat exchanger, and passes through the shell side of the letdown reheat heat exchanger. The moderating and letdown reheat heat exchangers heat the letdown stream prior to its entering the resin beds. The temperature of the letdown at the point of entry to the demineralizers is controlled automatically by the temperature control valve which controls the flow rate on the tube side of the letdown reheat heat exchanger. After passing through the demineralizers, the letdown stream enters the shell side of the moderating heat exchanger, passes through the tube side of the letdown chiller heat exchanger and then goes to the volume control tank. The temperature of the letdown stream entering the volume control tank is controlled automatically by adjusting the shell side flow rate on the letdown chiller heat exchanger.

Thus, for boron release, an increase in the boric acid concentration in the reactor coolant is accomplished by sending the letdown flow at relatively high temperatures to the thermal regeneration demineralizers. The water flowing through the demineralizers now releases boron which was stored by the resin at low temperature during a previous boron storage operation. The boron enriched reactor coolant is returned to the Reactor Coolant System via the Chemical and Volume Control System.

Although the Boron Thermal Regeneration System is primarily designed to compensate for xenon transients occurring during load follow, it can also be used to handle boron swings far in excess of the design capacity of the demineralizers. During startup dilution for example, the resin beds are first saturated, then washed off to the recycle holdup tanks in the Boron Recycle System, then again saturated and washed off. This operation continues until the desired dilution in the Reactor Coolant System is obtained.

As an additional function, a thermal regeneration demineralizer can be used as a deborating demineralizer, to dilute the Reactor Coolant System down to very low boron concentrations towards the end of core life. To make such a bed effective, the effluent concentration from the bed is kept very low, close to zero ppm boron. This low effluent concentration is achieved by using fresh resin. Use of fresh resin is coupled with the normal replacement cycle of the resin; one resin bed is replaced during each core cycle.

9.3.6.3 Component Description

Component safety classifications and design codes are given in Table 3-4 and a summary of principal component design parameters is given in Table 9-25.

9.3.6.3.1 Chiller Pumps

These centrifugal pumps circulate the water through the chilled water loop. One pump is supplied for each chiller.

9.3.6.3.2 Moderating Heat Exchanger

The moderating heat exchanger operates as a regenerative heat exchanger between incoming and outgoing streams to and from the thermal regeneration demineralizers.

The incoming flow enters the tube side of the moderating heat exchanger. The shell side fluid, which comes directly from the demineralizers, enters at low temperature during boron storage and high temperature during boron release.

9.3.6.3.3 Letdown Chiller Heat Exchanger

During the boron storage operation, the process stream enters the tube side of the letdown chiller heat exchanger after leaving the moderating heat exchanger. The letdown chiller heat exchanger cools the process stream to allow the thermal regeneration demineralizers to remove boron from the coolant. The desired cooling capacity is adjusted by controlling the chilled water flow rate passed through the shell side of the heat exchanger.

The letdown chiller heat exchanger is also used during the boron release operation to cool the liquid leaving the thermal regeneration demineralizers to insure that its temperature does not exceed that of normal letdown to the volume control tank.

9.3.6.3.4 Letdown Reheat Heat Exchanger

The letdown reheat heat exchanger is used only during boron release operations and it is then used to heat the process stream. Water used for heating is diverted from the letdown line upstream of the letdown heat exchanger in the Chemical and Volume Control System, passed through the tube side of the letdown reheat heat exchanger and then returned to the letdown stream upstream of the letdown heat exchanger.

9.3.6.3.5 Chiller Surge Tank

The chiller surge tank handles the thermal expansion and contraction of the water in the chiller loop. The surge volume in the tank also acts as a thermal buffer for the chiller.

9.3.6.3.6 Thermal Regeneration Demineralizers

The function of the thermal regeneration demineralizers is to store the total amount of boron that must be removed from the Reactor Coolant System to accomplish the required dilution during a load cycle in order to compensate for xenon buildup resulting from a decreased power level. Furthermore, the demineralizers are able to release the previously stored boron to accomplish the required boration of the reactor coolant during the load cycle in order to compensate for a decrease in xenon concentration resulting from an increased power level.

The thermally reversible ion storage capacity of the resin applies only to borated ions. The capacity of the resin to store other ions is not thermally reversible. Thus, during boration, when borated ions are released by the resin, there is no corresponding release of the ionic fission and corrosion products stored on the resin.

The demineralizers are of the type that can accept flow in either direction. The flow direction during boron storage is therefore always opposite to that during release. This provides much faster response when the beds are switched from storage to release and vice versa, than would be the case if the demineralizers could accept flow in only one direction.

9.3.6.3.7 Chillers

One chiller is provided for each unit; also, one chiller is provided which can serve either unit if required. The chillers are located in a chilled water loop containing a surge tank, chiller pumps, the letdown chiller heat exchanger, piping, valves and controls.

The purpose of the chillers are twofold:

1. *To cool down the process stream during storage of boron on the resin.*
2. *To maintain an outlet temperature from the Boron Thermal Regeneration System at or below 115°F during release of boron.*

9.3.6.4 System Operation

A master switch is provided which places the system in either the boron release or the boron storage mode of operation.

When the switch is set for boron storage, it automatically:

1. *aligns the proper flow path for the boron storage mode of operation,*
2. *shuts off the letdown reheat heat exchanger tube flow which puts this heat exchanger out of operation,*
3. *transfers control of the control valve at the letdown chiller heat exchanger shell side outlet to the thermocouple located between the letdown reheat heat exchanger and the demineralizers, and*
4. *starts a chiller and chiller pump.*

When the switch is set for boron release, it automatically:

1. *aligns the proper flow path for the boron release mode of operation,*
2. *energizes the control of the tube side flow rate to the letdown reheat heat exchanger by a signal from the thermocouple between this heat exchanger and the demineralizers,*
3. *transfers control of the control valve at the letdown chiller heat exchanger shell side outlet to the thermocouple located in the line leading to the volume control tank, and*
4. *starts a chiller and chiller pump.*

After the mode of operation has been selected and the system prepared for operation by actuation of the master switch, flow is admitted to the Boron Thermal Regeneration System by throttling back on the diversion valve in the letdown line. The flow rate through the Boron Thermal Regeneration System is dictated by the desired reactor coolant dilution or boration rate.

When the boron concentration of the reactor coolant reaches the desired level, the Boron Thermal Regeneration System is shut down by placing the master switch in the off position.

9.3.6.5 Safety Evaluation

Any partial or total malfunction of the Boron Thermal Regeneration System results only in loss of unit load-following capability. This system is non-safety related. The postulated full power dilution accident considered in Chapter 15 is not influenced by dilution with this system. The dilution flow depends solely upon the delivery capability of the charging pumps which remains unchanged with or without Boron Thermal Regeneration System operability.

9.3.6.6 Tests and Inspections

The Boron Thermal Regeneration System is in intermittent use throughout normal reactor operation. The system operation is verified by testing prior to system use. Periodic visual inspection and preventive maintenance are conducted using normal industry practice.

9.3.6.7 Instrumentation Application

9.3.6.7.1 Temperature

Instrumentation is provided to monitor the chiller outlet temperature and to control chiller operation. Instrumentation is also provided to monitor the chiller surge tank temperature. Readout for both sets of instrumentation is located on the main control board.

Instrumentation is provided to control the temperature of the letdown flow passing through the demineralizers. During dilution, it controls a valve which throttles the letdown chiller heat exchanger shell side flow. During boration, it controls the valve which throttles the letdown reheat heat exchanger tube side flow. Readout and high temperature alarm are provided on the main control board.

Protection of the thermal regeneration demineralizer resins from high temperature flow is provided by instrumentation which, upon reaching the high temperature setpoint, operates a three-way valve in the letdown line upstream of the mixed bed demineralizers in the Chemical and Volume Control System in order to divert the letdown flow to the volume control tank. Readout and a high temperature alarm are provided on the main control board.

Instrumentation is provided which monitors the temperature of the flow leaving the demineralizers. Temperature indication is provided on the main control board.

The temperature of the flow leaving the Boron Thermal Regeneration System during boration (boron release) operations is controlled by instrumentation which controls a valve which throttles the letdown chiller heat exchanger shell side flow. Thus the temperature of the fluid being routed to the volume control tank is prevented from becoming too high.

9.3.6.7.2 Pressure

Instrumentation is provided which monitors and gives local indication of the pressure at each chiller pump suction and discharge and at the inlet and outlet to the bank of demineralizers.

9.3.6.7.3 Flow

Instrumentation on the return line to the chiller surge tank maintains chiller loop flow at a constant value by controlling the valve which adjusts the amount of flow bypassing the letdown chiller heat exchanger. Thus, if the shell side flow in the heat exchanger is restricted by the temperature controlled valve, the bypass valve is automatically adjusted to maintain full flow in the chiller loop.

Instrumentation is provided to monitor the flow rate through the Boron Thermal Regeneration System. Indication is on the main control board.

9.3.6.7.4 Level

Instrumentation is provided to measure the fluid level in the chiller surge tank. Level readout and high and low level alarms are provided on the main control board.

9.3.7 References

1. Nuclear Regulatory Commission, Letter to All Holders of Operating LIcenses or Construction Permits for Nuclear Power Reactors, from Frank J. Miraglia, Jr., August 8, 1988, "Instrument Air Supply System Problems Affecting Safety-Related Equipment."

2. Duke Power Company, Letter from H.B. Tucker to NRC, February 10, 1989, re: "Instrument Air Supply System Problems Affecting Safety-Related Equipment (NRC Generic Letter 88-14)."

3. Duke Power Company, Letter from D.L. Rehn to NRC, January 12, 1995, re: Closure of Generic Letter 88-14, "Instrument Air."

THIS IS THE LAST PAGE OF THE TEXT SECTION 9.3.

THIS PAGE LEFT BLANK INTENTIONALLY

9.4 Air Conditioning, Heating, Cooling and Ventilation Systems

9.4.1 Control Room Area Ventilation

9.4.1.1 Design Bases

The Control Room Area Ventilation System is designed to maintain the environment in the control room envelope, control room area, and switchgear rooms, as indicated on Figure 9-108 thru Figure 9-117 within acceptable limits for the operation of unit controls, for maintenance and testing of the controls as required, and for uninterrupted safe occupancy of the control room envelope during post-accident shutdown. Refer to Section 6.4 for further information regarding control room envelope habitability.

The control room envelope, and other support areas as shown on Figure 9-108 thru Figure 9-111 are designed to maintain approximately 74°F and 50 percent maximum relative humidity. The battery room is designed to maintain approximately 80°F. The mechanical equipment room is designed to maintain a maximum temperature of 100°F. All other areas, as shown on Figure 9-108 thru Figure 9-111 are designed to maintain a maximum temperature of 85°F. These conditions are maintained continuously during all modes of operation for the protection of instrumentation and controls, and for the comfort of the operators. Outdoor design temperatures meet or exceed those given in Table No. 1, Chapter 23 of the ASHRAE 1977 Fundamentals Handbook.

Pressurization of the control room envelope is provided to prevent entry of dust, dirt, smoke, radioactivity and toxic gases originating outside the pressurized zones. Pressurization is maintained at a positive pressure of ≥ 0.125 inch water gauge, relative to the adjacent areas with a makeup flow rate of ≤ 4000 cfm.

Outdoor air for pressurization is taken from either of two locations such that a source of uncontaminated air is available regardless of wind direction. One fresh air intake is located at the intersection of column lines DD and 45, and the other is at the intersection of column lines DD and 69. Both intakes are at elevation 594+0. Each intake is located on the outside of the Reactor Building diametrically opposed to that unit's vent. Normally air is taken from both intakes. All outside air is filtered as described in Section 12.3.3.

Each outside air intake location is monitored for the presence of radioactivity, chlorine, and products of combustion. Should a high radiation level, smoke concentration level or chlorine concentration be detected in the intake, station procedures direct the operator to manually close the most contaminated intake. This will ensure continuous control room envelope pressurization under a radiation smoke or chlorine event.

Each outside air intake is provided with a tornado isolation damper to prevent depressurization of the control room envelope and the control room area during a tornado having a maximum wind speed of 300 mph, a translational velocity of 60 mph and a pressure decrease of 3 psi occuring in 3 seconds.

The following Control Room Area Ventilation System subsystems are each provided with two 100 percent capacity trains. Each meets the single failure criterion. If one train fails indication is provided in the control room. Switchover is accomplished manually by the operator. Electrical and control component separation is maintained between trains. These subsystems include the following:

1. Control Room air handling units,

2. Control Room Area air handling units,
3. Switchgear Room air handling units,
4. Water chillers, chilled water pumps and piping serving the above air handling units,
5. Outside air pressurizing filter trains (includes 4 inch carbon bed filter) and fans.

All essential air conditioning and ventilating equipment, ductwork and supports are designed to withstand the safe shutdown earthquake. Essential electrical components required for the heating, cooling, and pressurization of the control room envelope during accident conditions are connected to emergency Class 1E standby power.

Instrumentation is provided to indicate the temperature and radioactivity level in the control room envelope.

The chlorine, smoke, and radiation detectors are non-safety related instruments. The smoke detectors are purchased as Fire Protection Related equipment insuring the purchase of UL approved equipment, proper installation, and performance testing.

9.4.1.2 System Description

The Control Room Area Ventilation System subsystems are shown on Figure 9-108 thru Figure 9-117 and consist of the following:

1. Control Room Ventilating System,
2. Control Room Area Ventilating System,
3. Control Room and Control Room Area Pressurizing System,
4. Switchgear Room Ventilating Systems,
5. Control Room Area Chilled Water System.

The Control Room Ventilating System consists of two 100 percent capacity air handling units located in the mechanical equipment room at elevation 594+0. Each air handling unit supplies approximately 26,000 cfm of conditioned air to the main control room. Each air handling unit is equipped with a filter bank containing prefilters and final filters with filter efficiencies of approximately 30 percent and 85 percent, respectively. The filter efficiency is based on the ASHRAE test method in accordance with ASHRAE Standard 52.68. A portion of the control room return air passes through the pressurizing filter train for cleanup.

The Control Room Area Ventilating System consists of two 100 percent capacity air handling units located in the mechanical equipment room at elevation 594+0. Each air handling unit supplies approximately 73,000 cfm of conditioned air to the control room area, i.e., the battery and equipment room, and the cable room, motor control center rooms and the electrical penetration room. Air handling unit filter efficiencies are approximately 30 percent and 85 percent respectively based on the ASHRAE test method in accordance with ASHRAE Standard 52.68.

The Control Room and Control Room Area Pressurizing System consists of two 100 percent capacity filter trains. Each filter train is constructed as described in Section 12.3.3. Each pressurizing filter train supplies approximately 6,000 cfm of filtered air of which approximately 4000 cfm is outside air for pressurization and 2,000 cfm is return air recirculated for cleanup purposes.

The Switchgear Room Ventilating Systems consist of two 100 percent capacity air handling units for each Switchgear Room. Each air handling unit supplies approximately 10,000 cfm of conditioned air to the switchgear room. Each air handling unit is equipped with prefilters having an efficiency of approximately 30 percent based on the ASHRAE test method in accordance with ASHRAE Standard 52.68.

The Control Room Area Chilled Water System consists of two 100 percent capacity water chillers, pumps, piping and control systems. This equipment is located in the mechanical equipment room at elevation 594+0.

9.4.1.3 Safety Evaluation

The Control Room Area Ventilation systems are engineered safety features. Each redundant train (100 percent capacity) of air handling units, water chillers, pumps, pressurizing filter trains and fans, and outside air intake isolation valves is served from separate trains of the Emergency Class 1E Power System. This assures the integrity and availability of one train of the Control Room Area Ventilation System in the event of any single active failure.

Design of the Control Room Area Ventilation System is such that the maximum radiation dose received by the control room personnel under accident conditions is within the limits of General Design Criterion 19 of Appendix A to 10CFR 50. The dose evaluation is presented in Section 15.6.

The Control Room Area Ventilation System is designed to maintain temperature, cleanliness and pressurization in the areas served during normal plant operation, shut-down, post-accident conditions, and in all feasible weather conditions. A failure analysis is presented in Table 9-26.

Two isolation valves are provided on each outside air intake to ensure the capability of manual closure of the intake on high radiation, high smoke concentration, or high chlorine concentration.

During normal operation each of the two 100% capacity, redundant outside air intakes are used to handle approximately 2000 cfm each. Each intake is sized to handle 4000 cfm required for pressurization of the control room envelope.

9.4.1.4 Inspection and Testing Requirements

The Control Room Area Ventilation System is in continuous operation and is accessible for periodic inspection. Essential electrical components, switchovers, and starting controls are tested during preoperational tests and periodically thereafter to demonstrate system readiness and operability and as required by the Technical Specifications.

9.4.2 Fuel Building Ventilation System

9.4.2.1 Design Bases

The purpose of the Fuel Building Ventilation System (VF) is to: (1) Control fission product emission; (2) maintain a suitable environment for the operation, maintenance, and testing of equipment; (3) maintain a suitable access and work environment for personnel.

The Fuel Building Ventilation System as shown on Figure 9-118, Figure 9-119, and Figure 9-120 is designed to maintain a maximum inside temperature to 110°F and a minimum inside temperature to 50°F. Outdoor design temperatures meet or exceed those given in Table No. 1, Chapter 23 of the ASHRAE 1977 Fundamentals Handbook.

The exhaust side of the Fuel Building Ventilation System consists of two 100 percent exhaust systems per unit. Each exhaust system consists of two 50 percent capacity filter trains and fans. This meets the single failure criterion. Switchover between sets of filter trains is accomplished manually by the operator. Electrical and control component separation is maintained between trains.

All essential fans, filters, dampers, ductwork and supports are designed to withstand the safe shutdown earthquake.

Essential electrical components required for ventilation of the fuel handling area during accident conditions are connected to emergency Class 1E standby power.

In order to control airborne activity, the ventilation air is generally supplied directly to the clean areas and exhausted for the potentially contaminated areas, creating a positive flow of air from the clean areas to the potentially contaminated areas.

The Fuel Building Ventilation System (VF) is normally in continuous operation. The Fuel Building Ventilation System will operate in the filtered mode of operation whenever irradiated fuel handling operations above or in the fuel pool are in progress.

