CHAPTER 3

PLANT DESCRIPTION

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CHAPTER 3

PLANT DESCRIPTION

3.0 PLANT DESCRIPTION

This chapter discusses the proposed construction and operation of two nuclear generating units at the Lee Nuclear Site. The parameters associated with the station appearance, water use, transmission facilities, and its relationship to the surrounding area are described in the following sections:

- External Appearance and Plant Layout (Section 3.1)
- Reactor Power Conversion System (Section 3.2)
- Plant Water Use (Section 3.3)
- Cooling System (Section 3.4)
- Radioactive Waste Management System (Section 3.5)
- Nonradioactive Waste Systems (Section 3.6)
- Power Transmission System (Section 3.7)
- Transportation of Radioactive Materials (Section 3.8)

This Environmental Report (ER) identifies and evaluates the design parameters, site characteristics, and site interface values for the two proposed units. For purposes of this ER, the site is defined as the property within the Lee Nuclear Station owner-controlled area, or the site boundary line. The vicinity is the area within a 6-mile (mi.) radius from the centerpoint of the site. The region of the site is the area within a 50-mi radius from the centerpoint of the site.

3.1 EXTERNAL APPEARANCE AND PLANT LAYOUT

The Lee Nuclear Station is located in the eastern portion of Cherokee County in north central South Carolina on a site, encompassing approximately 1900 acres. It is on the west side of the Broad River at a point about 35 miles (mi.) southwest of Charlotte, North Carolina; 25 mi. northeast of Spartanburg, South Carolina; and 7.5 mi. southeast of Gaffney, South Carolina. Within South Carolina, the closest village center to the Lee Nuclear Station site is the unincorporated village of Cherokee Falls, which is approximately 2 mi. to the northwest.

The site boundary line is illustrated in Figure 1.1-3. The exclusion area boundary is illustrated in FSAR Figure 2.1-209. The access highway and railroad to the site as well as the highways, railways and waterways in the vicinity of Lee Nuclear Station are illustrated in Figure 1.1-2.

Figures depicting site features and structures include:

- The gaseous release points and their elevations are discussed in Sections 3.5 and 3.6. Structure locations are depicted in FSAR Figure 1.1-202.
- The liquid release points and their elevations are discussed in Section 3.6. Structure locations are depicted in FSAR Figure 1.1-202.
- The location of the meteorological towers is illustrated in FSAR Figure 2.3-247.
- The waste water retention basin (WWRB) is illustrated in FSAR Figure 1.1-202.
- The construction zone is illustrated in Figure 3.1-1.
- The land to be cleared is illustrated in Figure 4.3-1.

The Lee Nuclear Station contains two units comprised of five principal building structures each consisting of the nuclear island, turbine building, annex building, diesel generator building, and radwaste building. The structures that make up each nuclear island are the containment building, shield building, and auxiliary building.

The containment building, a seismic Category 1 structure, is a freestanding cylindrical steel containment vessel with elliptical upper and lower heads. It is surrounded by a seismic Category I reinforced concrete shield building. In conjunction with the internal structures of the containment building, the shield building provides the required shielding for the reactor coolant system and the other radioactive systems and components housed in the containment. The auxiliary building is a seismic Category I reinforced concrete structure. It shares a common basemat with the containment building and the shield building.

The annex building is a combination reinforced concrete and steel framed structure with insulated metal siding.

The diesel generator building is a single-story steel-framed structure with insulated metal siding.

The turbine building is a steel column and beam structure. Additional plant structures are shown in FSAR Figure 1.1-202 including the switchyard and transmission towers, warehouses and administration/office buildings, the intake and outlet structures as well as various ponds and basins.

The circulating water system (CWS) for the units includes six mechanical-draft cooling towers (three for each unit). The Broad River is used for make up water for the circulating water and auxiliary cooling systems. The Unit 1 cooling tower pad is located west of the Unit 1 nuclear island; the Unit 2 cooling tower pad is located east of the Unit 2 nuclear island. Locations of the cooling towers are shown in Figure 1.1-202.

In addition to the CWS cooling towers, the units also require service water system towers. These mechanical-draft cooling towers are located within the power block.

The overall plant arrangement is such that building configurations and structural designs minimize the building volumes and quantities of bulk materials (concrete, structural steel, rebar) consistent with safety, operational, maintenance, and structural needs to provide an aesthetically pleasing effect. Natural features of the site are preserved as much as possible and utilized to reduce the station's impact on the environment. Landscaping is planned for the site, areas adjacent to the structures, and in the parking areas to blend with the natural surroundings in order to reduce visual impacts. Most of the planned landscaping materials occur naturally in the locality.

Photographs which show the station from several vantage points where a visual impact may be expected are included in Figures 3.1-2 to 3.1-6. These photographs have been modified to depict the likeness of the AP1000 Units as proposed in this ER. As shown on the photographs, very little or no visual impact is expected from most vantage points. Figure 3.1-2 illustrates the visual impact from a local educational vantage point. Figure 3.1-3 illustrates the visual impact from a local industrial site and Figure 3.1-4 from a cultural vantage point. Figure 3.1-5 illustrates the visual impact from a local transportation corridor. Figure 3.1-6 illustrates the appearance of the Lee Nuclear Site with the proposed units.

3.2 REACTOR POWER CONVERSION SYSTEM

The Lee Nuclear Station is a dual-unit site with Westinghouse AP1000 pressurized water reactors. The architect-engineer is discussed in Final Safety Analysis Report (FSAR) Section 1.4. Major components for each unit include a single reactor pressure vessel, two steam generators (SGs) and four reactor coolant pumps for converting reactor thermal energy into steam. One high-pressure turbine and three low-pressure turbines drive a single electric generator. Figure 3.2-1 provides a simplified diagram of the reactor power conversion system.

Each reactor has a rated core thermal power of 3400 Megawatts thermal (MWt) and a nuclear steam supply system (NSSS) thermal output of 3415 MWt. The rated gross electrical power is 1,199.5 Megawatts electric (MWe). The rated net electrical power is at least 1000 MWe.

The reactor contains a matrix of fuel rods assembled into 157 mechanically identical fuel assemblies along with control and structural elements. The assemblies, containing various fuel enrichments, are configured into the core arrangement located and supported by the reactor internals. The reactor internals also direct the flow of the coolant past the fuel rods. The coolant and moderator are light water at a normal operating pressure of 2250 pounds per square inch absolute (psia). The fuel, internals, and coolant are contained within a heavy-walled reactor pressure vessel. A fuel assembly consists of 264 fuel rods in a 17x17 square array.

AP1000 fuel characteristics are provided in DCD Table 4.1-1.The fuel rods consist of enriched uranium, in the form of cylindrical pellets of uranium dioxide contained in ZIRLO™ tubing, with an initial enrichment of 2.35 to 4.45 weight (wt.) percent uranium 235 (U-235). The average concentration of U-235 in reloads is 4.51 wt. percent. The total weight of uranium dioxide is 211,588 pounds(lb.). Reload core designs, as well as the initial cycle design, are anticipated to operate approximately 18 months between refueling, accumulating a cycle burnup of approximately 21,000 megawatt-days per metric tons of uranium (MWD/MTU). The U.S. Nuclear Regulatory Commission (NRC) has approved maximum fuel rod average burnup of 60,000 MWD/MTU. Extended burnup to 62,000 MWD/MTU has been established for the AP1000 in DCD Subsection 4.3.1.1.1 and Subsection 3.8.2.3. The NRC allows a maximum fuel burnup of 60,000 MWD/MTU in Title 10 Code of Federal Regulations (CFR) 51.52 (a).

The Zirlo™ tubing is plugged and seal-welded at the ends to encapsulate the fuel. An axial blanket composed of fuel pellets with reduced enrichment may be placed at each end of the enriched fuel pellet stack to reduce the neutron leakage and to improve fuel utilization.

The reactor is connected to two SGs via two primary hot leg pipes and four primary cold leg pipes. A reactor coolant pump is located in each primary cold leg pipe to circulate pressurized reactor coolant through the reactor core. The coolant flows through the reactor core, making contact with the fuel rods containing the enriched uranium dioxide fuel. As the coolant passes through the core, heat from the nuclear fission process is transferred from the fuel rods to the coolant. The heat is transported to the SGs by the circulating reactor coolant and passes through the SG tubes to heat the feedwater from the secondary system. Reactor coolant is pumped back to the reactor by the reactor coolant pumps, where it is reheated to start the heat transfer cycle over again. Inside the SGs, the heat from the primary system is transferred through the tube walls to convert the incoming feedwater from the secondary system into steam. The steam is transported from the SGs by the main steam piping to drive the high-pressure and low-pressure turbines connected to the electric generator. After passing through three low-pressure turbines, the steam is condensed back to water by cooled water circulating inside the tubes of three main condensers. The heat rejected in the main condensers is removed by the circulating water system. The condensate is then preheated and pumped back to the SGs as feedwater to repeat the steam cycle.

3.2.1 ENGINEERED SAFETY FEATURES

Engineered safety features protect the plant workers and the public in the event of an accidental release of radioactive fission products from the reactor coolant system. The engineered safety features function to localize, control, mitigate, and terminate such accidents and to maintain radiation exposure levels to the public below applicable limits and guidelines, such as those in 10 CFR Part 20. The following subsections describe Lee Nuclear Station design elements that are defined as engineered safety features.