The Fuel Building Ventilation System is located completely within a Seismic Category I structure and all essential components (exhaust filter trains, exhaust fans, exhaust ductwork) are fully protected from floods and tornado missile damage. The outside air intake opening for the ventilating air supply unit is protected by missile shields above and in front of the opening.

9.4.2.2 System Description

The Fuel Building Ventilating System is shown on Figure 9-118, Figure 9-119, and Figure 9-120, and consists of the following components: (per unit basis)

1. One 100 percent capacity ventilation supply air handling unit and associated dampers and ductwork.
2. Two 100 percent capacity Exhaust Systems complete with filter trains and associated fans, dampers, ductwork, supports and control systems.

Outside air is supplied to the fuel building area by a supply system consisting of one 100 percent capacity fan with heating and cooling coils, filter section and associated ductwork. Supplemental cooling is available from the Containment Chilled Water System when necessary to maintain a suitable work environment for personnel. The air handling unit supplies approximately 26,260 cfm. The filter section contains particulate type filters. This portion of the system has no standby capacity, and normally operates continuously.

The Fuel Building Ventilation Exhaust System for each unit consists of four-50 percent capacity filter trains. This portion of the Fuel Building Ventilation System is an engineered safety feature. Each filter train is constructed as described in Section 12.3.3. Two 50 percent capacity filter trains are paired to operate as a single 100 percent capacity exhaust system with the two sets of filter trains receiving separate emergency power. Total exhaust flow is approximately 33,130 cfm.

Each of the 50 percent capacity filter trains is equipped with a bypass section. The normal mode of operation for the filter trains is in the bypass position. Radiation detection is provided in the duct system header, upstream of the filter train inlet and at the unit vent Upon indication of high radioactivity in the exhaust duct system, the bypass dampers will automatically close and the filter train inlet dampers will automatically open to direct air flow through the filter trains. Any time irradiated fuel handling takes place, the exhaust air flow is directed through the filter trains. The operator will manually switchover from the bypass mode to the filter mode from the control room. Air from the Fuel Handling Area Exhaust System is directed to the unit vent, where it is monitored before release to the atmosphere.

The Fuel Building Ventilation Supply and Exhaust Systems are designed such that a minimum of ten air changes per hour over the fuel pool are afforded to continuously purge the area of heat, humidity, and particulate matter.

9.4.2.3 Safety Evaluation

The Fuel Building Exhaust System is an engineered safety feature. Each redundant set of filter trains (two-50 percent capacity) fans, and motor operated dampers is served from separate trains of the emergency Class 1E standby power. This assures the integrity and availability of the Exhaust System in the event of any single active failure.

Air exhausted from the building is monitored by a radioactive gaseous detector sampling the air in the exhaust duct header between the building and the inlet to the filter trains. Additional monitoring of exhaust air is provided in the unit vent. Indication of radioactivity above allowable limits will automatically divert the flow of air through the filter trains prior to discharge into the atmosphere through the unit vent.

The Fuel Building Ventilation Exhaust system is available following a loss of offsite power; however, fuel building supply will not be available. A failure analysis of the Fuel Building Exhaust System is presented in Table 9-27. The effects of a fuel handling accident are discussed in Section 15.7.4.

9.4.2.4 Inspection and Testing Requirements

The Fuel Building Ventilation System is in continuous operation and is accessible for periodic inspection. Essential electrical components, switchovers, and starting controls are tested during preoperational tests and periodically thereafter as required in the Technical Specifications.

9.4.3 Auxiliary Building Ventilation System

9.4.3.1 Design Bases

The Auxiliary Building Ventilation System is designed to perform the following functions during normal plant operation and shutdown: (1) maintain a suitable environment for the operation, maintenance and testing of equipment; and (2) maintain a suitable environment for personnel access. During accident conditions the Auxiliary Building Ventilation System is designed to minimize the release of radioisotopes from the ECCS pump rooms. These rooms contain the following safety-related pumps: 1) Safety Injection Pumps; and 2) Residual Heat Removal Pumps; and 3) Centrifugal Charging Pumps; 4) Containment Spray Pumps. Each of these pumps is provided with water-cooled motors and where necessary, bearing coolers. Therefore, no ambient cooling is required in these rooms during an accident.

The Auxiliary Building Ventilation System serves all areas of the Auxiliary Building with the exception of the control room area and the fuel handling area. Ambient temperature limits within the Auxiliary Building during normal plant operation are a maximum of 110°F and a minimum of 55°F. Outdoor design temperatures meet or exceed those given in Table No. 1, Chapter 23 of the ASHRAE 1977 Fundamentals Handbook.

Ventilation air is supplied to both clean and potentially contaminated areas of the Auxiliary Building. Control of airborne activity is accomplished by exhausting air supplied to clean areas through the potentially contaminated areas. This air in turn is processed by the Filtered Exhaust System. This provides a positive flow of air from clean areas to areas of potential contamination. The remaining air supplied to clean areas is exhausted by the Unfiltered Exhaust System.

All air exhausted from the Auxiliary Building by the Filtered Exhaust System and the Unfiltered Exhaust System is directed to the unit vent where it is monitored by the unit vent radiation monitor prior to release to the atmosphere. During normal operation, the Auxiliary Building supply and unfiltered exhaust fans are automatically stopped upon indication of high radiation levels in the unit vent.

Upon receipt of an Engineered Safety Feature Actuation signal all Auxiliary Building Ventilation System components automatically shutdown. The Filtered Exhaust System automatically cycles on with emergency Class 1E standby power. All areas of the Auxiliary Building except the ECCS pump rooms are automatically isolated from the Filtered Exhaust System. The elevation 522 pipe chase communicates directly with the ECCS pump rooms therefore, the elevation 522 pipe chase is maintained at a negative pressure. The elevation 543 and 560 mechanical penetration rooms communicate directly with the elevation 522 pipe chase, therefore the penetration rooms are also maintained at a negative pressure. The VA filtered exhaust system maintains the ECCS pump rooms at a negative pressure with respect to all adjacent areas.

The following Auxiliary Building Ventilation System subsystems are engineered safety features with complete 100 percent capacity redundancy. Electrical power and control separation between train related components is maintained. These subsystems are as follows:

1. Auxiliary Building Filtered Exhaust System,
2. Auxiliary Shutdown Panel Room Air Conditioning Systems.

Essential electrical components required to maintain exhaust air flow from the ECCS pump rooms and to maintain 78°F in the auxiliary shutdown panel rooms during accident conditions are connected to emergency Class 1E standby power.

All essential components are designed to withstand the safe shutdown earthquake.

The Auxiliary Building Filtered Exhaust System and the Auxiliary Shutdown Panel Rooms Air Conditioning Systems are located completely within a Seismic Category I structure and all essential components are fully protected from tornado missile damage. The outside air intake penthouses are protected by missile shields.

9.4.3.2 System Description

The Auxiliary Building Ventilation System is shown on Figure 9-121, Figure 9-122, Figure 9-123, Figure 9-124, Figure 9-125, Figure 9-212, Figure 9-213, Figure 9-214, Figure 9-215, Figure 9-216, Figure 9-217, Figure 9-233, and Figure 9-249 and consists of the following subsystems:

1. Auxiliary Building General Ventilation Supply System;
2. Auxiliary Building Unfiltered Exhaust System;
3. Auxiliary Building Filtered Exhaust System;
4. Auxiliary Shutdown Panel Rooms Air Conditioning System;
5. Radwaste Area Ventilation System;
6. Counting Room Air Conditioning System; and
7. Supplementary ventilation systems.

9.4.3.2.1 Auxiliary Building General Ventilation Supply System

Outside air is supplied for the general ventilation in the Auxiliary Building. Each unit is provided a separate system consisting of two 50 percent capacity supply fans with hot water heating, YV chilled water cooling coils, and filter section. The filter section contains particulate type filters. All equipment in this subsystem is non-nuclear safety related.

Cooling water is supplied to the cooling coils by the Containment Chilled Water System which is described in Section 9.4.6. Cooling water flow is manually controlled. Hot water is supplied to the heating coils by the Plant Heating System. A three-way mixing valve in the hot water supply is controlled by a temperature controller.

9.4.3.2.2 Auxiliary Building Unfiltered Exhaust System

The Auxiliary Building Unfiltered Exhaust System consists of two-50 percent capacity fans and associated ductwork for each plant Unit. This system serves areas of the Auxiliary Building that are not subject to contamination. This system is non-nuclear safety related.

9.4.3.2.3 Auxiliary Building Filtered Exhaust System

The Auxiliary Building Filtered Exhaust System consists of two filter trains with fans, two 100 percent capacity preheater/demister sections and associated ductwork for each unit. This system serves areas of the Auxiliary Building that are subject to potential contamination. This system serves an engineered safety features function during accident conditions.

The Auxiliary Building Filtered Exhaust System serves both a non-safety and a safety related function. During normal plant operation the two filter trains and fans for each unit operate as two-50 percent capacity components of the Filtered Exhaust System for its respective unit. Radiation monitoring is provided upstream of filter trains and in the unit vent. During normal operation, high unit vent radiation levels will shut down the Unfiltered Exhaust and Supply Systems.

Auxililary Building Filtered Exhaust System normally operate in a filter bypass alignment, and automatically swaps to filter alignment upon a receipt of unit vent stack high radiation alarm (EMF35, 36); or a receipt of high radiation upstream of the filter units (0EMF41).

During accident conditions the two filter trains, fans, and preheater/demister sections for each unit will operate as two-100 percent capacity subsystems of the Filtered Exhaust System for its respective unit. Upon receipt of a signal, isolation dampers will close, shutting off air flow from all areas of the Auxiliary Building except for the rooms which contain safety related pumps which are part of the Emergency Core Cooling System (ECCS). One of the two 100 percent capacity exhaust ducts will exhaust air from the pump rooms through the associated preheater/demister section, filter train, and fan to the unit vent. This assures the integrity and availability of one train of the Filtered Exhaust System in the event of any single active failure.

The two preheater/demister sections, filter trains, centrifugal fans and associated isolation and inlet vane dampers for each unit are connected to separate trains of the Class 1E emergency standby power.

The Auxiliary Building Filtered Exhaust System initially operates at a reduced capacity during a LOCA event, pulling air only from the ECCS pump rooms. Supply air to the ECCS pump rooms is shut down to maintain the rooms at a negative pressure and prevent outleakage of fission products. Within 3 days of the initiation of a design basis event (i.e. LOCA), the Auxiliary Building Filtered Exhaust System is placed back into it’s normal alignment because credit is taken in the dose analyses for filtration of unidentified ECCS leakage in other areas of the Auxiliary Building.

The Auxiliary Building Filtered Exhaust System filter trains are described in Section 12.3.3.

9.4.3.2.4 Auxiliary Shutdown Panel Rooms Air-Conditioning System

The Auxiliary Shutdown Panel Rooms Air-Conditioning System is shown on Figure 9-122, Figure 9-126, and Figure 9-127.

The four auxiliary shutdown panel rooms are located on floor elevation 543+0 of the Auxiliary Building. A separate 100 percent capacity air conditioning unit is provided to serve each of the four rooms. The system is designed to maintain a maximum temperature of 78°F and a minimum temperature of 65°F. Electrical power to the air conditioning units is provided from the electrical power train associated with the room it serves. This assures the availability of at least one train of the auxiliary shutdown panel rooms.

The air conditioning units are of the self-contained design utilizing the Component Cooling Water System for condenser water. The Component Cooling System is described in Section 9.2.2. Each air conditioning unit has a filter section consisting of filters having an efficiency of approximately 30 percent based on the ASHRAE test method in accordance with ASHRAE Standard 52.68. The auxiliary shutdown panel room air conditioning units are controlled by room thermostats. During an ASP event, these units may utilize the Nuclear Service Water System water as a back up cooling source. The Nuclear Service Water System is described in Section 9.2.1.

9.4.3.2.5 Radwaste Area Ventilation System

Outside air is supplied to the hot machine shop, waste shipping, drum storage, and laundry areas of the radwaste area by one 100 percent capacity air handling unit consisting of a filter section, hot water preheat and chilled water cooling coils centrifugal fan, zone electric duct heaters and associated ductwork. The filter section contains particulate type filters. A cooling water three-way mixing valve is provided to maintain space temperature. The hot water coil tempers the incoming air and is controlled by a leaving air temperature controller. Electric duct heaters controlled by zone thermostats maintain zone conditions.

Outside air is supplied to the office, personnel decontamination, and lab areas by two 50 percent capacity air handling units consisting of chilled water cooling and hot water preheat coils, filter sections, centrifugal fans, zone electric duct heaters, and associated ductwork.

The filter section contains particulate type filters. A cooling water three-way mixing valve is provided for each air handling unit. The hot water preheat coil tempers the incoming air and is controlled by a leaving air temperature controller. Electric duct heaters controlled by zone thermostats maintain space temperatures.

Conditions are maintained in the counting room and environmental lab by a single 100 percent capacity air handling unit consisting of a filter section, direct expansion (DX) coil, air cooled condenser, centrifugal fan, zone electric duct heaters and associated ductwork. A refrigerant compressor and air cooled condensing unit are located on Auxiliary Building Roof (above Counting Room), to provide cooling for Counting Room only. The filter section contains filters having an efficiency of approximately 30 percent based on the ASHRAE test method in accordance with ASHRAE Standard 52.68. Electric duct heaters controlled by zone thermostats operate as required to maintain zone conditions.

Outside air supplied to the counting room and the environmental lab passes through a filter train to clean-up any background radiation in the atmosphere. This filter train consists of the following components.

1. Prefilter section containing filters with an efficiency of approximately 45 percent based on the ASHRAE test method with atmospheric dust in accordance with ASHRAE Standard 52.68.

2. High efficiency filter section containing filters with an efficiency of approximately 99.9 percent in removing 0.3 micron particles when tested with dioclyphthalate (DOP) smoke in accordance with the Instruction Manual for the installation, operation and maintenance of penetrometer, Filter Testing, DOP, Q107, Manual No. 136-300-175A, dated January 1965, U.S. Army Edgewood Arsenal.
3. Carbon adsorber section of the gasketless design with bed depth of two (2) inches of carbon. Adsorbers are filled with impregnated activated carbon complying with Table 2 of NRC Regulatory Guide 1.52 and Table 5-1 of ANSI N509. A Fire Detection and Protection System is provided for the adsorber section. See Section 11.2.2.2.9.4 for a description of the drain headers provided, which contain loop seals with automatic makeup.

Outside air is supplied to the Health Physics office area by one 100 percent capacity air handling unit consisting of a filter section, electric preheat and chilled water cooling coils, centrifugal fan, zone electric duct heaters and associated ductwork. The filter section contains particulate type filters. A cooling water three-way mixing valve is provided to maintain space temperatures. Electric duct heaters controlled by zone thermostats, operate as required to maintain zone conditions.

Air supplied to the radwaste area is exhausted from the clean areas by the Auxiliary Building Unfiltered Exhaust System and from areas of potential contamination by the Auxiliary Building Filtered Exhaust System. The Radwaste Area Ventilation System is not a nuclear safety related system and operates only during normal plant operation and shutdown.

9.4.3.2.6 Counting Room Air Conditioning System

Outside air supplied to the counting room and the environmental lab passes through a filter train to clean-up any background radiation in the atmosphere. This filter train consists of the following components.

1. Prefilter section containing filters with an efficiency of approximately 30 percent based on the ASHRAE test method with atmospheric dust in accordance with ASHRAE Standard 52.68.
2. High efficiency filter section containing filters with an efficiency of approximately 99.9 percent in removing 0.3 micron particles when tested with dioclyphthalate (DOP) smoke in accordance with the Instruction Manual for the installation, operation and maintenance of penetrometer, Filter Testing, DOP, Q107, Manual No. 136-300-175A, dated January 1965, U.S. Army Edgewood Arsenal.
3. Carbon adsorber section of the gasketless design with bed depth of two (2) inches of carbon. Adsorbers are filled with impregnated activated carbon complying with Table 2 of NRC Regulatory Guide 1.52 and Table 5-1 of ANSI N509. A Fire Detection and Protection System is provided for the adsorber section. See Section 11.2.2.2.9.4 for a description of the drain headers provided, which contain loop seals with automatic makeup.

The counting room is cooled by the counting room supply unit which contains a refrigerant cooling coil. A roof top air cooled condensing unit supplies the cooling coil. Heating is provided for the counting room by electric duct heaters that are controlled by a room thermostat.

9.4.3.2.7 Supplementary Ventilation Systems

The waste evaporator package room, the recycle evaporator package room, and both reciprocal charging pump rooms are provided with a self-contained cooling unit to supplement the Auxiliary Building general ventilation supply. Water from the Auxiliary Building Cooling System (YN) is utilized as condenser water. Air supplied to these rooms by the General Ventilation Supply System is exhausted by the Auxiliary Building Filtered Exhaust System.

Each restricted instrument shop is provided with a self-contained cooling unit to maintain conditions. Water from the Auxiliary Building Cooling System (YN) is utilized as condenser water.

Each NM Sample Lab is provided with a self-contained cooling unit to maintain conditions. Water from the Auxiliary Building Cooling System (YN) is utilized as condenser water. In January 2011 a tube leak was confirmed in the 1B Reactor Coolant Hot Leg Sample Head Exchanger. This leak allowed Reactor Coolant to enter the YN system. In spite of efforts to decontaminate the YN system, low levels of contamination remain. Therefore, the YN System is being operated as a contaminated system.

The electrical penetration rooms are serviced by a non-safety air conditioning system.

The Unit 2 UHI facility is serviced by a non-safety related ventilation system; a subsystem of the VA System.

9.4.3.3 Safety Evaluation

The Auxiliary Building Ventilation System provides adequate capacity to assure that proper temperatures are maintained in the various portions of the building during normal operating and shutdown conditions.

Under normal operating conditions the supply and exhaust systems are balanced such that exhaust air flow exceeds supply air flow to minimize outleakage. Air from the filtered and unfiltered exhaust is directed to the unit vents where it is monitored before release to the atmosphere.