3.2.1.1 Containment

The containment vessel is a free standing cylindrical steel vessel with ellipsoidal upper and lower heads. It is surrounded by a Seismic Category I reinforced concrete shield building. The function of the containment vessel, as part of the overall containment system, is to contain the release of radioactivity following postulated design basis accidents. The containment vessel also functions as the safety-related ultimate heat sink by transferring the heat associated with accident sources to the surrounding environment. Subsection 3.2.1.1.1 further explains the function of this safety-related feature.

3.2.1.1.1 Passive Containment Cooling System

The function of the passive containment cooling system is to maintain the temperature below a maximum value and to reduce the containment temperature and pressure following a postulated design basis event. The passive containment cooling system removes thermal energy from the containment atmosphere. The passive containment cooling system also serves as the safety-related ultimate heat sink for other design basis events and shutdowns. The passive containment cooling system limits the release of radioactive material to the environment by reducing the pressure differential between the containment atmosphere and the external environment. This diminishes the driving force for leakage of fission products from the containment to the atmosphere in the event of a postulated design basis accident.

3.2.1.2 Containment Isolation System

The major function of the containment isolation system is to provide containment isolation to allow the normal or emergency passage of fluids through the containment boundary while preserving the integrity of the containment boundary, if required. This prevents or limits the escape of fission products that may result from postulated accidents. Containment isolation provisions are designed so that fluid lines penetrating the primary containment boundary are isolated in the event of an accident. This minimizes the release of radioactivity to the environment.

3.2.1.3 Passive Core Cooling System

The primary function of the passive core cooling system is to provide emergency core cooling following postulated design basis events. The passive core cooling system provides reactor coolant system makeup and boration during transients or accidents where the normal reactor coolant system makeup supply from the chemical and volume control system is lost or is insufficient. The passive core cooling system provides safety injection to the reactor coolant system to provide adequate core cooling for the complete range of loss-of-coolant accident events up to, and including, the double-ended rupture of the largest primary loop reactor coolant system piping. The passive core cooling system provides core decay heat removal during transients, accidents, or whenever the normal heat removal paths are lost.

3.2.1.4 Main Control Room Emergency Habitability System

The main control room emergency habitability system is designed so that the main control room remains habitable following a postulated design basis event. With a loss of all alternating current power sources, the habitability system maintains an acceptable environment for continued operating staff occupancy.

3.2.1.5 Fission Product Control

Post-accident safety-related fission product control is provided by natural removal processes inside containment, the containment boundary, and the containment isolation system. The natural removal processes, including various aerosol removal processes and pool scrubbing, remove airborne particulates and elemental iodine from the containment atmosphere following a postulated design basis event.

3.2.2 TURBINE-GENERATOR

The turbine-generator system is designed to change the thermal energy of the steam flowing through the turbine into rotational mechanical work, which rotates a generator to provide electrical power. It consists of a double-flow, high-pressure cylinder (high-pressure turbine) and three double-flow, low-pressure cylinders (low-pressure turbines) that exhaust to the condenser. It is a six-flow, tandem compound, 1800 revolutions per minute (rpm) machine. The turbine system includes stop, control, and intercept valves directly attached to the turbine and in the steam flow path, and crossover and crossunder piping between the turbine cylinders and the moisture separator reheater. The design is provided as the standard design in DCD Chapter 10.

Each turbine generator has an output of approximately 1199.5 MWe for the NSSS thermal output of 3415 MW. The generator rating is 1,375,000 kilovolt ampere (kVa) with a power factor of 0.9. The systems of the turbine cycle have been designed to meet the maximum expected turbine generator conditions.

The significant design features and performance characteristics for the major power conversion system components are listed in DCD Table 10.1-1. Turbine generator and auxiliaries design parameters are listed in DCD Table 10.2-1.

The main condenser is a three-shell, single-pass, multi-pressure, spring-supported unit with a total surface area of 12.36 $x10^5$ square feet (ft^2) or 4.12 $x10^5$ ft^2 per shell available for heat transfer. Each shell is located beneath its respective low-pressure turbine. The condenser is equipped with titanium tubes. The titanium material provides good corrosion and erosion resisting properties.

In a multipressure condenser, the condenser shells operate at slightly different pressures and temperatures. Condensate from the low pressure condenser shell drains through internal piping to the high pressure (hottest) shell where it is slightly heated and mixed with condensate in the high pressure shell. This condensate then flows through a single outlet to the suction of the condensate pumps.

The condenser shells are located below the turbine building operating floor and are supported on a spring-mounted foundation from the turbine building basemat. A rigid connection is provided between each low-pressure turbine exhaust opening and the steam inlet connections of the condenser. Two low-pressure feedwater heaters are located in the neck area of each condenser shell. Piping is installed for hotwell level control and condensate sampling.

Main Condenser design data are presented in DCD Table 10.4.1-1.

3.3 PLANT WATER USE

The Lee Nuclear Station generating units require water for both plant cooling and plant operations. The plant water consumption and water treatment are determined from the AP1000 Design Control Document, site characteristics, and engineering evaluations. The source of water for the station is the Broad River.

Raw water is required to support the needs of a new facility during operation, including the requirements of the normal heat sink main circulating water system. Water from the raw water clarifier supplies cooling water systems for plant auxiliary components (e.g., service water, fire protection, and demineralized water systems). Potable water is required for human consumption, sanitary, and other domestic purposes.

Subsection 3.3.1 discusses water consumption by the various cooling and other water use systems and the discharges from these systems. Subsection 3.3.2 discusses methods of treatment of water used in the plant and discharged back to the Broad River.

Figure 3.3-1 is a water balance summary for Lee Nuclear Station Units 1 and 2. Table 3.3-1 provides estimates of water use and blowdown discharged. The blowdown discharges upstream of the Ninety-Nine Islands Dam. Average and maximum water consumption is given in Table 2.3-14 along with maximum, average, and 7Q10 stream flowrates. Monthly stream flow values are given in Table 2.3-3 for USGS station 02152551 on the Broad River below Cherokee Falls.

3.3.1 WATER CONSUMPTION

3.3.1.1 Raw Water Sources

Waste heat is transferred from the main condenser to the atmosphere through the circulating water system (CWS). Makeup water from the Broad River is used to replenish water losses due to evaporation, drift and blowdown. Flowrates are as shown on Figure 3.3-1 and are tabulated in Table 3.3-1. During periods when Broad River flow is below the 7Q10 value, makeup water is supplied by the onsite ponds. A discussion of operations during periods of low flow is presented in Subsection 5.3.1.1.3. Cooling tower blowdown is routed along the reservoir side of the Ninety-Nine Islands Dam and discharged upstream of the dam.

A more detailed description of the CWS is presented in Section 3.4, Cooling System.

3.3.1.2 Service Water System

The Service Water System (SWS) supplies cooling water to remove heat from the nonsafety-related component cooling water system (CCS) heat exchangers in the turbine building. Cooling is supplied through a closed loop system using heat exchangers and mechanical draft cooling towers. The cooling towers require makeup water from the raw water clarifier to replace losses due to evaporation, drift, and blowdown. An alternative makeup water supply is available by gravity flow from one of the fire protection storage tanks, using water that is not dedicated to fire protection purposes. Flowrates are as shown on Figure 3.3-1 and are tabulated in Table 3.3-1.

The SWS is shown in DCD Figure 9.2.1-1. The system consists of two 100-percent-capacity service water pumps, automatic backwash strainers, a two-cell cooling tower with a divided basin, and associated piping, valves, controls, and instrumentation.

The service water pumps, located in the turbine building, take suction from piping which connects to the basin of the service water cooling tower. Service water is pumped through strainers to the component cooling water heat exchangers for removal of heat. Heated service water from the heat exchangers then returns through piping to a mechanical draft cooling tower where the system heat is rejected to the atmosphere. Cool water, collected in the tower basin, flows through fixed screens to the pump suction piping for recirculation through the system.

A small portion of the service water flow is normally diverted to the CWS. This blowdown is used to control levels of solids concentration in the SWS. An alternate blowdown flow path is provided to the Waste Water System. All discharges will be in accordance with applicable Federal, State and Local requirements (e.g., National Pollution Discharge Elimination Standards and Clean Water Act requirements). This is further detailed in Section 5.2.

A more detailed discussion of the SWS is presented in Section 3.4.

3.3.1.3 Demineralized Water Treatment System

The Demineralized Water Treatment System (DTS) receives water from the clarifier, processes this water to remove ionic impurities, and provides demineralized water to the Demineralized Water Transfer and Storage System (DWS). The design flow for makeup water to the DWS is given in Table 3.3-1. The DWS provides a reservoir of demineralized water to supply the condensate storage tank and for distribution throughout the plant. In addition to supplying water for makeup of systems which require pure water, the demineralized water is used to sluice spent radioactive resins from the ion exchange vessels in the chemical and volume control system, the spent fuel pool cooling system, and the liquid radwaste system to the solid radwaste system.

3.3.1.4 Potable Water System

The Potable Water System (PWS) is designed to furnish water for domestic use and human consumption. Potable water is supplied by the Draytonville Water District. Potable water flowrate is given in Figure 3.3-1.

3.3.1.5 Fire Protection System

The fire protection system (FPS) provides water to points throughout the plant where wet system type fire suppression (e.g., sprinkler, deluge, etc.) may be required. The FPS is designed to supply fire suppression water at a flow rate and pressure sufficient to satisfy the demand of any automatic sprinkler system plus 500 gpm for fire hoses for a minimum of two hours. Raw water for the FPS is provided from the raw water clarification system. The make up flowrate to the FPS is estimated to be 625 gpm, based on the requirements to refill one 300,000 gallon tank within an 8-hour period.

3.3.2 WATER TREATMENT

This section describes water treatment processes for plant potable, cooling and recirculating systems, including the purposes of the processes and the types of chemicals used. A detailed description of treatment system operating procedures, including plant operational and seasonal variations, is provided in Section 3.6. Section 3.6 describes the nonradioactive waste streams that are expected at Lee Nuclear Station, Units 1 and 2. Section 3.6 describes the frequency of treatment for each of the normal modes of operations, as well as the specific identities, quantities and points of addition of chemical additives.

A clarification subsystem will be used to reduce the amount of total suspended solids (TSS) in the raw water system that provides makeup to the service and demineralized water systems. The Clarification subsystem will treat the raw water with sodium hypochlorite to control microbiological growth. If required, an adjustment will be made for pH control (sulfuric acid) in the Raw Water System (RWS) to optimize the coagulation and flocculation process. A coagulant (aluminum sulfate) and coagulant aid (polymer) will be used in the clarification process. An additional polymer feed shall be used in sludge conditioning.

A more detailed discussion of the clarification subsystem is given in Section 3.6.

3.3.2.1 Circulating Water System

Circulating water chemistry, including blowdown and make up water from the Broad River, is maintained by the turbine island chemical feed system. Turbine island chemical equipment injects the required chemicals into the circulating water downstream of the CWS pumps. This maintains a noncorrosive, nonscale-forming condition and limits the biological film formation. The formation of biological film reduces the heat transfer rate in the condenser and the heat exchangers supplied by the CWS.

The chemicals used can be divided into six categories based upon function: biocide, algaecide, pH adjuster, corrosion inhibitor, scale inhibitor, and a silt dispersant. The pH adjuster, corrosion inhibitor, scale inhibitor, and dispersant are metered into the system continuously or as required to maintain proper concentrations. The biocide application frequency may vary with seasons. The algaecide is applied, as necessary, to control algae formation on the cooling towers.

Raw water treatment requirements are highly dependent on the water quality of the raw water supply which also experiences seasonal variations. The Broad River provides the source of make-up water for the CWS. The Lee Nuclear Station utilizes oxidizing chemistry (e.g., sodium hypochlorite, sodium bromide, etc.) for the control of bio-fouling and the growth of algae. Sulfuric acid is added, as necessary, to adjust the pH of the CWS. During periods of high river water turbidity or other conditions when deposition may lead to an increase in microfouling, silt dispersants such as polyacrylate may be used to minimize deposition within the CWS. Based on the materials of construction for the CWS, Lee Nuclear Station has not identified a need for a corrosion inhibitor. Based on an effective pH control program and the constituency of the dissolved and suspended solids found in the Broad River, no need for a scale inhibitor has been identified.

Duke Energy operates the Catawba Nuclear Station (CNS) which draws its intake water from Lake Wylie on the Catawba River. The Catawba River drains the water shed immediately to the East of the Broad River Basin. Based on a similarity of the water chemistry produced by the two water sheds and the similarity in construction of the cooling towers for these plants, CNS was used as a model for the design of the chemical treatment program for the CWS at Lee Nuclear Station.

Addition of biocide and water treatment chemicals is performed by turbine island chemical feed injection metering pumps and is adjusted as required. Chemical concentrations are measured through analysis of grab samples from the CWS. Residual chlorine is measured to monitor the effectiveness of the biocide treatment.

Chemical injections are interlocked with each circulating water pump to prevent chemical injection when the circulating water pumps are not running.

3.3.2.2 Service Water System

As with the CWS, service water chemistry is maintained by the turbine island chemical feed system. This injection maintains a noncorrosive, nonscale forming condition and limits biological film formation. Chemicals are injected into service water pump discharge piping located in the turbine building.

The chemicals can be divided into six categories based upon function: biocide, algaecide, pH adjuster, corrosion inhibitor, scale inhibitor, and silt dispersant. Specific chemicals used within the system, other than the biocide, are determined by the site water conditions. The pH adjuster, corrosion inhibitor, scale inhibitor, and dispersant are metered into the system continuously or as required to maintain proper concentrations. A sodium hypochlorite treatment system is provided for use as the biocide and controls microorganisms that cause fouling. The biocide application frequency may vary with the seasons. Algaecide is applied, as necessary, to control algae formation on the cooling tower.

Chemical concentrations are measured through analysis of grab samples. Chlorine residual is measured to monitor the effectiveness of the biocide treatment. Addition of water treatment chemicals is performed by chemical feed system injection metering pumps and is adjusted as required.

Chemical injections are interlocked with each service water pump to prevent injection into a train when the associated service water pump is not running.

3.3.2.3 Potable Water System

The potable water supply source is the Draytonville Water District water system.

3.3.2.4 Demineralized Water System

Clarified water supplied to the DWS is treated by filtration and primary and secondary processes consisting of reverse osmosis units and an electrodeionization system. A pH adjustment chemical is added upstream of the filtration units to adjust the pH of the reverse osmosis influent. The pH is maintained within the operating range of the reverse osmosis membranes to inhibit scaling and corrosion. A dilute antiscalant, chemically compatible with the pH adjustment chemical, is used to increase the solubility of salts and decrease scale formation on the membranes.

Both the pH adjustment chemical and antiscalant are injected into the demineralized water treatment process from the turbine island chemical feed system.

3.3.2.5 Fire Protection System

Treatment of raw water for fire system use consists of clarification and filtration through strainers as needed to prevent fouling.

TABLE 3.3-1
PLANT WATER USE

(Total for Two Units)

Stream	Normal (gpm)	Maximum (gpm)
Circulating Water System		
Evaporation Rate	24,270	28,026
Drift Rate	3	3
Blowdown Rate	8,087	28,023
CWS Makeup Flowrate	32,239	55,931
Service Water System		
Evaporation Rate	368	1248
Drift Rate	1	2
Blowdown Rate	121	410
SWS Makeup Flowrate	490	1660
Demineralized Water Makeup Flowrate	300	1080
Fire Protection System Makeup Flowrate	1	625

3.4 COOLING SYSTEM

The Lee Nuclear Station, Units 1 and 2, cooling systems and their anticipated cooling system modes of operation are described in Subsection 3.4.1. Design data and performance characteristics for the cooling system components are presented in Subsection 3.4.2. The parameters provided are used to evaluate the impacts to the environment from cooling system operation. The environmental interfaces of these systems are the plant intake and discharge structures as well as the cooling towers.

3.4.1 DESCRIPTION AND OPERATIONAL MODES

Lee Nuclear Station is provided with two cooling systems that transfer heat to the environment during normal modes of plant operation. These systems are the service water system (SWS) and the circulating water system (CWS). There are six anticipated operational modes: (1) power operation, (2) startup, (3) hot standby, (4) safe shutdown, (5) cold shutdown, and (6) refueling. Heat generated during each operational mode is released to the atmosphere and to the Broad River, from the CWS and SWS. The amounts of heat released to the atmosphere and to the Broad River during each mode of operation are provided in Table 3.4-1.

The CWS is supplied with makeup water from the Make-Up Pond A intake structure to replace water consumed during system operations. The quantities of water withdrawn, consumed, and discharged for the CWS and the SWS are provided in Table 3.4-2.

There is no National Pollutant Discharge Elimination System (NPDES) permit for Lee Nuclear Station at this time. There is no existing plant at the site, therefore, there are no discharges requiring a permit. Duke Energy has an established process for acquiring and complying with the required permits, as necessary, for Lee Nuclear Station as described in Table 1.2-1.

3.4.1.1 System Description

3.4.1.1.1 Raw Water System

The raw water system (RWS) supplies water to the Make-Up Pond A for plant use, including CWS cooling tower makeup water to replace the volume consumed as a result of evaporation, drift, and blowdown. Makeup water is supplied at a rate of 33,030 gallons per minute (gpm) for two operating units. The basic system configuration is shown in Figure 3.3-1 and Reference 4.

At the river water intake pumping station, the raw water is first strained by the curtain wall and bar screens, then it passes through the traveling screens as described in Subsection 3.4.2.1.

The traveling screens are through flow type, installed in the vertical position and designed for continuous operation. The screens are fish handling screens of the modified “Ristroph” design (or equivalent) with Fletcher type fish friendly buckets on each screen basket. The screens have dual pressure spray header systems with provisions for separate fish and debris troughs. The troughs are supplied with supplemental flow sufficient to move the fish and the debris through the separate return troughs. The fish return trough will exit the intake on the downriver side and return the fish to the section of the Broad River downstream of the intake structure.