The Auxiliary Building Filtered Exhaust System and the Auxiliary Shutdown Panel Rooms Ventilation System are engineered treated as safety features. Each redundant set of components is served from separate trains of the Emergency Class 1E Power System. This assures the integrity and availability of these systems in the event of any single active failure.

The Auxiliary Building supply and exhaust systems are available after a loss of offsite power, thus providing a virtually uninterruptable service to the Auxiliary Building.

A single failure in the Auxiliary Building ventilation system could reduce the supply and/or exhaust capacity, depending upon the failed component. A failure analysis of the Filtered Exhaust System and the Shutdown Panel Rooms System is provided in Table 9-28.

9.4.3.4 Inspection and Testing Requirements

The Auxiliary Building Ventilation System is in continuous operation and is accessible for periodic inspection. Essential electrical components, switchovers, and starting controls are tested during preoperational tests and periodically thereafter to demonstrate system readiness and operability as required by the Technical Specifications.

9.4.4 Diesel Building Ventilation System

9.4.4.1 Design Bases

The Diesel Building Ventilation System is designed to provide a suitable environment for the operation of equipment and personnel access for inspection, testing, and maintenance.

The Diesel Building Ventilation System is designed to maintain the building temperature between 60°F minimum and 110°F maximum when the diesel is not operating, and between 60°F minimum and 120°F maximum when the diesel is operating. All temperature changes will occur gradually.

All essential fans, dampers, ductwork, and supports are designed to withstand the safe shutdown earthquake.

Essential electrical components required for ventilation of the Diesel Building during accident conditions are connected to emergency Class 1E standby power.

The Diesel Building Ventilation System is located completely within a Seismic Category I structure. The ventilation air supply and exhaust openings are fully protected from tornado missile damage.

9.4.4.2 System Description

The Diesel Building Ventilation System is shown on Figure 9-128 and consists of the following subsystems:

1. Normal Ventilation System
2. Emergency Ventilation System

The Normal Ventilation System for each diesel enclosure consists of one 100 percent capacity fan, shutoff damper, filter section and associated ductwork. The filter section contains particulate type filters. The Normal Ventilation System has no standby capacity and operates only during normal plant operation (diesel off-cycle). The normal ventilation fan will be cycled off when its associated diesel is started, either for test purposes or by an Engineered Safety Features Actuation signal.

A self contained cooling unit is provided for each of the Emergency Diesel Generator Battery Enclosures to provide a controlled environment for the nuclear safety related batteries (1/2 DGBA and 1/2 DGBB) for the 125Vdc Essential Diesel Aux Power System. This unit is not required during emergency diesel operation and is provided for normal operating conditions to help prolong battery life and to remove the build up of gasses and hydrogen concentrations within the enclosure.

The Emergency Ventilation System for each diesel enclosure consists of two 50 percent capacity fans, ductwork, and modulating return air and outside air dampers arranged to maintain space temperature between 60°F and 120°F when the diesel is operating. As the space temperature rises, proportioning controls are provided to modulate the outdoor air dampers toward the open postion and the return air dampers toward the closed position. Excess make-up air to the diesel enclosure is relieved through automatic (pressure-operated) relief dampers.

The enclosures containing the diesel generator starting and control circuits meet NEMA 12 standards (drip and dust proof). These enclosures protect the electrical equipment from dust and other contaminants.

9.4.4.3 Safety Evaluation

The Diesel Building Ventilation System automatically maintains a suitable environment in each diesel enclosure under all operating conditions. Since the Diesel Building Ventilation System is duplicated for each diesel, a single failure will not impair the safety function.

9.4.4.4 Inspection and Testing Requirements

The Normal Ventilation System is in continuous operation during diesel offcycles and is accessible for periodic inspection.

Essential electrical components, switchovers, and starting controls are tested during preoperational tests and periodically thereafter coincident to testing of the diesels as required by the Technical Specifications.

9.4.5 Containment Purge Ventilation System

9.4.5.1 Design Bases

The Containment Purge Ventilation System is designed to maintain the environment of the containment within acceptable limits for personnel access during inspection, testing, maintenance and refueling operations; and to limit the release of any contamination to the environment.

The design bases include provisions to:

1. Clean up containment purge exhaust during refueling.
2. Supply fresh air for contamination control when the containment is or will be occupied.
3. Supply fresh air for contamination control when the incore instrumentation room is or will be occupied.
4. Exhaust containment air to the outdoors through the purge exhaust filter trains whenever the Purge Air Supply System is operated.
5. Assure isolation of the system penetrations in the containment vessel.

Only Item 5 above is a safety-related function.

Each containment penetration for the Purge Ventilation Supply and Exhaust Subsystems is provided with two isolation valves, one on each side of the containment wall. This meets the single failure criterion. See Section 6.2.4 for a complete description of the penetration assemblies including isolation valves.

The Containment Purge Ventilation System is not an Engineered Safety Feature.

9.4.5.2 System Description

The Containment Purge Ventilation System is shown on Figure 9-129 and Figure 9-130 and consists of the following subsystems: (per unit basis)

1. Containment Purge Supply System
2. Containment Purge Exhaust System
3. Incore Instrumentation Room Purge Supply System
4. Incore Instrumentation Room Purge Exhaust System

Outside air is supplied to the Containment by the Containment Purge Supply System. The system consists of two 50 percent capacity air handling units. Total supply capacity is approximately 25,000 cfm. Each air handling unit consists of a filter section, hot water heating coil, shutoff damper, and fan. The filter section contains filters having an efficiency of approximately 30 percent based on the ASHRAE test method with atmospheric dust in accordance with ASHRAE Standard 52.68. This equipment is located outside the Reactor

Building in the Auxiliary Building at elevation 611+0. There is one supply duct penetration through the Reactor Building wall into the annulus area. There are four purge air supply penetrations through the containment vessel, two to the upper compartment and two to the lower compartment. Two normally closed isolation valves at each penetration through the containment vessel provide containment isolation. One normally closed isolation damper at the Reactor Building wall provides annulus isolation.

Purge air is exhausted from the containment through the Containment Purge Exhaust System to the unit vent where it is monitored for radioactivity level by the unit vent monitor prior to release to the atmosphere. The Containment Purge Exhaust System consist of two 50 percent capacity filter trains and fans. Total exhaust capacity is approximately 25,000 cfm. This equipment is located outside the Reactor Building in the Auxiliary Building at elevation 594+0. There is one purge exhaust duct penetration through the Reactor Building wall from the annulus area. There are three purge exhaust penetrations through the containment vessel, two from the upper compartment and one from the lower compartment. Two normally closed isolation valves at each penetration through the containment vessel provide containment isolation. One normally closed isolation damper at the Reactor Building wall provides annulus isolation.

The upper compartment purge exhaust ductwork is arranged to draw exhaust air into a plenum around the periphery of the refueling canal, effecting a ventilation sweep of the canal during the refueling process. The lower compartment purge exhaust ductwork is arranged so as to sweep the reactor well during the refueling process (see Figure 9-130).

The Incore Instrumentation Room Purge Supply System consists of one 100 percent capacity air handling unit. Supply capacity is approximately 1,000 cfm. The air handling unit consists of a filter section, hot water heating coil, and fan. The filter section contains filters having an efficiency of approximately 30 percent based on the ASHRAE test method with atmospheric dust in accordance with ASHRAE Standard 52.68. This equipment is located outside the Reactor Building in the Auxiliary Building at elevation 594+0. There is one purge supply penetration through the Reactor Building wall and one through the containment vessel. Two normally closed isolation valves at the containment penetration provide containment isolation. One isolation damper at the Reactor Building wall provides annulus isolation.

The Incore Instrumentation Room Purge Exhaust System consists of one 100 percent capacity filter train and fan. Exhaust capacity is approximately 1,000 cfm. Purge air is exhausted to the unit vent where it is monitored for radioactivity level by the unit vent monitor prior to release to the atmosphere. This equipment is located in the Auxiliary Building at elevation 594+0. There is one purge exhaust penetration through the Reactor Building wall and one through the containment vessel. Two normally closed isolation valves at the penetration through the containment vessel provide containment isolation. One isolation damper at the Reactor Building wall provides annulus isolation.

The containment purge supply fans, purge exhaust fans, and filter trains are controlled in two trains. The controls are designed to have simultaneous starting and stopping of the matching supply and exhaust equipment. Controls are also provided to reduce purge flow rate. The controls for the Incore Instrumentation Room Purge System are designed to have simultaneous starting and stopping of the supply and exhaust equipment. The controls are also designed to initiate an automatic shutdown and containment isolation upon receipt of a containment isolation signal.

The containment purge exhaust system filter trains are described in Section 12.3.3.

9.4.5.3 Safety Evaluation

Each Containment Purge Ventilation System supply and exhaust penetration through the containment vessel is equipped with two normally closed isolation valves, each connected to separate control trains. A failure in one train will not prevent the remaining isolation valve from providing the required isolation capability. The isolation valves and containment penetrations are the only portions of the Containment Purge Ventilation System that are engineered safety features, and are discussed in Section 6.2.4. Design specifications for the purge system isolation valves are presented in Table 9-29.

The containment purge exhaust system is isolated on a high radiation signal. A non safety related electric preheater located within the purge exhaust system ductwork is designed to maintain ≤70% relative humidity and provide additional safety margin.

Since containment purge system operation is intermittent, electric heaters within the filter unit operate to dry out any moisture that may have accumulated in the carbon filter bed from humidity in the ambient air.

A fuel handling accident inside the containment has been analyzed assuming the Purge System is in operation during refueling operations. This analysis is described in Section 15.7.4.

9.4.5.4 Inspection and Testing Requirements

The nonessential components are not normally in operation and are accessible for periodic inspection. Essential components and controls are tested during preoperational tests and periodically thereafter as required by the Technical Specifications.

9.4.6 Containment Ventilation and Chilled Water System

9.4.6.1 Design Bases

The Containment Ventilation and Chilled Water System is designed to maintain acceptable temperature limits within the confines of the Reactor Building upper and lower compartments to ensure proper operation of equipment and controls during normal plant operation and normal shutdown and for personnel access during inspection, testing, and maintenance. The Containment Chilled Water System can be aligned to provide supplemental cooling for the Fuel Handling Area Supply Vent Units. During the spring, summer and fall, the Containment Chilled Water System may be aligned to provide cooling to the Auxiliary Building Supply Units.

The Lower Containment Ventilation System is designed to maintain a maximum air temperature of 120°F in the lower compartment during normal plant operation. Fan-coil units are provided to allow any combination of units to operate during normal plant operation to maintain containment temperature limits.

The Control Rod Drive Mechanism (CRDM) Ventilation System is designed to operate during normal plant operation in conjunction with the Lower Containment Ventilation System. This subsystem pulls air from the lower compartment through the CRDM shroud with sufficient air flow to limit the air temperature exiting the CRDM shroud to 170°F or less. This air is returned to the intake side of the Lower Containment Ventilation System fan-coil units. The CRDM Ventilation System consists of four 33 1/3 percent capacity vane-axial fans (three of which normally operate with one on standby) and associated ductwork.

The Incore Instrumentation Room Ventilation System is designed to maintain an air temperature in the instrumentation room of 100°F during normal plant operation, with a maximum of 120°F.

Two 100 percent capacity fan-coil units are provided. One fan-coil unit will normally be in operation with the remaining fan-coil unit on standby.

The Containment Auxiliary Carbon Filter System is designed to provide cleanup of airborne contamination in the lower compartment during normal plant operation and normal shutdown. Two fan-filter units are provided in the lower compartment with associated ductwork.

The Upper Containment Ventilation System is designed to maintain a maximum air temperature of 100°F in the upper compartment during normal plant operation and normal shutdown. Four fan-coil units are provided to allow any combination of units to operate during normal plant operation to maintain containment temperature limits.

The cooling medium for the lower and upper containment fan-coil units, incore instrumentation room fan-coil units and reactor coolant pump motor heat exchangers is the Containment Chilled Water System. During a loss of offsite power, the cooling medium for the containment heat exchangers described above is provided by the Nuclear Service Water System. The Containment Chilled Water System also provides a means to maintain the fuel handling area and the Auxiliary Building under 110°F maximum during the summer season or when necessary to maintain a suitable work environment for personnel. The Containment Chilled Water System is not available on the Blackout Power System. In the event of a loss of offsite power, the Auxiliary Building Supply Units may be provided cooling by the Nuclear Service Water System. The Containment Ventilation System except for the Containment Auxiliary Carbon Filter Units is energized from the Blackout Power System upon loss of offsite power; however the Containment Ventilation System is not an engineered safety feature and is not required to operate during LOCA conditions. The Nuclear Service Water System is described in Section 9.2.1.

9.4.6.2 System Description

The Containment Ventilation and Chilled Water System is shown on Figures 9-131, 9-269, and 9-270 is composed of the following subsystems:

1. Lower Containment Ventilation System
2. Control Rod Drive Mechanism (CRDM) Ventilation System
3. Incore Instrumentation Room Ventilation System
4. Upper Containment Ventilation System
5. Containment Auxiliary Carbon Filter System
6. Containment Chilled Water System

The Lower Containment Ventilation System consists of four fan-coil units, associated dampers, a common plenum and ductwork system. The four fan-coil units are located in two annular concrete chambers around the periphery of the lower compartment. From one to four of the fan-coil units are normally required to operate to maintain conditions in the lower compartment. Lower compartment air passes directly through each active fan-coil unit where it is cooled and supplied to the various areas of the lower compartment through a common duct distribution system as shown in Figure 9-269. Vane-axial booster fans are provided to ensure design air flow to the pipe tunnel in the lower extremity of the lower compartment. A cooling water throttling valve for each fan-coil unit can be automatically controlled by area thermostats located near the return air openings to each fan-coil unit to maintain the lower containment temperature greater than or equal to 100°F during power operation. Since the entering air temperature for each fan-coil unit is greater than 100°F during power operation, the cooling water throttle valves are normally full open and automatic controls are unnecessary. The ability to bypass the automatic control thermostats also exists and is normally used to prevent tripping the water chillers on low chilled water flow. Backdraft dampers are provided in the discharge duct of each fan-coil unit to prevent back-flow through the standby unit.

The Control Rod Drive Mechanism (CRDM) Ventilation System consists of four 33 1/3 percent capacity vane-axial fans and associated dampers and ductwork. Three fans will normally operate with one on standby. The CRDM fans, located in the lower compartment outside the primary shield wall, pull the cooling air through the CRDM shroud and return it to the intake side of the active lower compartment fan-coil units through a common duct system. Each CRDM ventilating fan is provided with a backdraft damper located in the duct on the discharge of the fan to prevent back-flow through the standby fan.

The incore instrumentation room is a dead-ended space in the lower compartment of the containment. The Incore Instrumentation Room Ventilation System consists of two 100 percent capacity fan-coil units and common duct distribution system, located inside the conditioned space. One fan coil unit will normally operate with the other on standby. A cooling water throttling valve for each fan coil unit is automatically controlled by return air thermostats set to maintain the instrumentation room at 90°F. Backdraft dampers are provided in the discharge duct of each fan coil unit to prevent back-flow through the standby unit.

The Upper Containment Ventilation System consists of four fan-coil units and associated return air fans located in the upper compartment. One to four of the fan-coil units with their respective return air fans are required to operate to maintain conditions in the upper compartment during normal reactor operation. A cooling water throttling valve for each fan-coil unit is automatically controlled by return air thermostats set to maintain the upper compartment at 90°F.

The Containment Auxiliary Carbon Filter System consists of two 50 percent capacity fan-filter units and associated ductwork located in the lower compartment for reduction of airborne contamination. The number of containment auxiliary carbon filter units in operation (one or two) depends on the airborne activity levels observed. With the addition of booster fans, inlet plenums and temporary ductwork, airborne contamination generated during maintenance may be exhausted to and filtered by these units.

Each containment auxiliary carbon filter train was designed with the following components.

1. Prefilter section containing filters having an efficiency of approximately 75 percent based on the ASHRAE test method with atmospheric dust in accordance with ASHRAE Standard 52.68.
2. High efficiency filter section containing filters having an efficiency of approximately 99.97 percent in removing 0.3 micron particles when tested with dioclylphtalate (DOP) smoke in accordance with the Instruction Manual for the installation, operation and maintenance of penetrometer, Filter Testing, DOP, Q107, Manual No. 136-300-175A, dated January, 1965, U.S. Army Edgewood Arsenal.
3. Carbon Adsorber section of the carbon tray design in accordance with AACC-CS-8T.

The Containment Chilled Water System (YV) consists of three 50 percent capacity centrifugal water chillers and chilled water pumps, associated piping and valves. Major equipment is located in an adjacent yard structure. The system supplies a lower compartment header serving the lower compartment and incore instrumentation room fan-coil units and the reactor coolant pump motor heat exchangers. The YV system also supplies the upper containment ventilation system. The system can be aligned to provide cooling water to maintain the Fuel Handling Area and the Auxiliary Building under 110°F (maximum) during the summer season or when necessary to maintain a suitable work environment for personnel. The Containment Chilled Water System is not available on the Blackout Power System. During a loss of offsite power, the Containment Chilled Water System is isolated and cooling water is supplied by the Nuclear Service Water System.

9.4.6.3 Safety Evaluation

The Containment Ventilation and Chilled Water System provides adequate capacity to assure that proper temperature levels are maintained in the containment under operating conditions. Sufficient redundancy is included to ensure containment temperature limits are maintained during normal plant operation.

The Containment Ventilation and Chilled Water System is so arranged that all components of each subsystem are located wholly in the upper or lower compartment eliminating the need for ductwork penetrating the divider barrier thus enhancing the barrier integrity.

The Containment Ventilation and Chilled Water System is not considered an engineered safety feature and no credit has been taken for the operation of any subsystem or component in analyzing the consequences of any accident.

Refer to UFSAR Section 6.3.4.1 for a discussion of actions taken regarding use of ventilation filter material within the containment ventilation system air handling units in response to NRC Bulletin No. 93-02, "Debris Plugging of Emergency Core Cooling Suction Strainers".