A back-washing feature of the design removes debris and sends it back to the Broad River. A small portion of the raw water is used to supply two 100-percent-capacity screen wash pumps.

The remainder of the flow goes into Make-Up Pond A which provides makeup to the CWS cooling towers. These features are illustrated in Figure 9.2-202 of the Final Safety Analysis Report (FSAR).

At times of low river flow in the Broad River, water can be proportionally withdrawn from the onsite ponds to augment make-up water from the river. This is a backup supply of makeup water for the CWS, SWS, DWS, and fire protection system.(Reference 4).

The clarification subsystem is used to clarify the raw water pumped from Make-Up Pond A for use by the SWS and DWS. The remainder of the flow provides makeup to the CWS. These features are illustrated in Figure 9.2-205 of the FSAR and described in Reference 4.

3.4.1.1.2 Circulating Water System

The CWS supplies cooling water to remove heat from the main condensers, the turbine building closed cooling water system (TCS) heat exchangers, and the condenser vacuum pump seal water heat exchangers under varying conditions of power plant loading and design weather conditions. The main condensers are described in the AP1000 DCD Section 10.4.1. The CWS for each unit dissipates up to 7.628 x 10^6 British thermal units per hour (Btu/hr) of waste heat during normal plant operation at full station load. The CWS system for each unit consists of three 33-1/3-percent-capacity circulating water pumps, three mechanical-draft cooling towers, and associated piping, valves, and instrumentation. Makeup water to the CWS is provided by the RWS that pumps makeup water from Make-Up Pond A to the CWS, and makeup water to the clarification system used in the SWS, demineralized water system (DWS), and fire protection system (FPS). Water chemistry is controlled by the turbine island chemical feed system (CFS). The maximum expected blowdown temperature is 95ºF and averages 91ºF.

The circulating water pumps take suction from the circulating water intake structure and circulate the water through the TCS, the condenser vacuum pump seal water heat exchangers, and the tube side of the main condenser and back through the piping discharge network to the cooling towers. The system for each unit uses three mechanical-draft cooling towers for heat dissipation, with the exhaust from the plant's steam turbines directed to the main condenser where the heat of vaporization is rejected to a closed loop of cooling water.

The heated cooling water from the main condenser, turbine building closed cooling water heat exchangers, and the condenser vacuum pump seal water heat exchangers is circulated to the spray headers of the mechanical-draft cooling towers, where the heat content of the cooling water is transferred to the mechanical-draft-induced ambient air via evaporative cooling and conduction. The cooling water is then recirculated back to the main condenser, turbine building closed cooling water heat exchangers, and the condenser vacuum pump seal water heat exchangers to complete the closed-cycle cooling loop. Provision is made during cold weather to direct a portion of the circulating water flow into freeze-prevention spray headers on the periphery of the cooling tower. Air flowing through the peripheral spray is thus heated and allows de-icing in the central cooling tower baffles.

The flow to the cooling towers can be diverted directly to the basin, bypassing the cooling tower internals. This is accomplished by opening the bypass valve while operating one of the circulating water pumps. The bypass is normally used only during plant startup in cold weather or to maintain circulating water system temperature above 40°F while operating at partial load during periods of cold weather.

Turbine building closed cooling water in the TCS heat exchangers is maintained at a higher pressure than the circulating water to prevent leakage of the circulating water into the closed cooling water system.

Cooling water to the condenser vacuum pump seal water heat exchangers is supplied from the CWS. Cooling water flow from the CWS is normally maintained through all four heat exchangers to facilitate placing the spare condenser vacuum pump in service. Isolation valves are provided for the condenser vacuum pump seal water heat exchanger cooling water supply lines to facilitate maintenance.

3.4.1.1.3 Service Water System

The SWS supplies cooling water to remove heat from the nonsafety-related component cooling water system (CCS) heat exchangers in the turbine building.

During normal power operation the SWS supplies cooling water at a maximum temperature of 93.5°F to one component cooling water heat exchanger. During plant cooldown and refueling the SWS supplies cooling water to both component cooling water heat exchangers to support the cooling requirements for the CCS. System water flows and heat loads are given in DCD Table 9.2.1-1.

The SWS is illustrated in DCD Figure 9.2.1-1. The system consists of two 100-percent-capacity service water pumps, automatic backwash strainers, a two-cell cooling tower with a divided basin, and associated piping, valves, controls, and instrumentation. The service water pumps, located in the turbine building, take suction from piping which connects to the basin of the service water cooling tower. Service water is pumped through strainers to the CCS heat exchangers for heat removal (Reference 4). The temperature rise across the heat exchangers varies with each mode of operation. Heated service water from the heat exchangers then returns through piping to a mechanical-draft cooling tower, where the system heat is rejected to the atmosphere. Cool water, collected in the tower basin, flows through fixed screens to the pump suction piping and is then recirculated through the system.

A small portion of the service water flow is normally diverted to the CWS. This blowdown is used to control levels of solids concentration in the SWS. Blowdown from the SWS cooling tower is sent to either the CWS cooling tower basin or to the wastewater retention basin.

The SWS is arranged into two trains of components and piping. Each train includes one service water pump, one strainer, and one cooling tower cell. Each train provides 100-percent-capacity cooling for normal power operation. Cross-connections between the trains upstream and downstream of the CCS heat exchangers allow either service water pump to supply either heat exchanger, and allow either heat exchanger to discharge to either cooling tower cell. The RWS supplies makeup water to the SWS cooling tower to replace the water consumed as the result of evaporation, drift, and blowdown.

SWS materials are compatible with the cooling water chemistry and the chemicals used to control long-term corrosion and organic fouling. Water chemistry is controlled by the turbine island chemical feed system (CFS).

3.4.1.2 Operational Modes

3.4.1.2.1 Circulating Water System

The CWS provides cooling during the first four of the normal operation modes, which include power operation, startup, hot standby, and safe shutdown. The power operation mode rejects the most heat, as the CWS removes heat rejected from the turbine by way of the condenser during this operation mode. The Lee Nuclear Station units are estimated to be in the power operation mode for 97.2 percent of the 18 month operating cycle (approximately 17.5 months) (Reference 1). During startup, hot standby, and safe shutdown, a small amount of condenser heat is rejected by way of the condenser. Lee Nuclear Station units are expected to be in the startup mode for 0.1 percent of the operating cycle (6 hours), the hot standby mode for 0.4 percent of the operating cycle (46 hours), and the safe shutdown mode for 0.4 percent of the operating cycle (55 hours) (Reference 1). These time estimates do not include forced outages as they cannot be predicted.

3.4.1.2.2 Service Water System

The SWS provides heat removal from the CCS during all six modes of normal operation, which include power operation, startup, hot standby, safe shutdown, cold shutdown, and refueling. During refueling, the SWS also supports a full-core offload. Lee Nuclear Station units are estimated to be in the power operation mode for 97.2 percent of the operating cycle (approximately 17.5 months), the startup mode for 0.1 percent of the operating cycle (6 hours), the hot standby mode for 0.4 percent of the operating cycle (46 hours), the safe shutdown mode for 0.4 percent of the operating cycle (55 hours), the cold shutdown mode for 0.4 percent of the operating cycle (52 hours), and the refueling mode for 1.4 percent of the operating cycle (181 hours) (Reference 1). These time estimates do not include forced outages as they cannot be predicted.

3.4.1.3 Heat Generated, Dissipated to the Atmosphere, and Released in Liquid Discharges

3.4.1.3.1 Circulating Water System

In the first four modes of operation (power operation, startup, hot standby, and safe shutdown), heat is generated, dissipated to the atmosphere, and released in liquid discharges from the CWS. During each of these modes, the CWS releases heat to the atmosphere via the CWS cooling towers. The CWS cooling towers also release heat to the Broad River as liquid discharges via blowdown. The quantities of heat released during these modes of operation are summarized in Table 3.4-1.

3.4.1.3.2 Service Water System

The SWS is operating in all six modes of operation, including cold shutdown and refueling. During all six modes of operation, the SWS releases heat to the atmosphere via the SWS cooling tower, and as liquid discharges to the CWS basin or to the wastewater retention basin. The quantities of heat released during each of these modes of operation are shown in Table 3.4-1.

3.4.1.4 Water Source and Quantities of Water Withdrawn, Consumed, and Discharged

3.4.1.4.1 Circulating Water System

In each of the first four modes of operation (power operation, startup, hot standby, and safe shutdown), the CWS requires makeup water from the Broad River. This water is provided to the CWS by the RWS. To provide for the CWS requirements, the RWS must provide sufficient capacity to make up for cooling tower losses due to evaporation, drift, and blowdown, as well as provide intake screen washing flow and backwash flow. CWS operation results in the release of this water back to the environment. The cooling tower losses provide the major discharge source to the atmosphere via evaporation and drift. The blowdown operations provide a discharge path directly to the Broad River. The amount of water supplied by the system from the Broad River, along with the discharge quantities for each of the four modes of operation are provided in Table 3.4-2.