The NRC issued Generic Letter 96-06, "Assurance of Equipment Operability and Containment Integrity During Design-Basis Conditions," on September 30, 1996, requesting that licensees determine if containment air cooler cooling water systems are susceptible to either waterhammer or two-phase flow conditions during postulated accident conditions and to determine if piping systems that penetrate containment are susceptible to thermal expansion of fluid so that overpressurization of piping could occur. Evaluations of affected Catawba Nuclear Station systems and components were completed with response to the NRC submitted in the letter from M.S. Tuckman to the NRC, dated January 28, 1997. The evaluations determined that the Catawba Nuclear Station containment air cooler cooling water systems are not susceptible to either waterhammer or two-phase flow conditions during postulated accident conditions. The also concluded that the piping systems that penetrate the containment are not susceptible to thermal expansion of fluid so that overpressurization of piping could occur.

9.4.6.4 Inspection and Testing Requirements

The Containment Ventilation and Chilled Water System is in continuous operation during normal plant operation and is accessible for periodic inspection. Electrical components, switchovers, and starting controls are tested during preoperational tests to demonstrate system readiness and operability, as necessary.

9.4.7 Turbine Building Ventilation System

9.4.7.1 Design Bases

The Turbine Building Ventilation System is designed to provide a suitable environment for the operation of equipment and personnel access as required for inspection, testing, and maintenance.

The Turbine Building Ventilation System is designed to maintain the Turbine Building at 55-110 degrees F.

Treatment and monitoring of exhaust air is not provided since the Turbine Building has no potentially contaminated areas.

9.4.7.2 System Description

The Turbine Building Ventilation System is shown on Figure 9-133, Figure 9-255, Figure 9-256, Figure 9-257, Figure 9-258 and Figure 9-259. The system primarily consists of exhaust fans and air handlers which provide ventilation and conditioning for various areas and rooms inside the Turbine Building.

Eighteen of the exhaust fans are located on the Turbine Building roof at elevation 700+4 3/4. These fans are arranged to exhaust air from the mezzanine and operating levels of the Turbine Building.

Twelve of the exhaust fans are located on the Service Building roof at elevation 623+6. Each of the twelve fans is connected to one of five exhaust duct shafts arranged to exhaust air from the basement and mezzanine levels of the Turbine Building.

Outside air is drawn into the Turbine Building through outside air intake louvers located in the Turbine Building outside wall on the mezzanine level.

The Turbine Building Chilled Water System provides chilled water to the air handling units that cool the 6900 volt switchgear rooms.

Additional exhaust fans provide ventilation air for the Condenser Circulating Water Pump Motors, Heater Drain Tank Pump Pits, Main Turbine Oil Tank Room, Turbine Oil Transfer Tank Room, and other areas inside the Turbine Building.

Air handlers provide air conditioning for the 6.9 kV Switchgear Room, Secondary Alarm Station, and various other rooms inside the Turbine Building.

9.4.7.3 Safety Evaluation

The Turbine Building Ventilation System maintains a suitable environment in each Turbine Building during normal plant operation. This system is not an Engineered Safety Feature and no credit has been taken for its operation during an accident.

9.4.7.4 Inspection and Testing Requirements

The Turbine Building Ventilation System is in continuous operation during normal plant operation and is accessible for routine inspection. System components and controls are tested during preoperational testing and thereafter system equipment operability is verified under the preventative and corrective maintenance program.

9.4.8 Nuclear Service Water Pump Structure Ventilation System

9.4.8.1 Design Bases

The Nuclear Service Water Pump Structure Ventilation System is designed to provide a suitable environment for the operation of equipment, and personnel access for inspection, testing, and maintenance.

Ambient temperature limits within the nuclear service water pump structure are maximum 115°F and minimum 35°F. Outdoor design temperatures are based on extreme worst case historical data.

Two 100 percent capacity supply fans with duct distribution system are provided for each pump compartment. This meets the single failure criterion. Switchover is accomplished manually by the operator. Electrical power and control separation between train related components is maintained.

All essential fans, dampers, ductwork and supports, are designed to withstand the safe shutdown earthquake.

Essential electrical components required for ventilation of the building during accident conditions are connected to emergency Class 1E standby power.

The Nuclear Service Water Pump Structure Ventilation System is located completely within a Seismic Category I structure and all essential components are fully protected from tornado missile damage.

9.4.8.2 System Description

The Nuclear Service Water Pump Structure Ventilation System is shown on Figure 9-134 and consists of two 100 percent capacity essential vane-axial supply fans with associated dampers, ductwork, supports and control systems per pump compartment. A nonessential vane-axial fan is provided in both pump compartments to supply ventilation air to the pool area below the pumps when maintenance or inspection is performed in this area.

Each essential fan is provided with a check damper on the fan discharge to prevent backflow through the fan on standby. Each essential fan will be controlled by a local AUTO/OFF selector switch.

Modulating outside air and return air dampers are proportionally controlled to maintain space temperature.

9.4.8.3 Safety Evaluation

The Nuclear Service Water Pump Structure Ventilation System is an engineered safety feature. The two 100 percent capacity fans in each pump compartment are served from separate trains of the Emergency Power System. This assures the integrity and availability of the ventilation system in the event of a loss of offsite power or any single active failure.

9.4.8.4 Inspection and Testing Requirements

The Nuclear Service Water Pump Structure Ventilation System operates as required to limit temperature in the pump structure and is accessible for periodic inspection. Essential electrical components, switchovers, and starting controls are tested during preoperational tests.

9.4.9 Annulus Ventilation System

Note:

This section of the FSAR contains information on the design bases and design criteria of this system/structure. Additional information that may assist the reader in understanding the system is contained in the design basis document (DBD) for this system/strucutre.

9.4.9.1 Design Bases

The Annulus Ventilation System functions in conjunction with the secondary containment (Section 6.2.3) to minimize the release of radioactivity (specifically radioiodines) from the containment to the environment following a design basis LOCA. This system does not provide any normal ventilation functions and operates only during accident conditions.

The design bases for the VE System are to limit operator and site boundary doses following a Design Bases Accident to within 10CFR 50.67 guidelines. This is accomplished by the following functions: (1) produce and maintain a pressure at least as negative as 0.25 inches water gauge throughout the annulus, (2) reduce the concentration of radioactivity (specifically radioiodines) in the air within, and discharged from, the annulus through filtration and recirculation of annulus air, and (3) provide long term fission product removal capacity within the annulus through holdup (i.e., decay) and filtration.

This system is provided with two independent, 100 percent capacity ventilation filter systems complete with fans, filters, dampers, ductwork, supports and control systems for each unit. This meets the single failure criteria. Switchover between redundant trains is accomplished manually by the operator. Electrical and control component separation is maintained between trains.

All essential system components, including fans, filter trains, dampers, ductwork, and supports are designed to withstand the Safe Shutdown Earthquake.

Essential electrical components required for ventilation of the annulus during accident conditions are connected to emergency Class 1E standby power.

9.4.9.2 System Description

The Annulus Ventilation System is shown on Figure 9-135 and consists of redundant ventilation subsystems for each unit. Each ventilation subsystem consists of a filter train, fan, dampers, associated ductwork, supports and control systems. The Annulus Ventilation System filter trains are described in Section 12.3.3.

The Annulus Ventilation System functions to discharge sufficient air from the annulus to effect a negative pressure with respect to the containment and the atmosphere. Subsequent to attaining a negative pressure, additional air is discharged as necessary to maintain the pressure throughout the entire annulus at or below -0.5 inches water gauge. This lower design limit provides additional design margin to assure the specified design basis negative pressure of -0.25" w.g. is attained. In order to mix the in leakage in as large a volume as possible, air is displaced from the upper level of the annulus and passed through the filter train before being returned to the annulus at a low level.

The Annulus Ventilation System is activated by the safety injection signal (Ss). Upon receipt of this signal the system starts and aligns the recirculation and discharge dampers to maintain a negative pressure in the annulus. The recirculation and discharge dampers modulate to exhaust air as required to maintain a negative pressure of ≈-1.5" w.g. This design setpoint assures that under all conditions, all points in the annulus will be at least 0.5" w.g. negative which exceeds the –0.25” w.g. design basis minimum value.

Computer code CANVENT has been developed by Duke Power Company to analyze the thermal effects of a loss-of-coolant accident (LOCA) in a Westinghouse "ice condenser" containment. CANVENT is capable of evaluating the following factors:

1. Steady state (pre-LOCA) radial temperature distributions corresponding to fixed outside Reactor Building and inside containment temperatures.
2. Radial temperature distributions in the steel containment and concrete Reactor Building during post-LOCA transient.

3. Temperature and pressure in annulus between the Containment and Reactor Building during post-LOCA transient.
4. Capability of the annulus ventilation fans to quickly attain and maintain a vacuum in the annulus after a LOCA occurs.

Typical results of a CANVENT analysis are provided in Table 6-75. A detailed listing of standard CANVENT analysis assumptions is provided in Section 6.2.3.3.

9.4.9.3 Safety Evaluation

The Annulus Ventilation System is an engineered safety feature. Each redundant (100 percent capacity) ventilation subsystem is served from separate trains of emergency Class 1E standby power system. If one ventilation subsystem fails, the transfer of function to the other ventilation subsystem is performed manually from the Control Room by the operator. A failure analysis of the Annulus Ventilation System is presented in Table 9-30.

Containment leakage for process lines, hatches, and the fuel transfer tube is eliminated due to the design features of the Containment Isolation System as discussed in Sections 6.2.3 and 6.2.4.

Assumptions relating to the effectiveness of the Annulus Ventilation System in removing radioactive iodine following a design basis LOCA are presented in Section 15.6.5.3. A key assumption from Section 15.6.5.3 is that filtration credit for the Annulus Ventilation System is not taken until the annulus reaches a negative pressure of at least 0.25 inches water gauge at all locations. This is consistent with the design bases in Section 9.4.9.1.

9.4.9.4 Inspection and Testing Requirements

The Annulus Ventilation System is not a normally operating system. It is accessible for periodic inspection. Essential electrical components, switchovers, and starting controls are demonstrated functional during preoperational testing and periodically thereafter as required by the Technical Specifications. Additional periodic tests ensure that the mechanical functional capabilities of the Annulus Ventilation System remain consistent with the safety analysis assumptions described in Section 15.6.5.3.

THIS IS THE LAST PAGE OF THE TEXT SECTION 9.4.

THIS PAGE LEFT BLANK INTENTIONALLY.

9.5 Other Auxiliary Systems

9.5.1 Fire Protection System

Note:

This section of the UFSAR provides a general discussion of various elements of the Fire Protection Program at Catawba Nuclear Station. In addition, Table 9-31 provides a summary of documents submitted to the NRC which address elements of the Fire Protection Program. Additional information that may assist the reader in understanding the Fire Protection Program is contained in design basis documents CNS-1465.00-00-0006, "Plant Design Basis Specification for Fire Protection" and CNS-1435.00-00-0002, "Design Basis Specification for Post Fire Safe Shutdown". DBD CNS-1465.00-00-0006 is "incorporated by reference" into the UFSAR and subject to the control and reporting requirements of 10CFR50.71(e). See Section 1.5.

This section of the UFSAR describes the Fire Protection Program as intended to meet the requirement of 10CFR50.48, "Fire Protection Program".

> **10 CFR 50.48 states in part,**
> "(a) Each operating nuclear power plant must have a fire protection plan that satisfies Criterion 3 of appendix A of this part. The plan must also describe specific features necessary to implement the program…such as the means to limit fire damage to structures, systems, or components important to safety so that the capability to safely shut down the plant is ensured."

Appendix A of 10 CFR 50 provides the General Design Criteria for Nuclear Power Plants.

> **10 CFR 50 Appendix A, General Design Criterion 3 states in part,**
> "Structures, systems, and components important to safety shall be designed and located to minimize, consistent with other safety requirements, the probability and effect of fires and explosions….Fire detection and fighting systems of appropriate capacity and capability shall be provided and designed to minimize the adverse effects of fires on structures, systems, and components important to safety…."

Catawba's fire protection plan was reviewed against NUREG 0800, Standard Review Plan, Section 9.5-1, "Fire Protection Program", as documented in the Catawba Safety Evaluation Report (SER), NUREG 0954.

> **Catawba Safety Evaluation Report, NUREG 0954 states in part (pg. 9-34),**
> "The Staff has reviewed the Fire Protection Program for conformance with SRP Section 9.5-1, Fire Protection, (NUREG 0800)."

The Standard Review Plan provided guidelines acceptable to NRC Staff for developing and implementing a fire protection program at a nuclear power plant in accordance with General Design Criteria 3. The SRP defines the purpose of the Fire Protection Program for a nuclear power plant.

> **The Standard Review Plan states in part (pg. 9.5.1-9),**
> "The purpose of the Fire Protection Program is to ensure the capability to shutdown the reactor and to maintain it in a safe shutdown condition and to minimize radioactive releases to the environment in the event of a fire."

Catawba's original Fire Protection Program was submitted by letter dated December 1977, with revisions dated, June 1979, August 1981, and November 1983 as the Fire Protection Review

(FPR) which included a Response to the Branch Technical Position and a Fire Hazard Analysis. The Fire Protection Review is currently documented and maintained in the Plant Design Basis Specification for Fire Protection.

This UFSAR section identifies those fire protection systems, structures, components and programs necessary to meet the requirements of 10 CFR 50.48 “Fire Protection.” Therefore, only those fire protection systems, structures, components and programs specific to protecting the ability to achieve and maintain safe shutdown and minimize radioactive release are addressed.

The original requirements for operability, testing, surveillance, maintenance and compensatory actions for fire protection features were initially contained in the Catawba Technical Specifications issued along with the operating licenses for the station. As permitted by Generic Letter 88-12 (Removal of Fire Protection Requirements from Technical Specifications), Catawba submitted a license amendment request dated March 13, 1990, to relocate the fire protection requirements to the UFSAR. By letter dated November 30, 1990, the NRC staff approved the relocation of fire protection technical specifications to the UFSAR, specifically UFSAR Chapter 16, Selected Licensee Commitments, Section 16.9, Auxiliary Systems. In addition, the staff issued a license condition pertaining to the fire protection program and established the criteria by which changes can be made to the program.

9.5.1.1 Design Bases

Fire in the Auxiliary Building, Reactor Building, Diesel Building, and Nuclear Service Water Pump Structure could affect Seismic Category I safety related structures, systems or components (SSC’s). Fires in non Seismic Category I structures that could potentially present a fire exposure hazard to Seismic Category I SSC’s were considered. The only Non Seismic Category I Structure located adjacent to Seismic Category I Structures is the Service Building. The Fire Hazard Analysis concluded that the 3 hour fire barrier between the Auxiliary Building and the Service Building provides adequate protection from an exposure fire in the Service Building. Thus, fire protection features in the Service Building are not part of the Fire Protection Licensing Basis. Those required fire protection features in the Auxiliary Building, Reactor Building, Diesel Building, and Nuclear Service Water Pump Structure that are identified in the Fire Hazards Analysis (FHA) are part of the fire protection licensing basis.

The Fire Protection Program uses the defense in depth concept to ensure the capability to achieve and maintain safe shutdown and minimize radioactive releases. The defense in depth concept includes the following:

1. Prevent fires from starting.
2. Promptly detect, control and extinguish those fires that do occur.
3. Provide protection for structures, systems and components important to safety so that a fire that is not promptly extinguished by the fire suppression activities will not prevent the safe shutdown of the plant.

The elements of the licensing basis of the Fire Protection Program are as follows:

1. Provide administrative controls for control of combustible and flammable materials, hot work, and impairments to fire protection features.
2. Provide automatic fire detection with local alarm and annunciation in the control room.
3. Provide automatic fixed fire protection systems (sprinkler and CO2 systems).
4. Provide a trained, full time fire brigade.

5. Provide portable extinguishers and hose stations for manual fire fighting.
6. Provide fire barriers to minimize the potential for fire propagation.
7. Provide retaining walls / curbs, or drains to collect fire suppression water.
8. Provide protection against an unsafe condition or damage to safety class equipment due to inadvertent operation of, or a crack in, a moderate-energy line of the water based portion of the fire suppression system.
9. Provide capability to mitigate smoke spread and migration.

9.5.1.2 System Description

Note:

References to NFPA Standards throughout this section refer to the “Code of Record”. The Code of Record is defined as the year/edition of the NFPA Standard that was current during the original licensing phase of the plant. All NFPA Codes of Record are listed in the Plant Design Basis Specification for Fire Protection.

Administration controls are included in fleet guidance documents to manage control of flammable and combustible materials, hot work activities, and impairments to fire protection features.

The fire detection system includes ionization and photoelectric smoke detectors, heat detectors, and ultra violet detectors. Actuation of any one device initiates an alarm located in the Control Room. The fire detection and alarm system is designed in accordance with NFPA 72D, Standard for Installation, Maintenance and Use of Proprietary Protective Signaling Systems, and NFPA 72E, Standard on Automatic Fire Detectors. Deviations from these standards are documented in the Design Basis Specification for the Fire Detection System (EFA) and the Plant Design Basis Specification for Fire Protection.

The water based portion of the fire suppression systems (RF and RY) furnishes water by three full capacity electric motor driven fire pumps supplied from Lake Wylie. Each pump has a rated capacity of 2,500 gpm at 144 psig. The capacity of the pumps ensures that a single pump can supply the maximum sprinkler demand including 500 gpm for hose stream. The RY System provides water for the yard loop and associated hydrants (see Figure 9-136 thru Figure 9-144). Only the two fire hydrants located adjacent to the Nuclear Service Water Pump Structure are relied upon to protect a Seismic Category I SSC.

The RF System, in conjunction with RY system provides water for interior fire protection. It also provides the backup cooling water supply for the E and F instrument air compressors when normal recirculated cooling water (KR) is not available. There are two Auxiliary Building connections to the yard loop. The RF System contains valves, hose cabinets and sprinkler systems to provide coverage for areas of the plant containing fire protection features that are included in the fire protection licensing basis. The water supply and distribution systems are designed in accordance with NFPA 20, Standard for Installation of Centrifugal Fire Pumps and NFPA 24, Standard for Outside Protection. Deviations from these standards are documented in the Design Basis Specification for the Fire Protection System (RF/RY) and the Plant Design Basis Specification for Fire Protection.