3.4.1.4.2 Service Water System

The SWS is operating in all six modes of operation, including cold shutdown and refueling. During each mode of operation, the SWS requires makeup water from the Broad River. The clarified water storage tank, which is a component of the RWS, provides sufficient capacity to supply the SWS with makeup for cooling tower losses due to evaporation, drift, and blowdown. The cooling tower losses are the major discharge source to the atmosphere via evaporation. The blowdown is recycled as makeup to the CWS cooling tower basin. The amount of water supplied by the system from the Broad River, along with the discharge quantities for each of the modes of operation are provided in Table 3.4-2.

During plant startup, the SWS normally provides service to both component cooling water system heat exchangers. This requires that both service water pumps, strainers, and cooling tower cells be in service. At the end of this phase of operation, when one of the component cooling water system heat exchangers is removed from service, one of the service water pumps, strainers, and cooling tower cells may also be removed from service.

3.4.2 COMPONENT DESCRIPTIONS

Lee Nuclear Station is designed with an intake system which supplies the necessary water to the plant from the Broad River. The intake system includes the river intake structure, Make-Up Pond A intake structure, and Make-Up Pond B intake structure. The location of the intake system is illustrated in Figure 3.1-1. This system is described in Subsection 3.4.2.1 and (Reference 4).

Lee Nuclear Station is designed with one discharge point for CWS blowdown, liquid radwaste system (WLS) discharge, and wastewater system (WWS) discharge. The blowdown discharge system is described in Subsection 3.4.2.2.

3.4.2.1 Intake System

The intake system is designed to provide the raw water requirements for the plant. The primary consumptive users are the CWS and SWS. All other users (demineralized water, fire protection, alternate radwaste dilution) are minimal in comparison.

The intake system consists of the river intake structure, the Make-Up Pond A intake structure, the Make-Up Pond B intake structure, Make-Up Pond A, and Make-Up Pond B. The general site location of the intake system is shown in Figure 3.1-1. A cross-section of the intake system is illustrated in Figure 3.4-1 and (Reference 4). Bathymetric data and water use data are provided in Section 2.3.

The intake system replaces water lost from the cooling towers due to evaporation and blowdown. The river intake structure serves as a platform to support trash racks, traveling screens, pumps, motors, and other equipment. The pumps located at the river intake structure are sized to transfer the maximum flow of 60,000 gpm to Make-Up Pond A, where a second set of pumps is located. These pumps are sized to supply the required makeup to the cooling towers basin (References 2 and 4).

Sizing of the intake screens provides for less than 0.5 feet per second (fps) through screen velocity and a design flow no greater than 5 percent of the mean annual river flow. The four (4) fourteen foot traveling screens provide for less than 0.5 fps through screen velocity. The USGS annual flow data for the Broad River was reviewed and the raw water requirement for the plant is less than 5 percent of the mean annual flow. (Reference 4)

Operation during periods of low flow and use of Make-Up Pond B is discussed in Subsections 3.4.1.1.1 and 5.3.1.1.3.

All intake water taken from the Broad River passes through a curtain wall, bar screens, and traveling screens designed to minimize uptake of aquatic biota and debris. Each traveling screen has fish collection and return capability. The screens are sized so that the average through-screen velocity is in accordance with the Section 316 (b) of the Clean Water Act (Reference 6). Return of impinged fish is to a location downstream of the intake as discussed in Subsection 3.4.1.1.1. Debris collected by the trash racks and traveling screens is collected and disposed of as solid waste (Reference 4).

During each operational mode, the raw water requirements vary. Therefore, the flow rates and intake velocities also vary. Flowrates for all modes of operation are given in Table 3.4-2.

3.4.2.2 Blowdown Discharge System

The primary purpose of the blowdown discharge system is to disperse cooling tower blowdown into the Broad River to limit the concentration of dissolved solids in the CWS and SWS.

Any additives in the discharge are approved by the U.S. Environmental Protection Agency as safe for humans and the environment. The volume and concentration of the constituents discharged to the environment will be governed by the NPDES permit as discussed in Section 3.6.

The blowdown discharge structure is located immediately upstream of the Ninety-Nine Islands Dam. The discharge arrangement is illustrated in Figure 5.3-4.

Average blowdown from the cooling towers is discharged into the Broad River at a rate of approximately 4044 gpm per unit, 8087 gpm site total. The maximum blowdown rate is approximately 14,012 gpm per unit, 28,023 gpm site total (Reference 4 and Figure 3.3-1). Makeup water for the CWS is from Make-Up Pond A intake structure. SWS makeup is provided from the clarification subsystem. The maximum blowdown temperature is conservatively assumed to be 95°F (Reference 4).

3.4.2.3 Heat Dissipation

The CWS has three mechanical-draft cooling towers per unit which together function as the normal heat sink. The cooling towers are approximately 60 feet high and have a concrete shell. Located on a raised berm the tower highest elevation is approximately 91 ft. above plant grade (References 3 and 5). The location of the cooling towers is illustrated in Figure 3.1-1. The cooling towers reject an average heat load of 1.53×10^{10} Btu/hr total for the two units to the environment, with an approach temperature of 10°F and a maximum return temperature of 116.2°F. As shown in Table 3.4-1, this heat is transferred to the atmosphere through the cooling towers and as liquid to the Broad River. The cooling towers occupy an area of approximately 11.4 acres (ac.) per unit. The conceptual design parameters for the CWS cooling towers are provided in Reference 3.

The SWS has one rectilinear mechanical-draft cooling tower per unit. The design is a counter flow, induced-draft tower divided into two cells. Each cell uses one fan, located in the top portion of the cell, to draw air upward through the fill, counter to the downward flow of water. One service water pump supplies flow to one operating cooling tower cell during normal plant operation. During plant shutdown cooling, both tower cells are placed in service along with both SWS pumps for increased cooling capacity. DCD Table 9.2.1-1 provides system flow rates and the heat duty for various operating modes of the SWS cooling tower. The SWS cooling tower maintains a maximum 93.5°F return temperature to the SWS heat exchangers during all operating modes. Temperature rise through the SWS heat exchangers is approximately 18.5 °F during normal operation and 16.5°F during cooldown operation.

3.4.3 REFERENCES

1. Westinghouse Electric Company MODE Residence Estimate, DCP/NUS0227.

2. Shaw Stone & Webster Inc. *Conceptual Design Report for the Raw Water System as Applied for Price Finalization*, Document No. SSWN-12402901-07, Charlotte, NC, July 17, 2007.

3. Shaw Stone & Webster Inc, *Conceptual Design Package for Circulating Water System (CWS)*, Document No. 12402901-M-CWS-CDP-0, Charlotte, NC, July 31, 2007.

4. Shaw Stone & Webster Inc, *Conceptual Design Package (CDP) for the Raw Water System (RWS)*, Document No. 12402901-M-RWS-CDP-2, Charlotte, NC, August 14, 2007.

5. Shaw Stone & Webster Inc, *Cooling Tower Impact Assessment*, Document No. 118879-R-M-001-2, Charlotte, NC, August 15, 2007.

6. Clean Water Act, 33 USC 1251 et seq.

TABLE 3.4-1
HEAT TRANSFER TO THE ATMOSPHERE AND RELEASED IN LIQUID DISCHARGES

(Single Unit Operation)

Modes of Operation	Total Heat Transferred to Environment SWS+CWS Btu/hr	Heat Dissipated to Atmosphere by SWS Btu/hr	Heat Released in Liquid Discharges by SWS Btu/hr	Heat Dissipated to Atmosphere by CWS Btu/hr	Heat Released in Liquid Discharges by CWS Btu/hr[(a)]
Power Operation	$7,772 \times 10^6$	103×10^6	[(b)]N/A	$7,628 \times 10^6$	40.6×10^6
Startup	$3,168 \times 10^6$	75.8×10^6	[(b)]N/A	[(c)]$3,051.6 \times 10^6$	40.7×10^6
Hot Standby	866×10^6	103×10^6	[(b)]N/A	762.8×10^6	0.22×10^6
Safe Shutdown	1109×10^6	346×10^6	[(d)]N/A	762.8×10^6	0.22×10^6
Cold Shutdown	170×10^6	170×10^6	[(d)]N/A	(0)	(0)
Refueling (Full Core Offload)	75×10^6	75×10^6	[(b)]N/A	(0)	(0)

a) River water temperature is assumed to be 80°F when calculating the heat contribution for blowdown

b) The SWS blows down to the CWS basin. The heat released in liquid discharges by the SWS is therefore included in the heat released in liquid discharges by the CWS.

c) The turbine bypass system has the capacity to bypass 40-percent of the full load main steam flow to the main condenser. For the purpose of this table, the 40-percent value is used to provide a conservative representation of the heat dissipate during cooldown and startup.

d) Discharges routed to the WWRB and diluted sufficiently to have a negligible impact.

TABLE 3.4-2
RAW WATER WITHDRAWN, CONSUMED, AND DISCHARGED

(Single Unit Values)

Modes of Operation	Water Source	Quantity Withdrawn (Raw Water) (gpm)	Quantity Consumed (CWS) (gpm)	Quantity Discharged (CWS) (gpm)	Quantity Consumed (SWS) (gpm)	Quantity Discharged (SWS) (gpm)
Power Operation	Broad River	16,365	12,137	4,044	185	0
Startup	Broad River	9,654	7,103	2,366	185	0
Hot Standby	Broad River	3,375	2,393	797	185	0
Safe Shutdown	Broad River	4,021	2,393	797	626	205
Cold Shutdown	Broad River	831	0	0	626	205
Refueling (Full Core Offload)	Broad River	246	0	0	185	61

Note:

Consumptive usage values for screen wash and water treatment are not included in this table due to their minimal impact on raw water withdrawal. These values are shown on the water balance summary Figure 3.3-1.

3.5 RADIOACTIVE WASTE MANAGEMENT SYSTEM

Radioisotopes are produced during the normal operation of nuclear reactors, primarily through the processes of fission and activation. Fission products may enter the reactor coolant by diffusing from the fuel pellet and then passing through the fuel cladding either through leaks or by diffusion. The primary cooling water may contain dissolved or suspended corrosion products and nonradioactive materials leached from plant components. These products and materials can be activated by the neutrons in the reactor core as they pass through the core. These radioisotopes leave the reactor coolant either by plant systems designed to remove impurities, by small leaks that occur in the reactor coolant system and auxiliary systems, or by opening of systems for maintenance.

Radioactive waste management systems are designed to minimize releases from reactor operations to values as low as reasonably achievable (ALARA). These systems are designed and maintained to meet the requirements of 10 CFR Part 20 and 10 CFR 50, Appendix I.

The design of the systems for the release of liquid and gaseous effluents comply with Regulatory Guide 1.112, Revision 1, “Calculation of Releases of Radioactive Materials in Gaseous and Liquid Effluents from Light-Water-Cooled Nuclear Power Reactors.”

3.5.1 LIQUID RADIOACTIVE WASTE MANAGEMENT SYSTEM

For each unit, the liquid radioactive waste management systems include the systems that may be used to process and dispose of liquids containing radioactive material. These include the following:

- Steam generator blowdown system (BDS).
- Liquid radwaste system (WLS).

The WLS is designed to control, collect, process, handle, store, and dispose of liquid radioactive waste generated as the result of normal operation, including anticipated operational occurrences.

The WLS provides holdup capacity as well as permanently installed processing capacity of 75 gpm through the ion exchange/filtration train. This is adequate capacity to meet the anticipated processing requirements of the plant. The projected flows of various liquid waste streams to the WLS under normal conditions are identified in DCD Table 11.2-1.

The WLS design accomodates equipment malfunctions without affecting the capability of the system to handle both anticipated liquid waste flows and possible surge load due to excessive leakage.

The WLS, shown in DCD Figure 11.2-2, Sheets 1 through 8, include tanks, pumps, ion exchangers, and filters. The WLS is designed to process, or store for processing by mobile equipment, radioactively contaminated wastes in four major categories:

- Borated, reactor-grade, waste water -- This input is collected from the reactor coolant system (RCS) effluents received through the chemical and volume control system (CVS), primary sampling system sink drains and equipment leakoffs and drains.

- Floor drains and other wastes with a potentially high suspended solids content -- This input is collected from various building floor drains and sumps and equipment leakoffs and drains.
- Detergent wastes -- This input comes from the plant hot sinks and showers, and some cleanup and decontamination processes. It generally has low concentrations of radioactivity.
- Chemical wastes -- This input comes from the laboratory and other relatively small volume sources. It may be mixed hazardous and radioactive wastes or other radioactive wastes with a high dissolved-solids content.

Nonradioactive secondary-system waste is not processed by the WLS. Secondary-system effluent is normally handled by the BDS and by the turbine building drain system.

Radioactivity can enter the secondary systems from steam generator tube leakage. If significant radioactivity is detected in secondary-side systems, blowdown is diverted to the WLS for processing and disposal.

3.5.1.1 Waste Input Streams

3.5.1.1.1 Reactor Coolant System Effluents

The effluent subsystem receives borated and hydrogen-bearing liquid from two sources: the reactor coolant drain tank and the CVS. The reactor coolant drain tank collects leakage and drainage from various primary systems and components inside containment. Effluent from the CVS is produced mainly as a result of RCS heatup, boron concentration changes and RCS level reduction for refueling.

Input collected by the effluent subsystem normally contains hydrogen and dissolved radiogases. Therefore, it is routed through the WLS vacuum degasifier before being stored in the effluent holdup tanks.

The WLS degasifier can also be used to degas the RCS before shutdown. This is done by taking one of the effluent holdup tanks out of normal waste service and draining it. Then normal CVS letdown is directed through the degasifier to the dedicated effluent holdup tank. From there, it is pumped back to the suction of the CVS makeup pumps with the effluent holdup tank pump. The makeup pumps return the fluid to the RCS in the normal fashion. This process is continued as necessary for degassing the RCS.

The input to the reactor coolant drain tank is potentially at high temperature. Therefore, provisions are made for recirculation through a heat exchanger for cooling. The tank is inerted with nitrogen and is vented to the gaseous radwaste system (WGS). Transfer of water from the reactor coolant drain tank is controlled to maintain an essentially fixed tank level to minimize tank pressure variation.

RCS effluents from the CVS letdown line or the reactor coolant drain subsystem pass through the vacuum degasifier, where dissolved hydrogen and fission gases are removed. These gaseous components are sent via a water separator to the WGS. A degasifier discharge pump then transfers the liquid to the currently selected effluent holdup tank. If flows from the letdown line and the reactor coolant drain tank are routed to the degasifier concurrently, the letdown flow has priority and the drain tank input is automatically suspended.

In the event of abnormally high degasifier water level, inputs are automatically stopped by closing the letdown control and containment isolation valves.

The effluent holdup tanks vent to the radiologically controlled area ventilation system (VAC) and, in abnormal conditions, may be purged with air to maintain a low hydrogen gas concentration in the tanks' atmosphere. Hydrogen monitors are included in the tanks vent lines to alert the operator of elevated hydrogen levels.

The contents of the effluent holdup tanks may be recirculated and sampled, recycled through the degasifier for further gas stripping, returned to the RCS via the CVS makeup pumps, discharged to the mobile treatment facility, processed through the ion exchangers, or directed to the monitor tanks for discharge without treatment. Processing through the ion exchangers is the normal mode.

The WLS processes waste with an upstream filter followed by four ion exchange resin vessels in series. Any of these vessels can be manually bypassed and the order of the last two can be interchanged, so as to provide complete usage of the ion exchange resin.

The top of the first vessel is normally charged with activated carbon, to act as a deep-bed filter and remove oil from floor drain wastes. Moderate amounts of other wastes can also be routed through this vessel. It can be bypassed for processing of relatively clean waste streams. This vessel is somewhat larger than the other three, with an extra sluice connection to allow the top bed of activated carbon to be removed. This feature is associated with the deep bed filter function of the vessel; the top layer of activated carbon collects particulates, and the ability to remove it without disturbing the underlying zeolite bed minimizes solid-waste production.

The second, third and fourth beds are in identical ion exchange vessels, which are selectively loaded with resin, depending on prevailing plant conditions.

After deionization, the water passes through an after-filter where radioactive particulates and resin fines are removed. The processed water then enters one of the monitor tanks. When one of the monitor tanks is full, the system is automatically realigned to process water to another tank.

The contents of the monitor tank are recirculated and sampled. In the unlikely event of high radioactivity, the tank contents are returned to a waste holdup tank or mobile system for additional processing.

The radioactivity level of the discharged fluids when mixed with the circulating water blowdown is expected to be below discharge limits. The discharge flow rate is set to limit the boric acid concentration in the circulating water blowdown stream to an acceptable concentration for local requirements. Detection of high radiation in the discharge stream stops the discharge flow and operator action is required to re-establish discharge. The raw water system, which provides makeup for the circulating water system, is used as a backup source for dilution water when cooling tower blowdown is not available for the discharge path.

3.5.1.1.2 Floor Drains and Other Wastes with Potentially High Suspended Solid Contents

Potentially contaminated floor drain sumps and other sources that tend to be high in particulate loading are collected in the waste holdup tank. Additives may be introduced to the tank to improve filtration and ion exchange processes. Tank contents may be recirculated for mixing and sampling. The tanks have sufficient holdup capability to allow time for realignment and maintenance of the process equipment.

The wastewater is processed through the waste pre-filter to remove the bulk of the particulate loading. Next it passes through the ion exchangers and the waste after-filter before entering a monitor tank.

Wastewater meeting the discharge limits is discharged to the circulating water blowdown through a radiation detector that stops the discharge if high radiation is detected.

3.5.1.1.3 Detergent Wastes

The detergent wastes from the plant hot sinks and showers contain soaps and detergents. These wastes are generally not compatible with the ion exchange resins. The detergent wastes are not processed and are collected in the chemical waste tank. If the detergent wastes activity is low enough, the wastes can be discharged without processing.

When sufficient detergent wastes are produced and processing is necessary, mobile processing equipment can be brought into one of the radwaste building mobile systems facility truck bays provided for this purpose.

3.5.1.1.4 Chemical Wastes

Inputs to the chemical waste tank normally are generated at a low rate, approximately 2 gpd. These wastes are only collected; no internal processing is provided. Chemicals can be added to the tank for pH or other adjustment. Since the volume of these wastes is low, they can be treated by the use of mobile equipment or by shipment offsite. If the activity is low enough, it can be discharged without processing.