Fixed water spray/sprinkler systems are provided for the following areas in the Auxiliary Building and Reactor Building.

1. Residual Heat Removal (ND) pump rooms and connecting corridor (522+0)
2. Component Cooling (KC) water pumps (560+0 and 577+0)
3. Centrifugal Charging (NV) pump rooms (543+0)
4. Carbon bed filters (In accordance with Reg Guide 1.52)
5. Auxiliary Feedwater (CA) pump rooms (543+0)
6. Battery Room Corridors (554+0)
7. Cable Room Corridors (574+0)
8. Reactor Building Annulus

These water based suppression systems are designed in accordance with NFPA 13, Standard for the Installation of Sprinkler Systems. Deviations from this standard are documented in the Design Basis Specification for the Fire Protection System (RF/RY) and the Plant Design Basis Specification for Fire Protection.

The Diesel Generator Buildings and the Auxiliary Feedwater Pump Pits are protected by automatic CO2 Systems with appropriate personnel alarms to warn of pending discharge. The CO2 systems are designed in accordance with NFPA 12, Standard on Carbon Dioxide Extinguishing systems. Deviations from this standard are documented in the Design Basis Specification for the Fire Protection System (RF/RY) and the Plant Design Basis Specification for Fire Protection.

The station has a fire brigade that is organized, equipped and trained in accordance with fleet guidance documents. The primary purpose of the Fire Brigade Organization is to minimize the consequences of postulated fires by rapid fire suppression utilizing manual fire fighting equipment, with or without the assistance of offsite fire agencies. The site Fire Brigade Organization is trained to be self-sufficient.

Manual fire fighting equipment (i.e., fire hoses and portable fire extinguishers) is located to provide effective use by the fire brigade for control and extinguishment in the incipient stages of a fire, thereby minimizing potential consequences of a fire. Hose stations supplied by the RF system are provided such that they are able to reach any area identified in the Fire Hazards Analysis with at least one effective hose stream and are installed in accordance with NFPA 14, Standard for the Installation of Standpipe and Hose Stations. Portable fire extinguishers are installed utilizing guidance from NFPA 10, Standard for Portable Fire Extinguishers and located to ensure effective use by the fire brigade. Deviations from these standards are documented in the Design Basis Specification for the fire Protection System (RF/RY) and the Plant Design Basis Specification for Fire Protection.

The primary means of protection for the Reactor Coolant Pumps is provided by an oil collection system as required by paragraph C.7.a of Section 9.5.1 of the Standard Review Plan. The RCP oil collection system is designed to contain any oil spill from the upper and lower oil pots and direct it to piping that goes to a drain tank. The oil collection system is designed to withstand the design-basis seismic event.

Passive fire protection (i.e., fire barriers) including walls, ceiling/floors, fire rated doors, fire rated dampers, fire rated cable wrap and penetration seals reduce the possibility of fire propagating across fire boundaries that separate fire areas and/or redundant components. The locations of required fire barriers are established based on the criteria given in UFSAR Chapter 16.9, Selected Licensee Commitments. Confining a postulated fire within a single fire area minimizes the scope of damage.

Fire fighting water is contained and collected by retaining walls/curbs or floor drains.

Inadvertent operation of, or a crack in a water based portion of the fire suppression system would not preclude safe shutdown of the plant since redundant trains of equipment required for safe shutdown are located in separate rooms, have adequate spatial separation, or have appropriate water spray shielding.

The fire brigade uses portable exhaust fans for smoke control and mitigation. In addition, smoke control is provided by the installed ventilation and exhaust systems. In the Auxiliary Building an exhaust system for numerous compartments maintains a slight negative pressure within the building to prevent out leakage. This system serves to control smoke generated by a fire and exhausts it to the station vent. The air and smoke exhausted to the environment from potentially contaminated areas is monitored and filtered, as required, such that limits of 10CFR 20 and the Selected Licensee Commitments are not exceeded.

The fire protection Quality Assurance program is a graded program that is focused on fire protection specialty items that are provided and installed to meet specific requirements of the current licensing basis. The fire protection Quality Assurance program is outlined in specification CNS-1435.00-00-0001 “Fire Protection Specification” (QA-3).

The power, control, and instrumentation cable used in Catawba is of an interlocked armor design without exposed plastic insulation in a galvanized steel jacket. All cables pass the IEEE Standard 383-1974. The armored cable design used for Catawba Nuclear Station has demonstrated high resistance to fire propagation as evidenced by testing of this design in a fully loaded, randomly filled, 400,000 BTU/hr exposure fire at the Underwriters Laboratories. The fully loaded trays showed no tendency for self-propagation.

Penetrations of fire barriers are sealed to provide protection equivalent to the rating of the original barrier. The design of the penetration seals meets the requirements of IEEE 634-1978 Standard on Electrical Cable Penetration Firestops including the hose stream test.

9.5.1.3 Safety Evaluation (Fire Hazard Analysis)

The Fire Protection Program at Catawba is based upon an evaluation of potential fire hazards throughout the Auxiliary, Reactor, Diesel Generator Buildings and Nuclear Service Water Pump Structure. Areas adjacent to these facilities are also evaluated to assure that the capability exists to safely shut down affected units following loss of functions due to a fire in any given fire area.

The safety evaluation for Seismic Category I structures is contained in the Fire Hazard Analysis. The Fire Hazard Analysis is maintained in the Plant Design Basis Specifications for Fire Protection.

The safety evaluation (Fire Hazards Analysis) assures that the capability exists to shutdown affected unit(s) following loss of function due to fire in any given fire area. A fire area is considered that portion of the plant which is separated from the remainder of the plant by three hour rated barriers, i.e. walls, floors or ceiling. The analysis defines each fire area, identifies equipment located in the area, identifies combustible material in the area and notes the method for meeting separation criteria.

The capability to safely shutdown the unit in the event of fire has been greatly enhanced by the addition of the standby shutdown system. This system provides all the functions, including dedicated power supplies, necessary to secure and maintain the unit in the hot standby condition for 72 hours without offsite power. While in the standby shutdown mode of operation, damage control measures can be taken, as necessary, to restore capability to achieve cold shutdown.

9.5.1.4 Inspection and Testing Requirements

Testing and inspections of fire protection features are conducted in accordance with UFSAR Chapter 16.9, Selected License Commitments, Auxiliary Systems. Fire extinguishers are inspected periodically and maintained annually.

9.5.1.5 Personnel Qualification

The site Fire Protection Engineer is qualified by training and experience for Member grade status in the Society of Fire Protection Engineers.

Site fire brigade member qualification is as stated in fleet guidance documents.

9.5.2 Communications Systems

9.5.2.1 Design Bases

The Catawba communication systems are designed to provide reliable intraplant and plant-to-offsite communications, and offsite emergency communications with public safety agencies.

The private automatic business exchange telephone system and the public address system provide diverse means of communication to all critical areas of the station during normal and emergency conditions. Additionally, a sound powered telephone system is provided between the auxiliary shutdown panel and selected locations in the plant. These diverse communication systems are independent of each other to assure effective communications assuming a single failure.

9.5.2.2 System Description

9.5.2.2.1 Intraplant Telephone System

The private automatic business exchange (PABX) telephone system provides independent private intraplant telephone communications throughout the vital areas of the station. The locations of PABX telephone stations are summarized in Table 9-32.

To assure its functional operability, the PABX telephone switch is provided with redundant common controls, critical electronics, and power supplies.

The PABX system is connected to the Intraplant Public Address System through an isolation device to preserve the independence of the two systems. This connection allows telephone system communications over the paging channel of the PA system as described below. The PABX system is also connected to the commercial telephone system and the Duke microwave/Fiber Optic Network.

Power is provided to the PABX equipment in the Communications Building from station Load Center (2SLYA) via an AC-DC-AC rectifier/battery inverter combination. A dedicated diesel generator is provided to automatically start and accept load should normal power be lost. Power to the PABX equipment in the Administration Building is from battery backed load centers.

9.5.2.2.2 Intraplant Public Address System

The intraplant Public Address (PA) System provides two independent channels of communication, page and party-line, throughout the critical areas of the station.

The page channel of the PA System provides intraplant communication over loud speakers with integral amplifiers. Page channel speaker-amplifiers are ring wired to preclude loss of system function in the event of a single cable failure.

The party-line channel of the PA System consists of additional handset circuits independent of the PABX system. Each party-line handset is provided the capability of selecting either the party-line phone channel or the paging channel.

Power to the PA System is from Unit 1 and Unit 2 through a shared 600VAC motor control center as described in Section 8.3.1.1.1.6.

9.5.2.2.3 Intraplant Sound-Powered Telephone System

Three sound-powered telephone circuits are provided for intraplant communications as follows:

Maintenance circuit:	This circuit consists of phone jacks located throughout the plant which can be patched together to establish communication between areas as necessary.
Refueling circuit:	This circuit consists of sound-powered phone stations connecting areas required for refueling operations.
Emergency circuit:	This circuit consists of sound-powered phone stations connecting the auxiliary shutdown panel with areas of the plant that may require local operation during an emergency shutdown.

The sound powered telephone system is powered from normal AC lighting panelboards under normal plant operating conditions. Should a loss of offsite power occur, a backup source is provided from emergency AC lighting panelboards located in their respective areas. The locations of the emergency sound-powered telephone stations are summarized in Table 9-32.

9.5.2.2.4 Emergency Offsite Communication

Emergency offsite communication is an extension of the PABX system. Emergency Notification System (ENS) telephones are labeled to distinguish them from the intraplant telephones. The locations of emergency public and fiber optic telephones are summarized in Table 9-32 and Table 9-33. Additionally, a security radio system is provided in accordance with 10CFR 73.55(f), and a emergency management radio system is provided in accordance with NUREG 0654.

Emergency Notification System (ENS) phones are located in the control room, Technical Support Center, and Emergency Operations Facility (EOF). These phones provide a communications link with the NRC-Bethesda and NRC-Region II. This system is powered from a non-essential, battery backed bus.

Duke Emergency Management Network (DEMNET) phones are located in the control room, Technical Support Center, and Emergency Operations Facility and provide simultaneous communications with Mecklenburg, Gaston, and York Counties and North and South Carolina. The system is a networked voice communication system which utilizes fiber optic lines and the internet as a communication path. This system is powered form non-essential, battery backed sources.

A radio system provides an independent communications link to the States, counties, General Office, and field monitoring teams. The base station radio is located at the Meteorological Tower; remote units are located in the Control Room, Technical Support Center and Emergency Operations Facility. The counties and States have portable radios. Each radio is powered by a non-essential AC source and has a built-in battery backup.

9.5.2.2.5 Power Supply Separation

A portion of the Intraplant Telephone Switch (PABX) is located in a separate building which also houses the rectifiers and batteries. The dedicated Standby Diesel Generator is located adjacent to the building. A separate portion receives power from battery backed load centers.

The Intraplant Pubic Address (PA) System is powered from two (2) shared Motor Control Centers that are located independent of each other. Motor Control Center SMXC is located in the Auxiliary Building and feeds PA Power Panelboard PAP-1 also located in the Auxiliary Building. Motor Control Center SMXS is located in the Service Building and feeds PA Power Panelboard PAP-2 also located in the Service Building. Therefore, the PA is fed from two (2) sources located in different buildings.

The Emergency Sound-Power Telephone System is powered on a per Unit basis, via a double feed circuit through a power transfer contactor. For Unit 1, the system is fed from diesel-backed Emergency Lighting Panelboard 1ELB and Normal Lighting Panelboard 1LA6. Panelboard 1ELB is located in the Auxiliary Building, EL. 560’-0”. Panelboard 1LA6 is located in the Auxiliary Building, EL. 543’-0”, thus separation is one floor elevation (17 feet). Unit 2 is similarly installed. The cabling running from 1ELB and 1LA6 to the Power Transfer Contactor is 2/C #12ALS.

9.5.2.3 Communication During Transient and Accident Conditions

In order to achieve a safe cold shutdown, it may be necessary for plant personnel to communicate with the control room or the emergency shutdown panel from selected working stations. These work stations and the communication systems available at each station are identified in Table 9-32 and Table 9-33.

The emergency sound-powered telephone system is the means of communication intended for use during accident conditions. Effective communication is provided by the emergency sound-powered phones in background noise levels as high as 110 dBA. PABX handsets are also available at all of the subject work stations and can be effectively used in noise levels of approximately 90 to 95 dBA.

Hand held radio transceivers are provided for use by station personnel in routine and emergency situations. A fixed location repeater base assures general coverage of the Turbine Building, Auxiliary Building, and Containment Building areas. The redundant Security repeaters receive emergency power, the Fire-brigade/OPS repeater has battery backup, and the individual radios have their own batteries.

9.5.2.4 Inspection and Testing

HISTORICAL INFORMATION NOT REQUIRED TO BE REVISED

All communication systems are inspected and checked for operability after installation to assure proper operation and coverage. After a unit is operational, plant noise levels will be measured during normal and simulated accident conditions. Based on these measurements, an *evaluation will be made to determine the need for sound isolation booths or noise-cancelling devices*.

The communication systems are used routinely and do not require periodic testing.

9.5.3 Lighting Systems

The plant is provided with adequate illumination through the integrated use of normal and emergency lighting systems. These lighting systems provide illumination for normal and emergency plant operation.

9.5.3.1 Normal Lighting System

The Normal Lighting System provides general illumination throughout the plant in accordance with the illumination levels recommended by the Illuminating Engineering Society. Power to the Normal Lighting System is supplied from independent 600VAC motor control centers through individual 600-208Y/120VAC dry-type transformer located in selected areas throughout the plant. All lighting in the Reactor Building is incandescent, while LED, incandescent, fluorescent, and high intensity discharge (HID) lighting is provided for the Auxiliary and Turbine Buildings. Normal lighting panelboards and their associated transformers are located such that a single failure in the Normal Lighting System will not result in a total loss of illumination in any vital area. The emergency 250 VDC lighting system and/or the emergency 8 hour battery lighting systems are provided should a failure in the normal lighting system occur.

9.5.3.2 Emergency Lighting Systems

9.5.3.2.1 Design Bases

The emergency lighting systems are designed to assure that adequate lighting is provided in all vital areas of the plant including essential access routes to these areas.

The Catawba control room can be illuminated by four independent lighting systems, the Normal Lighting System, the Emergency 208/120 VAC Lighting System, the Emergency 250 VDC Lighting System, and the Emergency 8 Hour Battery Lighting System.

A single failure analysis of the emergency lighting system is provided in Table 9-34.

Any one of the three emergency lighting systems is capable of providing adequate illumination for conducting a safe shutdown.

9.5.3.2.2 Emergency 250VDC Lighting System

The Emergency 250VDC Lighting System provides general emergency lighting for the control room and selected stairways and corridors throughout the plant. Voltage sensing relays automatically energize the normally deenergized emergency DC lighting system I the event of a loss of normal lighting. Power to the Emergency 250VDC Lighting system is from the 250VDC Auxiliary Power system as described in Section 8.3.2. Emergency 250VDC Lighting available for a safe shutdown condition is shown in Table 9-33. Emergency 250VDC Lighting available to illuminate safety related equipment is shown in Table 9-35.

9.5.3.2.3 Emergency 208Y/120VAC Lighting System

The Emergency 208Y/120VAC Lighting System provides general emergency lighting in the control room, stair, exits, corridors, and manned safe shutdown areas as listed in Table 9-33.

Emergency 280Y/120VAC Lighting available to illuminate safety related equipment is shown in Table 9-35.

All areas of the plant served by a Emergency AC light also have Emergency 250VDC lighting installed for backup coverage as described in section 9.5.3.2.2. Additional lighting in certain areas is provided by the Emergency 8 Hour Battery Lighting System as described in section 9.5.3.2.4. Voltage sensing relays automatically energize the normally deenergized emergency AC lighting in the vent of a loss of normal lighting.

The Emergency 208Y/120VAC Lighting System may be manually energized after a safety signal from 600VAC Essential MCC's 1EMXA, 1EMXJ, 2EMXA, 2EMXJ.

Power to train A and B of the Emergency 208Y/120VAC Lighting System is from the A and B diesel-generators, respectively, through independent trains of the Essential Auxiliary Power System as described in Section 8.3.1. This power will be available to the power system within 12 minutes.

9.5.3.2.4 Emergency 8 Hour Battery Lighting

The Emergency 8 Hour Battery Lighting System is provided specifically for station illumination and access/egress for safe shutdown of the plant and for any other emergency situations that may arise. This safe shutdown and other emergency lighting is provided in the control room, access and egress stairs, exits, and corridors, and manned safe shutdown areas as listed in Table 9-33. Emergency 8 Hour Battery Lighting available to illuminate safety related equipment is shown in Table 9-35

The 8 Hour Battery Lighting System consists of individual selfcontained, battery units. The units are normally on continuous charge from the unit normal auxiliary power system. Upon loss of normal voltage these are energized. Means are provided to test each lighting unit individually.

Deleted per 2015 update

9.5.4 Diesel Generator Engine Fuel Oil System

9.5.4.1 Design Bases

The Diesel Generator Engine Fuel Oil System is designed to provide for the storage of a seven-day supply of fuel oil for each diesel generator engine and to supply the fuel oil to the engine, as necessary, to drive the emergency generator. The system is designed to meet the single failure criterion, and to withstand the effects of natural phenomena without the loss of operability.

9.5.4.2 System Description

9.5.4.2.1 General

Plans and sectional elevations of the Diesel Building showing locations of major equipment and components, piping layouts for the fuel oil and other systems, and the fuel oil storage area with associated piping and components are shown in Figure 9-171 through Figure 9-180. The fuel oil system diagrammatics are shown in Figure 9-169 and Figure 9-170.

A separate and complete fuel oil storage and transfer system is provided for each diesel generator engine. Two underground storage tanks provide 90,000 gallons of fuel oil for each engine, which is sufficient to operate at full load for a period of time no less than seven days plus a margin to allow periodic testing.