3.5.1.1.5 Steam Generator Blowdown

If steam generator tube leakage results in significant levels of radioactivity in the steam generator blowdown stream, this stream is redirected to the WLS for treatment before release. In this event, one of the waste holdup tanks is drained to prepare it for blowdown processing. The blowdown stream is brought into that holdup tank, and continuously or in batches pumped through the waste ion exchangers. The number of ion exchangers in service is determined by the operator to provide adequate purification without excessive resin usage. The blowdown is then collected in a monitor tank, sampled, and discharged in a monitored fashion.

3.5.1.1.6 Radioactive Releases

Liquid waste is produced both on the primary side (primarily from adjustment of reactor coolant boron concentration and from reactor coolant leakage) and the secondary side (primarily from steam generator blowdown processing and from secondary side leakage). Primary and secondary coolant activity levels are based on operating plant experience.

Except for RCS degasification in anticipation of shutdown, primary side effluents are not recycled for reuse. Primary effluents are discharged to the environment after processing. Fluid recycling is provided for the steam generator blowdown fluid which is normally returned to the condensate system.

The liquid waste is discharged from the monitor tank in a batch operation, and the discharge flow rate is restricted as necessary to maintain an acceptable concentration when diluted by the circulating water discharge flow. The liquid waste is discharged into the Broad River in accordance with applicable discharge permit requirements.

The annual average release of radionuclides from the unit is determined using the PWR-GALE code. The PWR-GALE code models releases which use source terms derived from data obtained from the experience of operating PWRs. The code input parameters used in the analysis are listed in DCD Table 11.2-6. The annual releases for a single unit are presented in DCD Table 11.2-7.

3.5.1.1.7 Doses

The calculated maximum individual and population doses for normal plant operation are addressed in Section 5.4.

3.5.1.1.8 Cost Benefit Analysis of Population Doses

The site-specific cost-benefit analysis regarding population doses due to liquid effluents during normal plant operation is addressed in FSAR Subsection 11.2.3.5.

This FSAR subsection applies to the cost-benefit analysis for each unit. The dollar/person sievert reduction is included in the calculation for the cost-benefit analysis in the FSAR subsection.

3.5.2 GASEOUS RADIOACTIVE WASTE MANAGEMENT SYSTEM

For each unit, during reactor operation, radioactive isotopes of xenon, krypton, and iodine are created as fission products. A portion of these radionuclides is released to the reactor coolant. Leakage of reactor coolant thus results in a release to the containment atmosphere of the noble gases. Airborne releases can be limited both by restricting reactor coolant leakage and by limiting the concentrations of radioactive noble gases and iodine in the RCS.

Iodine is removed by ion exchange in the CVS. Removal of the noble gases from the RCS is not normally necessary because the gases will not build up to unacceptable levels when fuel defects are within normally anticipated ranges. If noble gas removal is required because of high concentration, the CVS can be operated in conjunction with the liquid radwaste system degasifier, to remove the gases.

The WGS is designed to perform the following major functions:

- Collect gaseous wastes that are radioactive or hydrogen bearing.
- Process and discharge the waste gas, keeping off-site releases of radioactivity within acceptable limits.

In addition to the WGS release pathway, release of radioactive material to the environment occurs through the various building ventilation systems. The estimated annual release includes contributions from the major building ventilation pathways.

The WGS is designed to receive hydrogen bearing and radioactive gases generated during process operation. The radioactive gas flowing into the gaseous radwaste system enters as trace contamination in a stream of hydrogen and nitrogen.

WGS inputs are as follows:

- Letdown diversion for dilution, RCS with maximum hydrogen concentration.
- Letdown diversion for RCS degassing.
- Reactor coolant drain tank liquid transfer to maintain proper reactor coolant drain tank level.
- Reactor coolant drain tank gas venting.

3.5.2.1 System Description

The WGS, as shown on DCD Figure 11.3-1 and Figure 11.3-2, is a once through, ambient-temperature, activated carbon delay system. The system includes a gas cooler, a moisture separator, an activated carbon-filled guard bed, and two activated carbon-filled delay beds. Also included in the system are an oxygen analyzer subsystem and a gas sampling subsystem.

DCD Table 11.3-2 lists the key design parameters for the WGS components.

The radioactive fission gases entering the system are carried by hydrogen and nitrogen gas. The primary influent source is the WLS degasifier. The degasifier extracts both hydrogen and fission gases from the CVS letdown flow which is diverted to the WLS or from the reactor coolant drain tank discharge.

Reactor coolant degassing is not required during power operation with fuel defects at or below the design basis level of 0.25 percent. However, the WGS periodically receives influent when CVS letdown is processed through the WLS degasifier during RCS dilution and volume control operations. Since the degasifier is a vacuum type and requires no purge gas, the maximum gas influent rate to the WGS from the degasifier equals the rate that hydrogen enters the degasifier (dissolved in liquid).

The other major source of input to the WGS is the reactor coolant drain tank. Hydrogen dissolved in the influent to the reactor coolant drain tank enters the WGS either via the tank vent or the WLS degasifier discharge.

The tank vent is normally closed, but is periodically opened on high pressure to vent the gas that has come out of solution. The reactor coolant drain tank liquid is normally discharged to the WLS via the degasifier, where the remaining hydrogen is removed.

The reactor coolant drain tank is purged with nitrogen gas to discharge nitrogen and fission gases to the WGS before operations requiring tank access. The reactor coolant drain tank is also purged with nitrogen gas to dilute and discharge oxygen after tank servicing or inspection operations which allow air to enter the tank.

Influents to the WGS first pass through the gas cooler where they are cooled to about 45°F by the chilled water system. Moisture formed due to gas cooling is removed in the moisture separator.

After leaving the moisture separator, the gas flows through a guard bed that protects the delay beds from abnormal moisture carryover or chemical contaminants. The gas then flows through two 100-percent capacity delay beds where the fission gases undergo dynamic adsorption by the activated carbon and are thereby delayed relative to the hydrogen or nitrogen carrier gas flow. Radioactive decay of the fission gases during the delay period significantly reduces the radioactivity of the gas flow leaving the system.

The activated carbon volume is twice the theoretical amount required to achieve the holdup times given in DCD Table 11.3-1.

The effluent from the delay bed passes through a radiation monitor and discharges to the ventilation exhaust duct. The radiation monitor is interlocked to close the WGS discharge isolation valve on high radiation. The discharge isolation valve also closes on low ventilation system exhaust flow rate to prevent the accumulation of hydrogen in the aerated vent.

3.5.2.2 System Operation

The WGS is used intermittently. During normal operation, the WGS is inactive. When there is no waste gas inflow to the system, a small nitrogen gas flow is injected into the discharge line at the inlet of the discharge isolation valve. This nitrogen gas flow maintains the WGS at a positive pressure, preventing the ingress of air during the periods of low waste gas flow.

When the WGS is in use, its operation is passive, using the pressure provided by the influent sources to drive the waste gas through the system.

The largest input to the WGS is from the WLS degasifier, which processes the CVS letdown flow when diverted to the WLS and the liquid effluent from the WLS reactor coolant drain tank.

The CVS letdown flow is diverted to the liquid radwaste system only during dilutions, borations, and RCS degassing in anticipation of shutdown. The design basis influent rate from the WLS degasifier is the full diversion of the CVS letdown flow, when the RCS is operating with maximum allowable hydrogen concentration. Since the WLS degasifier is a vacuum type that operates without a purge gas, this input rate is very small, about 0.5 scfm.

The WLS degasifier is also used to degas liquid pumped out of the reactor coolant drain tank. The amount of fluid pumped out, and therefore the gas sent to the WGS, is dependent upon the input into the reactor coolant drain tank. This is smaller than the input from the CVS letdown line.

The final input to the WGS is from the reactor coolant drain tank vent. A nitrogen cover gas is maintained in the reactor coolant drain tank. This input consists of nitrogen, hydrogen, and radioactive gases. The tank operates at nearly constant level, with its vent line normally closed, so this input is minimal. Venting is required only after enough gas has evolved from the input fluid to increase the reactor coolant drain tank pressure.

The influent first passes through a gas cooler. Chilled water flows through the gas cooler at a fixed rate to cool the waste gas to about 45°F regardless of waste gas flow rate. Moisture formed due to gas cooling is removed in the moisture separator, and collected water is periodically discharged automatically. To reduce the potential for waste gas bypass of the gas cooler in the event of valve leakage, a float-operated drain trap is provided which automatically closes on low water level.

The gas leaving the moisture separator is monitored for moisture, and a high alarm alerts the operator to an abnormal condition requiring attention. Oxygen concentration is also monitored. On a high oxygen alarm, a nitrogen purge is automatically injected into the influent line.

The waste gas then flows through the guard bed, where iodine and chemical (oxidizing) contaminants are removed. The guard bed also removes any remaining excessive moisture from the waste gas.

The waste gas then flows through the two delay beds where xenon and krypton are delayed by a dynamic adsorption process. The discharge line is equipped with a valve that automatically closes on either high radioactivity in the WGS discharge line or low ventilation exhaust duct flow.