Fuel oil is transferred by gravity from the storage tanks to the day tank which is located within retaining walls inside the Diesel Building. The day tank capacity of 550 gallons is a sufficient supply of fuel oil to operate the diesel generator engine in excess of 60 minutes at full load. A set of level switches located within the day tank control the position of the fuel oil transfer valve: opening the valve to allow fuel to flow to the day tank at low level, closing the valve to shut off the supply of fuel at high level. High and low level alarms are also provided both on the storage tanks and on the day tank. In the event of a transfer valve failure in the closed position, the day tank low level alarm, indicating 60 minutes of fuel reserve at full load, allows the operator to take corrective action. In such an event, a bypass line allows for manual filling of the day tank. In the event of a transfer valve in the open position, fuel oil would continue to flow from the storage tanks to the day tanks until the system reached hydrostatic equilibrium. Since there is no day tank overflow pipe fuel oil would rise in the Duke Class C day tank vent pipe to an elevation equivalent to that of the fuel oil in the storage tank, but well below the top of the vent. The day tank vent pipe is missile protected.

The fuel oil lines cross under the condenser cooling water lines which are moderate energy (70 psi) lines. It is anticipated that a break in these CCW lines would have minimal affect on the fuel oil lines. The fuel oil lines are bedded in a trench excavated into rock (minimum rock elevation is 587.6 on Unit 1 and 574.03 on Unit 2 which is above the fuel oil pipe at 572.2). Further, the CCW pipes are bedded in a 90 degree concrete support saddle which would virtually eliminate direct impingement on the fuel oil lines. Also, there are no structures above the fuel oil lines that would prevent near vertical seepage from occurring, therefore, insignificant undermining of the fuel oil lines is expected. Postulated loss of water will be detected at yard level due to the impervious zone of group I earth backfill confining these areas and the underlying rock.

The fuel oil tanks would not be affected by a possible loss of cooling water because they are located a considerable distance from the CCW lines.

During normal operation, fuel oil is pumped from the day tank to the engine by the engine driven fuel oil pump. The motor-driven fuel oil booster pump is normally isolated both electrically and mechanically, but may be operated if required during maintenance. The day tank provides sufficient positive suction to both the motor-driven fuel oil booster pump and the engine-driven fuel oil pump.

Each pump is provided with a duplex suction strainer and a discharge pressure relief valve, and an engine-mounted dual element fuel oil filter is provided on the common discharge header. Pressure gauges are located on the inlet and outlet sides of both strainers for local indication and an alarm is provided with each strainer to alert the operator of high differential pressure. Differential pressure indication and a high differential pressure alarm are also provided with the fuel oil filter.

Two fuel oil drip headers, one located on each bank of the diesel generator engine, contain unburned fuel leakage within the engine. The unburned fuel is removed from the drip headers through a piloted valve and ejector driven by the pressurized fuel oil return from the bypass headers to the day tank. The main circulation headers are fitted with a relief valve which prevents the engine fuel oil pressure from exceeding 40 psig and which discharges back to the day tank.

The day tank is surrounded by a fire wall which serves as a containment in the event of leaks or ruptures. The containment drain line is isolated by a normally closed, solenoid-operated valve. A high level signal from a level transmitter located within the containment opens this valve, allowing the oil to drain to the suction side of the lube oil transfer pump which is simultaneously activated and delivers the oil to a waste oil storage tank for Unit 2. For Unit 1, oil is pumped to the Diesel Generator Lube Oil System Pumpout Tanks.

An inspection program outlined in the Technical Specification ensures that the quality of the fuel oil delivered to the site and stored on site is maintained.

To prevent settling, stratification and deterioration of the fuel oil during extended storage periods, a system is provided to recirculate or transfer filtered fuel oil. Four fuel oil tanks (two half capacity storage tanks per redundant diesel) are centrally located and integrally connected with normally closed isolation valves and check valves to prevent backfilling and possible contamination of fuel oil between tanks. A manually operated, positive displacement recirculation pump takes suction from the flush mounted connection on the bottom of the storage tank and discharges the fuel oil at a rate of 50 gpm through the filtration system.

The filtration system is comprised of a clay polishing filter and two simplex filters. The flow path of fuel oil through the system is from the discharge of the pump, through the pre-filter, clay polishing filter, post-filter and back to the storage tank. The function of the pre-filter is to remove large particulate contaminants (>5 microns) prior to clay polishing and the function of the post-filter is to ensure that no contaminants (>1/2 microns) are released from the polisher to the storage tank. This alignment is used to neutralize the fuel oil.

For normal recirculation of the underground storage tanks, the clay polishing filter is valved out and the fuel oil is serviced by the pre-filter and post-filter. Clay polishing is not required during normal recirculation but only during specific situations.

The fuel oil is only required to be filtered through the clay polishing filter on an as needed basis. Since this filter is only required for limited use, it will remain drained when not in use. Although this filter is not used during the normal recirculation process, it can be used anytime the formation of particulate contaminants is detected in the storage tanks. The clay polishing process will remove the chemical additives in the fuel oil; therefore, following polishing the required additives will have to be replaced in the stored fuel oil.

The filtering and recirculation process is performed on a tank-by-tank basis with frequency of operation dependent on the results of the fuel oil inspection program outlined in the Technical Specifications. Since two half capacity storage tanks are provided per diesel, one tank will be aligned to supply fuel oil to its respective diesel while isolating the second tank through administrative control for filtering and recirculation.

Should the recirculation system be operating in the event of a LOCA, a redundant, safety related interlock is provided to shutdown the recirculation pump to prevent possible stirring of sediment. A redundant safety related interlock is also provided to shutdown the recirculation pump should the fuel oil in the storage tanks drop below Technical Specifications level to preclude loss of fuel oil in the event of a recirculation system pipe rupture.

These two safety related and redundant interlocks protect the Diesel Generator Fuel Oil System during operation of the recirculation system. They assure uninterrupted operation of the essential emergency diesels in the event of a Blackout or LOCA.

Fuel oil amenders are added as necessary to extend oil life by preventing oxidation, stratification, etc. A sample is used to inspect the oil for water content or degradation and if degradation is determined, the oil may be pumped out for disposal. Accumulated water in the fuel oil storage tanks will be removed by the recirculation system through a sample connection provided on the recirculation pump discharge as required by the Technical Specifications.

The day tank vent and fuel oil storage tank vents and fill connections which are exposed outdoors, are protected from tornado missiles due to the construction of the vents using heavy gauge pipe. Should a tornado missile strike a vent or fill connection the pipe will bend without crimping to relieve the impact load. The day tank vent terminates 3'-3" and 2'-4", for Units 1 and

2 respectively, above grade elevation (593'-6") and the fuel oil storage tank vent lines terminate 3' and 2'-8", for Units 1 and 2 respectively, above grade to prevent entrance of water. The fuel oil storage tank fill connection is 1'-7" above grade for both units. Each fill connection is provided with a locking dust cap and each vent line is down turned. The storage tanks can be filled and vented through the manway should the fill or vent lines become impaired.

9.5.4.2.2 Component Descriptions

Fuel is recirculated within the storage facility to prevent deterioration at the rate of 50 gpm at 30 psi by a recirculation pump. The pump is driven by a 3 HP, 575 volt, 3 phase, 60 Hz motor whose power source is the 600 VAC Unit Normal Auxiliary Power Supply (Section 8.3.1.1.1.5).

The motor driven fuel oil booster pump is normally isolated, both electrically and mechanically, but may be operated if required during maintenance to deliver fuel oil to the diesel at a rate of 8 gpm. The pump is driven by a 2 HP, 120 volt DC motor whose power source is the 125VDC Diesel Essential Auxiliary Power System (Section 8.3.1.1.3.11).

9.5.4.2.3 Instrumentation and Alarms

Each diesel generator engine is provided with sufficient instrumentation to monitor the operation of the fuel oil system. All alarms are separately annunciated on the local diesel engine control panel which also signals a general diesel trouble alarm in the control room. There are two redundant safety related interlocks provided on the fuel oil recirculation system. One interlock is provided to shutdown the recirculation pump in the event of a LOCA. The second interlock is provided to shutdown the recirculation pump should the fuel oil level in the storage tanks drop below Technical Specifications level. The fuel oil system is provided with the following instrumentation and alarms:

1. Fuel oil storage tanks –
   a. Low level and high level annunciators
   b. Tech spec low-low level alarm
   c. Level indication, 0-100%
   d. The capability for use of a stick gauge to measure the fuel oil level
2. Fuel oil day tank –
   a. Fuel oil transfer valve control
   b. High level alarm
   c. Low level alarm
   d. Level indication
3. Fuel oil strainers – (Engine-driven pump and motor-driven booster pump)

a. High differential pressure alarm -	Alerts the operator to take corrective action by manually switching over to the alternate clean strainer
b. Inlet and outlet pressure indication	

4. Fuel oil filter –

a. High differential pressure alarm - Alerts the operator to take corrective action by manually switching over to the alternate clean filter.

b. Differential pressure indication

c. Outlet pressure indication

d. Low fuel oil pressure alarm

5. Day tank retaining wall

   a. High and low level drain valve and lube oil transfer pump control High-high level alarm

   The periodic testing and maintenance of all diesel fuel oil system instruments is controlled by the Preventive Maintenance program. This program insures that instruments are periodically calibrated and tested, assuring reliability.

9.5.4.3 Safety Evaluation

The Diesel Generator Engine Fuel Oil System is a Duke Class C piping system with the exception of the Fuel Oil Recirculation System and the fuel oil storage fill line strainer which are Duke Class G piping systems. The Fuel Oil Recirculation System and the fuel oil storage tank fill line strainer are isolated from the essential Diesel Generator Fuel Oil System by normally closed Duke Class C isolation valves. The diesel engine and engine mounted components are constructed in accordance with IEEE-387. The off engine essential equipment and components and the nonessential (i.e., Fuel Oil Recirculation System) equipment and components are designed in accordance with the requirements of the codes listed in Table 3-4. The fuel oil system is designed and constructed in compliance with ANSI Standard N195, except in regards to an overflow line from the day tank, the flame arrestors on the storage tanks, and excluding all references to fuel oil transfer pumps. Flame arrestors have not been provided on the fuel oil storage tank vents or on the day tank vents. Based on sections 30 & 37 of the NFPA fire codes, No. 2 diesel fuel oil is a Class II combustible liquid (minimum flash point 125°F) which does not require installation of flame arrestors for either buried tanks or tanks installed inside of buildings.

Each diesel generator unit is housed separately in a Seismic Category I structure which forms one half of the Diesel Building, and the units themselves are fully independent and redundant for each nuclear unit. The results of a failure modes and effects analysis are presented in Table 9-37

The fuel oil storage capacity is based on continuous operation of the diesel generator engines at rated load for a period of seven days. A 10 percent margin in storage capacity is provided to preclude the necessity of refilling the tanks following routine performance testing. The exterior of carbon steel tanks and other underground carbon steel components is sandblasted to a SSPC-SP10-63, near white metal blast cleaning. A coal tar epoxy coating which meets the requirements of Corps of Engineers Specification C-200 and Government Specification MIL-P-23236 is applied to exterior surfaces at a dry film thickness of 16 mils. This coal tar epoxy is also applied to the exterior of stainless steel piping. In addition to being coated, the external surfaces of buried metallic piping and tanks are protected from corrosion by an impressed current cathodic protection system in accordance with NACE Standard RP-01-69 (1972 Revision).

The interior of the fuel oil storage tanks are not coated since the presence of fuel oil will act as a deterrent to internal corrosion. Requirements outlined in the Technical Specifications assure that the fuel oil storage tanks are maintained essentially full to provide a seven day supply. During surveillance intervals for sampling the fuel oil in the storage tanks outlined in the Technical Specifications, any accumulated water or sediment detected will be removed via the Fuel Oil Recirculation System. Based on worst meterological data (see FSAR Table 2-29), approximately 2 pounds of water (~ 1 quart) will condense per tank per year due to normal tank breathing (i.e., the volume displaced by fuel oil will be replaced with air-water vapor when fuel oil is consumed during normal monthly testing of the diesel). The fuel oil storage tanks are set at a level above the normal ground water table.

Diesel fuel oil 2D, as specified by ASTM D975, is normally delivered to the site by private carriers using 8,000 gallon tankers licensed by the ICC. Pipeline terminals are located in Greensboro, Salisbury, and Charlotte, North Carolina, and Spartanburg, South Carolina with suppliers also located in York, Rock Hill, and Gaffney, South Carolina. In addition, Duke Power owns two 6,000 gallon tankers which are stored at the Toddville warehouse in Charlotte. Diesel fuel oil would be available on one day's notice from the above sources. In case of adverse weather conditions, one additional day for delivery might be required. Therefore, if additional diesel fuel oil were ordered on the third day following a loss of offsite power event, additional supplies could be onsite by the fifth day. In the event of a probable maximum flood, however, it is postulated that all Catawba River bridges leading to the site would be impassable and delivery by truck would be impossible. In this case, air shipments of fuel oil could be arranged.

During normal operation of the diesel any accumulated sediment in the bottom of the fuel oil storage tanks is prevented from entering the supply line to the day tank since the outlet connection is raised t inches above the storage tank floor. Two half capacity fuel oil storage tanks per redundant diesel provide the ability to operate the diesel off one tank while isolating and filling the adjacent tank. Prior to the addition of new fuel oil during an accident the diesel would be aligned to one tank while the tank to be filled would be isolated through administrative control. In the event of an accident (blackout or LOCA), a sufficient reserve of fuel oil will be maintained to allow the diesel to operate off one storage tank while refilling the adjacent fuel oil storage tank.

To minimize the chances of a fire in the fuel oil system, piping is routed such that it is remote from other piping and equipment with potentially hot surfaces and from any source of open flame or sparks. The fuel oil day tank is surrounded by a wall which serves as a fire barrier and the redundant diesel engines are separated by three feet of steel-reinforced concrete.

There are no high energy lines within the Diesel Building and all moderate energy lines are properly supported and restrained to prevent damage to safety related systems, piping and components resulting from line failure.

9.5.4.4 Tests and Inspections

System components and piping are tested to pressures designated by appropriate codes. Inspection and functional testing are performed prior to initial operation; thereafter the system will be tested in accordance with the Technical Specifications.

9.5.5 Diesel Generator Engine Cooling Water System

9.5.5.1 Design Bases

The Diesel Generator Engine Cooling Water System is designed to maintain the temperature of the diesel general engine within an optimum operating range during standby and during full-load operation in order to assure its fast starting and load-accepting capability and to reduce thermal stresses. The system is also designed to supply cooling water to the engine lube oil cooler, the combustion air aftercoolers, and the governor lube oil cooler.

9.5.5.2 System Description

A separate and complete closed-loop cooling water system is provided for each diesel generator engine, receiving makeup water from the Demineralized Water System and uses as its sink the Nuclear Service water System (Figure 9-182). A surge tank, the jacket water standpipe located in the Diesel Building, provides positive suction pressure for the circulation pump and for the keep warm pump. The keep warm pump, which is electric motor-driven, operates continuously during engine standby to assure that the system is completely filled with water. When the diesel starts, the circulation pump, which is engine mounted and engine-driven, would operate to circulate cooling water through the closed loop system.

From the circulation pump, the cooling water passes through a three-way thermostatic control valve which regulates the flow of water through the shell side of the jacket water cooler by diverting varying amounts through a bypass line. From the jacket water cooler, the cooling water flows through the tube side of either the lube oil cooler or the combustion air aftercoolers and then through the engine itself, returning to the standpipe. A small fraction of the flow from the discharge side of the combustion air aftercooler is diverted to the engine governor lube oil cooler.

In order to keep the engine warm during standby, water which is circulated by the keep warm pump passes over a set of thermostatically-controlled electric heating elements before leaving the standpipe. From the keep warm pump, the water bypasses the jacket water cooler and thermostatic valve and thereafter follows the same path described above for the circulation pump flow. When the diesel starts and has attained rated speed, power to the heater and keep warm pump is automatically shut off and is automatically started when the diesel is shut down if the switch is in the auto mode.

Corrosion inhibiting agents will be added to the engine cooling water by means of a chemical pot feeder unit, which can be connected to the system and placed in service whenever necessary. These additives will be compatible with the materials which makeup the cooling water system, and will assure proper system performance by maintaining a water chemistry in accordance with Manufacturer's recommendations.

There are no minimum loading requirements for operation of the diesel generation engine. Testing of the Transamerica Delaval DSRV-16-4 (16 cylinder) diesel has proven the engines ability to operate at rated speed and unloaded for a minimum of seven days without degradation of the cooling water system performance nor of the load-accepting capability and reliability of the engine itself. This capability is inherent to the DSRV-16-4 engine design. There are no light load recommendations by Delaval for this engine. Test results are available for review. Station procedures require the diesel to be operated at a load specified by the manufacturer for no load-light load operations.

9.5.5.2.1 Component Descriptions

The diesel generator engine cooling water system removes heat from the engine lube oil system via the lube oil cooler. Oil flows on the shell side at the rate of 500 gpm. About 45% of the total cooling water flow passes through the engine lube oil coolers.

As combustion air leaves the turbocharger and before it enters the intake manifold, it passes through an aftercooler at the rate of 25,696 scfm. About 55% of the total cooling water flow passes through the turbocharger aftercoolers.

A small portion of the cooling water leaving the aftercooler is diverted to the engine governor lube oil cooler (approximately 1.5 gpm), but the resulting contribution to the total system heat balance is insignificant.

Total cooling water system flow (1550 gpm) circulates through the engine water jacket.

The nuclear service water system provides the heat sink for the cooling water system, flowing at 900 gpm through the tube side of the diesel generator engine jacket water cooler.

The jacket water keep warm pump provides a standby circulation flow of 50 gpm at 22 psi to maintain the engine in a warmed condition. The water is heated by an immersion-type heater in the jacket water standpipe. The pump is run by a 3.35 HP motor with the following characteristics: 557 volts, 3 phase, 60 Hz frequency. The heater is a 600 volts, 75 kw thermostatically-controlled unit. The source of power for each is the 600VAC Essential Auxiliary Power supply (Section 8.3.1.1.2.2).

A standpipe, with 600 gallon capacity, is provided in the cooling water system to accommodate coolant expansion and venting due to temperature changes and to compensate for system losses due to minor leaks and evaporation. The standpipe has a normal operating volume of 560 gallons and is equipped with a low level alarm which is set approximately 20 inches below the normal operating water level. Assuming that all the water between the alarm set level down to the minimum water level is available for system make-up, then there is potentially 173 gallons of water available to replace a leakage of up to 1 gallon per hour for seven (7) days of continuous operation. The engine-driven circulation pump requires an NPSH of 10 feet and the standpipe provides an available NPSH of 13 to 29.3 feet.

In the event a tube leak should develop in the jacket water cooler or the lube oil cooler, the Diesel Generator Cooling Water System would continue to maintain jacket water temperature. The Diesel Generator Cooling Water System operates at a lower pressure than the Nuclear Service Water system (sink) and the lube oil system. Leakage from either of these systems into the cooling water system would cause the jacket water standpipe to overflow into the Diesel Building sump. Initiation of the diesel sump pumps would activate a local alarm on the engine control panel and a common diesel alarm in the control room to alert the operator. The diesel, however, remains operable. Should a severe leak in the cooling water system develop, the jacket water low level alarm would alert the operator.

9.5.5.2.2 Instrumentation and Alarms

Each diesel generator engine is provided with sufficient instrumentation and alarms to monitor the operation of the cooling water system. All alarms are separated annunciated on the local diesel engine control panel which also signals a general diesel alarm in the control room. The following temperature, pressure, and level sensors will annunciate when they exceed the setpoints listed in Table 9-40.

1. Low-Pressure Jacket Water
2. Low-Level Jacket Water Standpipe
3. Low-Temperature Jacket Water In
4. Low-Temperature Jacket Water Out
5. High-Temperature Jacket Water In
6. High-Temperature Jacket Water Out Trip
7. High-High Temperature Jacket Water Out Trip

8. High Temperature Aftercooler water Level

The high-high temperature alarm will affect a diesel engine trip if the engine is in the test mode. This is to prevent damage to the engine. However, if such an alarm is received during the emergency mode (i.e., Blackout or LOCA) the trip signal is locked out and the engine continues to run. The high-high alarm in the emergency condition alerts the operator to prepare to switchover to the redundant diesel.

The engine jacket water inlet and outlet temperatures are also recorded by a multipoint recorder. The recorder is located on the generator control panel in the Diesel Building.

The periodic testing and maintenance of all diesel engine cooling water system instruments is controlled by the Preventive Maintenance program. This program insures that instruments are periodically calibrated and tested, assuring reliability.

9.5.5.3 Safety Evaluation

The Diesel Generator Engine Cooling Water System is a Duke Class C piping system. The diesel engine and engine mounted components are constructed in accordance with IEEE Standard 387. All essential off engine equipment and components are designed in accordance with the requirements of the codes listed in Table 3-4. Each diesel generator unit is house separately in a Seismic Category I structure which forms one half of the Diesel Building, and the unit themselves are fully independent and redundant for each nuclear unit.

The results of a failure modes and effects analysis are presented in Table 9-39.

In order to eliminate air pockets in the cooling water system, components and piping are vented during initial filling of the system. Once filled, the height of the vented jacket water standpipe ensures that both the keep-warm pump and circulation pump suction and the remaining system is filled with water. During standby and startup, any air trapped in the system is displaced by the pump discharge.

9.5.5.4 Tests and Inspections

System components and piping are tested to pressures designated by appropriate codes. Inspection and functional testing are performed prior to initial operation; thereafter, the system will be tested as required.

9.5.6 Diesel Generator Engine Starting Air System

9.5.6.1 Design Bases

The Diesel Generator Engine Starting Air System is designed to provide fast start capability for the diesel generator engine by using compressed air to rotate the engine until combustion begins and it accelerates under its own power.

The design basis of the Diesel Generator Engine Starting Air System is the ability of the system to support 5 successful engine starts without use of the air compressors.

9.5.6.2 System Description

9.5.6.2.1 General

Each diesel generator engine is provided with two independent starting air systems, each consisting of a compressor and aftercooler, a filter/dryer unit, air receivers, injection lines and valves, and devices to crank the engine as shown in Figure 9-183 and Figure 9-184.

Ambient air from within the diesel room is compressed. Cooled, filtered, dried, filtered again and then stored until needed in receiver tanks. The starting air storage capacity for each redundant diesel engine is sufficient for a minimum of five (5) successful engine starts without the use of the air compressor. Starting air is available for at least two automatic start attempts. If the diesel starting air pressure drops to ≤ 150 psig, automatic engine start lockout will occur. At 150 psig there is enough starting air remaining in the air receivers for at least three manual start attempts.

Starting air is supplied to the diesel generator engine by four starting air solenoid valves, with each valve supplying starting air to one end of the two cylinder banks on the engine. The starting air enters the left and right bank starting air manifolds which are interconnected within the engine to allow the capability of one or all the starting air solenoid valves operating to start the engine. From there, starting air is directed to both the left and right bank starting air distributors which admit the air to the individual cylinders on their respective banks, in firing order sequence (1L – 8R – 4L – 5R – 7L – 2R – 3L - 6R – 8L – 1R – 5L – 4R – 2L – 7R – 6L – 3R) to rotate the engine. The combined starting air manifold also supplies starting air to the governor oil pressure boost cylinder which acts as an accelerator pump to ensure the diesel attains rated speed within 11 seconds after receiving an automatic diesel start signal.

The starting air receiver tanks also supply air at reduced pressure to the engine control panel. Air enters the engine control panel where it is filtered and a self-contained pressure regulator maintains constant pressure of 60 PSI for the diesel shutdown to cylinder.

Relief valves on the compressor discharge line and on the air receiver tanks protect the starting air system from overpressurization.

9.5.6.2.2 Component Descriptions

The starting air compressors are driven by 8.7 HP, 575 volt, 3 phase, 60 Hz motors which are powered from the 600 VAC Essential Auxiliary Power Supply (Section 8.3.1.1.2.2). Each compressor discharges 24 scfm at 265 psia and the heat of compression is removed by a water-cooled aftercooler at the rate of 8600 Bu/hr. The drinking water system (Section 9.2.4.2.2) provides cooling water on the tube side.

To minimize the accumulation of moisture, the diesel engine starting air system is equipped with a multistage drying and filtering unit located in line between the aftercooler and the receiver tank. The air is first thrown through a cyclone-type moisture separator and is filtered before entering one of two alternating desiccant drying towers (alternating between active and regeneration cycles). The air is then filtered a second time before entering the receiver tank.

To minimize fouling of the starting air valves or filters with contaminants, drip-traps are provided on the cyclone-type moisture separator and the air dryer pre-filter to collect any oil carryover. Drains are also provided on the aftercooler and air receiver tanks. Periodic blowdown of the drip-traps and drain valves will minimize the buildup of contaminants in the starting air system. Strainers are provided upstream of the starting air solenoid valves to prevent rust carryover to the diesels.

Two starting air receiver tanks for each diesel engine provide 250 cubic feet of storage capacity. This capacity, as stated above, is sufficient to allow five (5) successful engine starts without the use of the compressor.

9.5.6.2.3 Instrumentation and Alarms

Each staring air receiver is equipped with a set of pressure switches which control the operation of the air compressor on its associated train; starting the compressor on low pressure and stopping the compressor on high pressure. Pressure gauges are located on the tanks for local indication with a low tank pressure alarm activated if the pressure falls to 220 psi. A pressure switch on the engine control panel alarms if the engine starting air manifold pressure falls to 160 psi. A pressure switch on the engine control panel alarms if the control air pressure upstream of the regulator falls to 80 psi.

If the starting air pressure to the starting air manifold drops to 150 psi with the engine failing to start, an automatic lockout will prevent further start attempts and an alarm alerts the operator to take corrective action. The automatic lockout ensures there will be sufficient reserve for a manual restart.

All starting air system alarms are annunciated separately on the local diesel engine control panel and signals a general diesel trouble alarm in the control room.

The periodic testing and maintenance of all diesel engine cooling water system instruments is controlled by the Preventive Maintenance program. This program insures that instruments are periodically calibrated and tested, assuring reliability.

9.5.6.3 Safety Evaluation

The Diesel Generator Engine Starting Air System is Duke Class F from the starting air compressor through the desiccant drying towers, and Duke Class C from the starting air receiver tank inlet check valve to the engine connections. The diesel engine and engine mounted components are constructed in accordance with IEEE Standard 387. The starting air receiver tank is designed in accordance with the requirements of the ASME Boiler and Pressure Vessel Code, Section III, Class 3. The starting air compressor and the starting air dryer are designed in accordance with the requirements of the codes listed in Table 3-4. Each diesel generator unit is housed separately in a Seismic Category I structure which forms one half of the Diesel Building, and the units themselves are fully independent and redundant for each nuclear unit. The results of the failure modes and affects analysis are presented in Table 9-41.

9.5.6.4 Tests and Inspections

System components and piping are tested to pressures designated by appropriate codes. Inspection and functional testing are performed prior to initial operation; thereafter, the system will be tested in accordance with the Technical Specifications.

Periodic blowdown of the starting air tanks is done to check for moisture. The frequency will be determined based upon operating experience.

Air dryer desiccant is inspected per the manufacturers recommendations (approximately every six months).

9.5.7 Diesel Generator Engine Lube Oil System

9.5.7.1 Design Bases

The Diesel Generator Engine Lube Oil System is designed to deliver clean lubricating oil to the diesel generator engine, its bearings and crankshaft, and other moving parts. By means of heaters, the lube oil system is designed to deliver warmed oil to the engine during standby to assure its fast-starting and load accepting capability. The system also provides a means by which used oil may be drained from the engine and its components, and replaced with clean oil.

9.5.7.2 System Description

9.5.7.2.1 General

Each diesel generator unit utilizes the “dry sump” lube oil system, in which the supply of lubricating oil for the engine is stored in a separate sump tank, independent of, and set a lower elevation than the engine crankcase. As oil accumulates in the crankcase, it drains by gravity into the 579-gallon sump tank. Additions of clean oil are made to the sump tank from an 8000-gallon storage tank located underground and outside the Diesel Building, and used oil is removed from the sump tank via a transfer pump to an 8000-gallon used oil storage tank for Unit 2 (see Figure 9-185, Figure 9-186, and Figure 9-187). For Unit 1, the transfer pump discharge is routed to a quick connect type fitting in the Diesel Generator Lube Oil System Pumpout Tank enclosure at ground level (see Figure 9-272).

The engine-driven lube oil pump picks up oil from the sump tank through a built-in suction pipe with foot valve and delivers the oil in sequence from the pump discharge first to the oil pressure regulating valves which limit the maximum pressure on the pump discharge, and then in series through the lube oil cooler, the full-flow lube oil filter and finally to the full-flow lube oil strainer. From the strainer, the oil enters the engine internal circulation system.

During engine standby, the motor-driven prelube oil pump operates continuously to ensure complete filling of the internal lube oil system. Oil which is circulated by the prelube oil pump passes over a set of thermostatically controlled electric heating elements before leaving the sump tank to maintain the engine in a warmed state. From the prelube oil pump, the oil passes in series through the prelube oil filter, the prelube oil strainer and enters the engine internal circulation system. A separate drip lube system provides a continuous, metered flow of oil to the turbocharger bearings during engine standby to ensure adequate bearing lubrication for startup.

The diesel generator engine crankcase is vented to the atmosphere through the roof of the Diesel Building. The lube oil filters and strainers are vented in the following manor; the pre-lube filters into the room through normally closed valves, the full-flow filters to the lube oil sump tank, and the pre-lube and full-flow strainers to the engine gearcase. The lube oil sump tank is vented to the atmosphere through the roof. The crankcase is equipped with blowout panels to prevent high pressures from damaging the engine.

The design lube oil storage tank is provided with an individual fill and vent line located outdoors. To prevent entrance of water into the storage tanks the vent and fill lines terminate 3 feet and 1’-7” respectively above grade elevation. The fill connection is provided with a locking dust cap and the vent is down turned.

Each diesel is provided with a 579 gallon capacity lube oil sump tank. The sump tank has a normal operating volume of 450 gallons and is equipped with allow level alarm which is set above technical specification surveillance requirement which is >400 gallons. From the low level alarm point to the minimum operating level there are approximately 400 gallons. With an established oil consumption rate of 1.2 gallons per hour at full load, this volume is sufficient to operate the diesel in excess of seven days without requiring replenishment.

Should it become necessary to make additions of lube oil to the diesel, lube oil is available in an 8,000 gallon storage tank located underground and outside the Diesel Building. A manually operated, positive displacement clean lube oil pump takes suction from the storage tank and discharges lube oil through a simplex filter (particle removal rating of 17 microns) to the intended diesel. The pump suction is raised 6 inches above the storage tank floor to prevent any accumulated water from entering the diesel lube oil sump tank. Accumulated water in the bottom of the storage tank is removed through a sample connection flush on the bottom of storage tank.

Catawba Nuclear Station has implemented the recommendations of IE Circular 80-05 concerning the additions of lube oil to an operating Diesel Generator (D/G) engine.

A station operating procedure addresses addition of makeup oil to the D/G engine. This procedure emphasizes that the D/G may be operating during the lube oil addition. Specific steps are also incorporated that require the operator to verify that the appropriate lube oil sump tank level changes as expected during the makeup process. The operating procedure has a section for receiving lube oil which includes the verification of lube oil type and quality through oil sample analysis. Sign off steps in the procedure require the operator to have the procedure on hand during all D/G lube oil evolutions. The procedure is filed in the control room area to ensure proper administrative controls.

The clean lube oil storage tank is currently drained. Olil addition to the engines is made via 55 gallon drums. Oil is pumped from the drums directly to the engine sump tanks. The clean lube oil storage tank system has not been abandoned and can be placed in service if desired.

Lubricating oil leakage is detected by:

1. Routine surveillance
2. Low lube oil sump levels alarm
3. Low lube oil pressure and alarm

System leakage into the lube oil system through the jacket water is minimized by the normal operating pressure of the lube oil being higher than the jacket water pressure. Oil leakage from the diesel is collected in a sump in the diesel room.

The truck fill connection for clean lubricating oil is locked and is keyed differently from other fill connections. Administrative controls govern the issuance of this key.

Periodic monitoring of the level instrumentation associated with the lube oil sump tank may indicate leakage of oil from the system. Corrections will be made in accordance with applicable operating and maintenance procedures. Makeup to the system is manually initiated from the clean oil storage tank.

9.5.7.2.2 Component Descriptions

During operation of the diesel generator engine, its lube oil system is cooled via each engine's lube oil cooler. The shell side flow of lube oil is cooled by the engine jacket water cooling system flowing on the tube side (Section 9.5.5). The lube oil cooler and the jacket water cooler performance basis is provided on each respective cooler's manufacturer drawing in the form of an included specification sheet.

The lube oil transfer pump moves oil at the rate 20 gpm at a pressure of 125 psi from the lube oil sump tank. For Unit 2, the transfer pump discharge is routed to the used oil storage tank. For Unit 1, the transfer pump discharge is routed to a quick connect type fitting in the Diesel Generator Lube Oil System Pumpout Tank at ground level. The pump is driven by 3HP, 575 volt, 3 phase, 60 Hz motor.

The prelube oil pump delivers warmed oil to the engine during standby at the rate of 50 gpm. The pump is driven by a 7.5 HP, 575 volt, 3 phase, 60 Hz motor.

Two lube oil sump tank heaters are provided to keep the oil warm and fluid during engine standby. The heaters are 600 volt, 24 kw immersion-type heaters.

The above-mentioned motors and heaters are powered from the 600 VAC Essential Auxiliary Power Supply (Section 8.3.1.1.2.2).

The clean lube oil transfer pump delivers oil from the clean lube oil storage tank to the lube oil sump tank at 20 gpm and 125 psi. It is driven by a 5 HP, 575 volt, 3 phase, 60 Hz motor.

The used lube oil transfer pump transfer oil from the used lube oil storage tank to a truck or tanker for disposal. The design flow rate is 100 gpm at 22 psi. The pump is driven by a 10 HP, 575 volt, 3 phase, 60 Hz motor.

The clean and used lube oil transfer pump motors are powered form the 600VAC Station Normal Auxiliary Power Supply (Section 8.3.1.1.1.6).

9.5.7.2.3 Instrumentation and Alarms

Each diesel generator engine is provided with sufficient instrumentation and alarms to monitor the operation of the lube oil system. All alarms are separately annunciated on the local diesel engine control panel which also signals a general diesel trouble alarm in the control room. The lube oil system is provided with the following instrumentation and alarms:

> The lube oil sump tank is equipped with a local level indicator along with a low level annunciator to alert the operator to take corrective action.
>
> The full flow filters are equipped with locally-mounted pressure gauges. A high differential pressure alarm alerts the operator to manually switchover to the alternate clean filter, there is no bypass.
>
> The engine mounted full flow strainers are equipped with a high differential pressure alarm which alerts the operator to manually switchover to the alternate clean strainer, there is no bypass.
>
> The diesel generator engine is equipped with both temperature and pressure monitoring systems with separate alarm and trip switches to alert the operator of abnormal operating conditions. Pressure and temperature alarm and trip setpoints are listed in Table 9-43. If a shutdown setpoint/alarm is exceeded while the engine is operating during the test mode, a diesel trip will automatically shutdown the engine to prevent incurring any damage.
>
> However, if such a shutdown/alarm is received during the emergency mode (i.e., Blackout or LOCA) the trip is locked out and the engine continues to run. The alarms alert the operator to prepare to switch over to the redundant diesel for power. Only a low-low engine lube oil pressure shutdown/alarm will trip the engine regardless of the diesel operating mode.
>
> The engine inlet and outlet lube oil temperatures are also recorded by a multipoint recorder. The recorder is located on the generator control panel in the Diesel Building.

The periodic testing and maintenance of all diesel engine lube oil system instruments is controlled by the Preventive Maintenance program. This program insures that instruments are periodically calibrated and tested, assuring reliability.

9.5.7.3 Safety Evaluation

The Diesel Generator Engine Lube Oil System is a Duke Class C piping system with the exception of the Clean and Used Lube Oil Transfer System which is a Duke Class G piping system. The two systems are separated by Duke Class C isolation valves. The diesel engine and engine mounted components are constructed in accordance with IEEE Standard 387. The off engine essential equipment and components and the nonessential (i.e., Clean and Use Lube Oil Transfer System) equipment and components are designed in accordance with the requirements of the codes listed in Table 3-4. Each diesel generator unit is housed separately in a Seismic Category I structure which forms half of the Diesel Building, and the units themselves are fully independent and redundant for each nuclear unit.

The results of a failure modes and effects analysis are presented in Table 9-42.

The exterior of carbon steel tanks and other underground carbon steel components is sandblasted to a SSPC-SP10-63, Near White Metal Blast Cleaning. A coal tar epoxy coating which meets the requirements of Corps of Engineers Specification C-200 and Government Specification MIL-P-23236 is applied to exterior surfaces at a dry film thickness of 16 mils. This coal tar epoxy is also applied to the exterior of stainless steel piping.

In addition to being coated, the external surfaces of buried metallic piping and tanks are protected from corrosion by an impressed current cathodic protection system in accordance with NACE Standard RP-01-69 (1972 Revision). Periodic monitoring, as described by the maintenance procedure, will remove any accumulated moisture from the tanks.

The governor lube oil coolers on the diesel generator engines (Delaval RV 16-4) are located at an elevation below the governor lube oil level, thereby, not affecting the starting reliability of the engines.

The interior of the clean lube oil storage tank is not coated since the presence of lube oil will act as a deterrent to internal corrosion. During the intervals for sampling the lube oil in the storage tanks, any accumulated water will be removed.

9.5.7.4 Tests and Inspections

System components and piping are tested to pressures designated by appropriate codes. Inspection and functional testing are performed prior to initial operation; thereafter the system will be tested in accordance with the Technical Specifications.

9.5.8 Diesel Generator Engine Air Intake and Exhaust System

9.5.8.1 Design Bases

The Diesel Generator Engine Air Intake and Exhaust System is designed to supply clean air for combustion to the diesel generator engine and to dispose of the engines exhaust. The system is housed in a building designed to withstand the effects of natural phenomena and credible missiles.

9.5.8.2 System Description

9.5.8.2.1 General

Each diesel generator is provided with a two pipe combustion air intake system. Combustion air is drawn in through in line air filters prior to entering the turbocharger.

Each diesel generator is provided with a two pipe exhaust system. The waterjacketed exhaust manifold discharges directly into the engine-mounted turbochargers. The exhaust piping then joins to pass through a single exhaust silencer and exits the building.

The diesel generator building arrangement is shown on Figure 9-189, Figure 9-190, and Figure 9-191. Additional details for the building's ventilation system intakes and the combustion air intakes is shown in Figure 9-192 and Figure 9-171.

Each diesel generator room is provided with three ventilation intake plenums. The two outer plenums provide outside and/or return air for the Emergency Ventilation System described in Section 9.4.4.2. The center plenum provides outside air for the Normal Ventilation System and the diesel generator combustion air intakes. During emergency operation, the combustion air intake and the ventilation air intakes are physically separate systems.

The two redundant diesel generator rooms serving each respective Catawba Unit are located adjacent to one another. Outside air intakes are located at one end of the building and exhausts (both Diesel and Ventilation System) at the opposite end of the structure. The intake and exhaust structures are separate for each diesel room and are similar in design. The structure utilizes missile shielding overhangs which in combination with the low intake face velocities ~ 300 (feet/minute) eliminates carryover of rain, snow, ice, or freezing rain. Each intake and exhaust structure is served by a 100% capacity floor drain. In addition a sump, formed by the 3 foot curb at the bottom of the intake and exhaust structures, provides over 3200 gallon capacity preventing accumulation of snow, ice, or freezing rain from interfering with emergency diesel generator system operation.

9.5.8.2.2 Component Descriptions

The turbocharger, driven by the hot exhaust gases on one side, compresses the intake air on the other side and forces it through the engine intercooler at the rate of 25,695 scfm.

The intercooler removes heat from the compressed intake air at the rate of 6,243,885 Btu/hr, decreasing the air temperature from 164°F to 149°F. Cooling water flows at 850 gpm through the tube side and its temperature increases from 149°F to 162°F.

9.5.8.2.3 Instrumentation and Alarms

Each diesel generator engine unit is provided with sufficient instrumentation and alarms to monitor the combustion intake and exhaust system. A multipoint recorder on the local generator control panel records the individual cylinder exhaust temperatures and the inlet and outlet turbocharger exhaust temperatures. The chart recorder will annunciate a high temperature alarm on the local diesel engine control panel and signal a general diesel trouble alarm in the control room if a cylinder temperature exceeds 1050°F. A high temperature will not effect a trip on the engine. A manual advance is also provided on the chart recorder to allow each individual cylinder to be checked as well as the inlet and outlet turbocharger exhaust temperatures.

9.5.8.3 Safety Evaluation

The Diesel Generator Engine Air Intake and Exhaust System is a Duke Class C piping system. The diesel engine and engine mounted components are constructed in accordance with IEEE Standard 387. The off engine essential components are designed in accordance with the requirements of the codes listed in Table 3-4. The intake filter, intake silencer, and exhaust silencer are not ASME Section III Class 3 code approved since no code built components are available. These components are seismically qualified by shaker table tests or analysis performed by the manufacturer. The components are installed in the Diesel Building with Seismic Category I restraints. Each diesel generator unit is housed separately in a Seismic Category I structure which forms one half of the Diesel Building. The units themselves are fully independent and redundant for each nuclear unit.

The intake air plenum and the exhaust gas plenum for each diesel generator unit are at opposite ends of the Diesel Building, approximately 100 feet apart. This fact and an analysis of the diesel generator engine exhaust using the Stumke model for buoyant plumes establish that the rise of the exhaust gases is sufficient to preclude the possibility of recirculation to the point that system integrity is jeopardized.

Normal ventilation flowrate is 5% of the diesel run mode ventilation flowrate. Normal ventilation is filtered (as described in Section 9.4.3.2.7) to maintain engine room cleanliness. All Diesel Building interior surfaces are painted to minimize concrete dust. These rooms are inspected periodically for cleanliness and cleaned as necessary. Diesel intake air is taken at a height of 10 feet above grade to minimize the intake of dust.

Onsite storage of gases consists of oxygen (two 51 cu. ft. cylinders), hydrogen (six 51 cu. ft. cylinders), and nitrogen (six 51 cu. ft. cylinders and one 3,000 gallon liquid storage tank). Oxygen and nitrogen are stored approximately 200 ft from Unit 1 Diesel Building (approximately 1,200 ft from Unit 2) and hydrogen is stored approximately 400 ft. from the Unit 1 Diesel Building (approximately 1,400 ft from Unit 2), and therefore, pose no threat to the proper operation of the diesel generator engines. The results of the failure mode and effects analysis are presented in Table 9-44.

A Fire Hazards Analysis of the Diesel Generator Building is found in Duke's ***[HISTORICAL INFORMATION IN ITALICS BELOW NOT REQUIRED TO BE REVISED]*** *"Response to Appendix A to Branch Technical Position APCSB 9.5-1".*

Primary fire protection is provided by an automatic carbon dioxide system. The system is activated by temperature detectors which alarm and annunciate in the control room. The circuit is supervised to annunciate control malfunctions.

Each diesel room is provided with electrically separate CO_2 actuation systems to preclude a common malfunction affecting both diesel rooms. Upon actuation alarms are given, the CO_2 System master valve opens-charging the supply header, ventilation systems shut down and the hazard selector valve opens discharging CO_2.

The CO_2 System piping would not remain intact during a seismic event, preventing discharge, although the diesel equipment will function during a CO_2 release. A "purge" switch located immediately outside the diesel room will utilize the ventilation system to remove CO_2.

Products of combustion will be contained by closing the ventilation system dampers early in the CO_2 detection/actuation sequence. The intake structures are separated by a 3-hour rated fire wall (approximately 20 ft. height). The volume of CO_2 discharged will not fill the intake structure preventing carryover into the adjacent structure. Excess CO_2 will exit through the lower exhaust structure openings (approximately 10 ft difference). Infiltration into the adjacent room's intake will not degrade diesel performance since the relay contacts, switch contacts and other electromechanical devices associated with starting/operation are housed in Class 1E, drip proof, bottom-entry NEMA 12 control panels. Process control devices located external to the control panels are NEMA 4 enclosures. In accordance with NEMA publication No. ISI.1-1977, NEMA 12 enclosures provide protection against fibers, flyings, lint, dust, dirt, light splashing seepage, dripping, and external condensation of non-corrosive liquids. NEMA 4 enclosures provide water-tight protection.

Manual hose stations are provided as a secondary fire protection system. Floor drains are provided to remove fire protection water if secondary means are needed in addition to the CO_2 System.

9.5.8.4 Tests and Inspections

System components and piping are tested to pressures designated by appropriate codes. Inspection and functional testing are performed prior to initial operation; thereafter, the system will be tested in accordance with the Selected Licensee Commitments.

9.5.9 Diesel Generator Room Sump Pump System

9.5.9.1 Design Bases

The Diesel Generator Room Sump Pump System is designed to remove leakage and equipment drainage from the Diesel Building.

While the Nuclear Service Water (RN) System is aligned in Single Supply Header Operation as described in 9.2.1.7, it will be necessary to maintain the WN Sump Pumps operable. This is because they will be required to handle a postulated passive single failure external leak of RN Piping in the D/G Rooms on a long term basis. The WN pumps have a capacity of 50 GPM, which is adequate capacity to provide long term handling of an external leak passive failure in a Diesel Generator room. The maximum assumed value for credible external passive failure leakage in the Diesel Generator Rooms is 50 GPM, which is conservative for a packing leak in a 10" butterfly valve.

Outside of RN Single Supply Header Operation, the WN Sump Pumps are not required for D/G Operability.

9.5.9.2 System Description

Two sump pumps, each with a design capacity of 50 gpm, are provided in each diesel generator room (one diesel generator unit per room). The pumps are located in the pit below the lube oil sump tank and discharge through the Service Building Sump Pump System to the Conventional Waste Water Treatment System (see Figure 9-193).

9.5.9.3 Safety Evaluation

The Diesel Generator Room Sump Pump System is a Duke Class C piping system. The system components are designed in accordance with the requirements of the ASME Boiler and Pressure Vessel Code, Section III, Class 3. Each diesel generator unit is house separately in a Seismic Category I structure which forms one half of the Diesel Building. The units themselves are fully independent and redundant for each nuclear unit, and therefore, they meet the requirements of the single failure criterion.

9.5.9.4 Tests and Inspections

System components and piping are tested to pressures designated by appropriate codes. Inspection and functional testing are performed prior to initial operation; thereafter, equipment not in continuous use is subject to periodic testing and visual inspection.

9.5.10 Containment Air Release and Addition System

9.5.10.1 Design Bases

The Containment Air Release and Addition System (VQ) is designed to provide a means of controlling the containment pressure between 0.3 psig and –0.1 psig during normal plant operations including start-up and shutdown transients. Containment pressure fluctuations due to postulated accidents are mitigated by safety related systems, rather than the Containment Air Release and Addition System.

Capacity is based on consideration of the estimated in leakage rate of air into the containment, the limits of 10CFR 50 and Appendix I for routine releases, and the limits of 10CFR 100 assuming concurrent loss of coolant accident and fan discharge. Also the capacity is such that the differential pressure from lower containment to upper containment is small enough to prevent the ice condenser doors from opening.

The containment air release fans are automatically shut off when the containment pressure is depressed to 0 psig to limit the impact on ECCS back pressure analysis and Containment negative pressure analysis.

The Containment isolation valves will automatically shut on an engineered safety signal to prevent containment air from being purged to the atmosphere during a loss of coolant accident or a steam break accident.

A comparison of the design of the VQ system to Branch Technical Position CSB 6-4 is given in Table 9-45.

9.5.10.2 System Description

The Unit 1 Containment Air Release and Addition System is shown on Figure 9-194. Each unit is provided with an identical system. Each system consists of two redundant containment air release filters for removing radioactive iodines and particulates, two redundant containment air release fans, and associated valves, piping, and instrumentation.

Containment pressure increase may result from heatup of the containment atmosphere during start-up, leakage of air supplied to control and other air operated valves, or Nitrogen or Breathing Air System leakage.

Containment pressure reduction is accomplished by removing air from the upper containment. Containment pressure build-up is expected to result from leakage in the lower containment, but upper containment exhaust is preferred since it reduces the consequences of a loss of coolant accident concurrent with discharge. The open area between upper and lower containment is adequate to allow for equilibration of upper and lower containment for the range of pressure under consideration.

When the pressure inside the Containment increases to a set value an alarm is set off in the control room. After it is determined that the pressure increase was not due to a loss of coolant or steam break accident and the containment air chemistry has been determined, the containment air is purged to the unit vent by opening valves 1VQ10, 1VQ2A, and 1VQ3B, then starting one fan. The flow rate and volume of air purged from the Containment is monitored to ensure that station does not exceed any radiation release limits. Valve 1VQ10 automatically closes on a high radiation signal from a radiation monitor located in the unit vent and valves 1VQ2A and 1VQ3B automatically close on a containment high radiation signal. When the pressure is decreased to 0 psig, valve 1VQ10 automatically closes and the fan automatically shuts off.

Containment pressure decrease may result from overcooling during a unit shutdown. An alarm is set off in the control room when the pressure inside the Containment has decreased to a set value. Air is then added to the Containment from the Auxiliary Building by opening valves 1VQ15B, 1VQ16A, and 1VQ13. Valves 1VQ15B and 1VQ16A automatically close on a high containment radiation signal. After the containment pressure increases to 0 psig, valve 1VQ13 automatically closes.

9.5.10.3 Safety Evaluation

The Containment Air Release and Addition System is only used for controlling Containment pressure during normal unit operation. Other than containment isolation, the system serves no safety related function.

Containment pressure fluctuations due to postulated accidents are mitigated by safety related systems other than the Containment Air Release and Addition System.

Isolation valves are located both inside and outside of the Containment on each containment penetration. Each train related containment isolation valve receives independent emergency diesel power and will close on a engineered safety feature actuation signal. The purge flow rate and containment isolation valve closure time will limit the amount of Containment air escaping to the atmosphere if there is a concurrent air release or addition and loss of coolant accident so that the release is within the limits of 10CFR 100.

Filters are provided on the air release lines to remove radioactive iodines and particulates prior to discharge to the atmosphere.

9.5.10.4 Test and Inspection Requirements

The Containment Isolation System is functionally tested under conditions of normal operation in accordance with the procedure outlines in Chapter 14 to ensure that all valves close properly and that containment total leakage requirements are met.

Preoperational tests were performed to insure proper fan operation and flow paths.

9.5.10.5 Instrumentation Requirements

9.5.10.5.1 Pressure Instrumentation

Containment pressure instrumentation is provided to give control room indication of containment pressure, alarm when containment pressure inside containment increases to + 0.125 psig, shut valve 1VQ10 when containment pressure decreases to 0.00 psig, alarm when containment pressure decreases to –0.03 psig, and shut valve 1VQ13 when containment pressure increases to 0.00 psig.

Local indication is given of differential pressure across the prefilter and HEPA filters within each filter train.

9.5.10.5.2 Flow Instrumentation

The volume of air released from containment is controlled by valve 1VQ10. Flow rate and totalized flow indication for the air released out of containment is provided on the controller for 1VQ10 in the control room.

Instrumentation is provided to automatically shut off the containment air release fans when low flow is detected.

9.5.11 Groundwater Drainage System

Note:

This section of the FSAR contains information on the design bases and design criteria of this system/structure. Additional information that may assist the reader in understanding the system is contained in the design basis document (DBD) for this system/structure.

9.5.11.1 Design Bases

The Groundwater Drainage System (WZ) is designed to relieve hydrostatic pressure from the Auxiliary and Turbine Buildings by discharging groundwater collected in sumps to the yard drains. The Auxiliary Building portion of the system is safety related because it protects a Category 1 seismic structure. Therefore, the Auxiliary Building subsystem is classified as ANS Safety Class 3, seismic design is required on all components, and missile barriers are required for sumps. Parts and Components are designed to meet ASME Section III Class 3. Sump pumps A2, B1, C1 and C2 are QA Condition 4 components.

9.5.11.2 System Description

The Groundwater Drainage System is shown on Figure 9-195 and Figure 9-196.

The Auxiliary Building has three sumps and the Turbine Building has two sumps (one per unit). The underdrainage grid drains to the groundwater drainage sumps are described in Section 2.4.13.5.

Each sump contains two groundwater drainage sump pumps and associated valves and piping. The pumps located in the Auxiliary Building sumps receive emergency diesel power with each pump supplied from a different train of emergency power. Each sump pump is capable of discharging 300 GPM.

When the water level in a sump reaches a set level, one of the pumps will automatically start. The discharge piping from the Auxiliary Building terminates at the Building wall or nearby yard drain. The Turbine Building piping may be routed to the nearest yard drain. If the water level continues to rise to a second set level, the second pump will automatically start. When the water level reaches a low level both pumps will automatically stop.

Table 9-46 presents the Groundwater Drainage System component design parameters.

9.5.11.3 Safety Evaluation

The Auxiliary Building subsystem is safety related because it protects a Category 1 seismic structure. Therefore, the Auxiliary Building sump pumps and their associated discharge valves are classified Safety Class 3. However, only Auxiliary Building sump Pumps A1 and B2 are classified as QA Condition 1. Each of these pumps is independently capable of maintaining the groundwater level for the Auxiliary-Reactor Building area. Each of the two pumps have separate Diesel Generator power supplies. Thus, single failure of either Pump A1 or Pump B2 will not degrade WZ System performance below system requirements.

9.5.11.4 Tests and Inspections

System components and piping are tested to pressures designated by appropriate codes. Functional tests are performed before initial operation.

9.5.11.5 Instrumentation Application

A level switch in each sump starts the respective groundwater drainage sump pump on high level.

Another level switch in each sump starts the second groundwater drainage sump pump on high-high level and sets off an alarm in the control room.

Both pumps will stop on low level.

THIS IS THE LAST PAGE OF THE TEXT SECTION 9.5.

THIS PAGE LEFT BLANK INTENTIONALLY.