The adsorption of radioactive gases in the delay bed occurs without reliance on active components or operator action. Operator error or active component failure does not result in an uncontrolled release of radioactivity to the environment. Failure to remove moisture prior to the delay beds (due to loss of chilled water or other causes) results in a gradual reduction in WGS performance. Reduced performance is indicated by high moisture and discharge radiation alarms. High-high radiation automatically terminates discharge.

3.5.2.3 Radioactive Releases

Releases of radioactive effluent by way of the atmospheric pathway occur due to:

- Venting of the containment that contains activity as a result of leakage of reactor coolant and as a result of activation of naturally occurring Ar-40 in the atmosphere to form radioactive Ar-41.
- Ventilation discharges from the auxiliary building that contains activity as a result of leakage from process streams.
- Ventilation discharges from the turbine building.
- Condenser air removal system (gaseous activity entering the secondary coolant as a result of primary to secondary leakage is released via this pathway).
- WGS discharges.

Because these releases are ongoing, there is no accumulation of gaseous waste in the gaseous waste management system. Therefore, there is no criteria needed for timing of releases.

3.5.2.4 Estimated Annual Releases

The annual average airborne releases of radionuclides from the plant are determined using the PWR-GALE code. The GALE code models releases using realistic source terms derived from data obtained from the experience of many operating pressurized water reactors. The code input parameters used in the analysis to model the AP1000 plant are provided in DCD Table 11.2-6. The expected annual releases for a single unit are presented in DCD Table 11.3-3.

3.5.2.5 Release Points

Airborne effluents are normally released through the plant vent or the turbine building vents. The plant vent provides the release path for containment venting releases, auxiliary building ventilation releases, annex building releases, radwaste building releases, and WGS discharge. The turbine building vents provide the release path for the condenser air removal system, gland seal condenser exhaust and the turbine building ventilation releases.

The plant vent is located at an approximate elevation of 773 ft. The turbine building vents are located at an approximate elevation of 735 ft.

3.5.2.6 Doses

The calculated maximum individual and population doses for normal plant operation are addressed in Section 5.4.

3.5.2.7 Cost Benefit Analysis of Population Doses

The site-specific cost-benefit analysis regarding population doses due to gaseous effluents during normal unit operation is addressed in FSAR Subsection 11.3.3.4.

This FSAR subsection applies to the cost-benefit analysis for each unit. The dollar/person sievert reduction is included in the calculation for the cost-benefit analysis in the FSAR subsection.

3.5.3 SOLID RADIOACTIVE WASTE MANAGEMENT SYSTEM

Lee Nuclear Station operating procedures direct plant operators to segregate wastes so as not to create mixed wastes. However the waste handling system is designed to allow handling and disposal of mixed waste, if it is created, as described below.

For each unit, the solid waste management system (WSS) is designed to collect and accumulate spent ion exchange resins and deep bed filtration media, spent filter cartridges, dry active wastes, and mixed wastes generated as a result of normal plant operation, including anticipated operational occurrences. The system is located in the auxiliary and radwaste buildings. Onsite processing and packaging of wastes are by mobile systems in the auxiliary building rail car bay and in the mobile systems facility part of the radwaste building. The packaged waste is stored in the auxiliary and radwaste buildings until it is shipped offsite to a licensed disposal facility. If offsite processing is to be used, the waste is pre-staged to accumulate a shippable volume and then packaged to meet transportation requirements in time to support the shipment schedule.

The use of mobile systems for the processing functions permits the use of the latest technology and avoids the equipment obsolescence problems experienced with installed radwaste processing equipment. The most appropriate and efficient systems may be used as they become available.

This system does not handle large, radioactive waste materials such as core components or radioactive process wastes from the plant's secondary cycle. However, the volumes and activities of the secondary cycle wastes are provided in DCD Tables 11.4-1, 11.4-4, and 11.4-8 and are discussed below.

3.5.3.1 System Description

The WSS includes the spent resin system. The flows of wastes through the WSS are shown on DCD Figure 11.4-1. The radioactivity of influents to the system are dependent on reactor coolant activities and the decontamination factors of the processes in the CVS, spent fuel cooling system, and the liquid waste processing system.

The parameters used to calculate the estimated activity of the influents to the WSS are listed in DCD Table 11.4-1.

The radioactivity of the dry active waste is expected to normally range from 0.1 curies per year to 8 curies per year with a maximum of about 16 curies per year. This waste includes spent HVAC filters, compressible trash, non-compressible components, mixed wastes and solidified chemical wastes. These activities are produced by relatively long-lived radionuclides (such as Fe-55, Co-60, Cs-134 and Cs-137), and therefore, radioactivity decay during processing and storage is minimal. These activities thus apply to the waste as generated and to the waste as shipped.

The estimated expected and maximum annual quantities of waste influents by source and form are listed in DCD Table 11.4-1 with disposal volumes. The annual radwaste influent rates are derived by multiplying the average influent rate (e.g. volume per month, volume per refueling cycle) by one year of time. The annual disposal rate is determined by applying the radwaste packaging efficiency to the annual influent rate. The influent volumes are conservatively based on an 18-month refueling cycle. Annual quantities based on a 24-month refueling cycle are less than those for an 18-month cycle.

All radwaste that is packaged and stored is shipped for disposal. Although some radwaste is pre-staged for offsite processing, Lee Nuclear Station has no provision for permanent storage of radwaste. Radwaste is stored ready for shipment. It is current Duke practice to use offsite vendors for sorting and volume reduction of dry waste. For purposes of projecting environmental impacts, it is conservatively assumed that the dry solid waste is compacted onsite. Shipped volumes of radwaste for disposal are estimated in DCD Table 11.4-1 from the estimated expected or maximum influent volumes by making adjustments for volume reduction processing by mobile systems and the expected container filling efficiencies. For drum compaction, the overall volume reduction factor, including packaging efficiency, is 3.6. For box compaction, the overall volume reduction factor is 5.4. These adjustments result in a packaged internal waste volume for each waste source, and the number of containers required to hold this volume is based on the container's internal volume. The disposal volume is based on the number of containers and the external (disposal) volume of the containers.

The expected disposal volumes of wet and dry wastes are approximately 547 and 1417 cubic feet per year, respectively as shown in DCD Table 11.4-1. The wet wastes shipping volumes include 510 cubic feet per year of spent ion exchange resins and deep bed filter activated carbon, 20 cubic feet of volume reduced liquid chemical wastes and 17 cubic feet of mixed liquid wastes. The spent resins and activated carbon are initially stored in the spent resin storage tanks located in the rail car bay of the auxiliary building. When a sufficient quantity has accumulated, the resin is sluiced into two 158 cubic feet high-integrity containers in anticipation of transport for offsite disposal. Liquid chemical wastes are reduced in volume and packaged into three 55-gallon drums per year (about 20 cubic feet) and are stored in the packaged waste storage room of the radwaste building. The mixed liquid wastes fill less than three drums per year (about 17 cubic feet per year) and are stored on containment pallets in the waste accumulation room of the radwaste building until shipped offsite for processing.

The two spent resin storage tanks (275 cubic feet usable, each) and one high integrity container in the spent resin waste container fill station at the west end of the rail car bay of the auxiliary building provide more than a year of spent resin storage at the expected rate, and several months of storage at the maximum generation rate. The expected radwaste generation rate is based upon the following:

- All ion exchange resin beds are disposed and replaced every refueling cycle.
- The WGS activated carbon guard bed is replaced every refueling cycle.
- The WGS delay beds are replaced every ten years.
- All wet filters are replaced every refueling cycle.
- Rates of compatible and non-compatible radwaste, chemical waste and mixed wastes are estimated using historical operating plant data.

The maximum radwaste generation rate is based upon the following:

- The ion exchange resin beds are disposed based upon operation with 0.25% fuel defects.
- The WGS activated carbon guard bed is replaced twice every refueling cycle.
- The WGS delay beds are replaced every five years.
- All wet filters are replaced based upon operation with 0.25% fuel defects.
- The expected rates of compatible and non-compatible radwaste, chemical waste and mixed wastes are increased by about 50%.
- Primary to secondary system leakage contaminates the condensate polishing system and blowdown system resins and membranes, which are replaced.

The dry solid radwaste includes 1383 cubic feet per year of compactable and non-compactable waste packed into about 14 boxes (90 cubic feet each) and ten drums per year. Drums are used for higher activity compactable and non-compactable wastes. Compactable waste includes HVAC exhaust filter, ground sheets, boot covers, hairnets, etc. Non-compactable waste includes about 60 cubic feet per year of dry activated carbon and other solids such as broken tools and wood. Solid mixed wastes will occupy 7.5 cubic feet per year (one drum). The low activity spent filter cartridges may be compacted to fill about 0.40 drums per year (3 cubic feet per year) and are stored in the packaged waste storage room. Compaction is performed by mobile equipment or is performed offsite. High activity filter cartridges fill three drums per year (22.5 cubic feet per year) and are stored in portable processing or storage casks in the rail car bay of the auxiliary building.

The total volume of radwaste to be stored in the radwaste building packaged waste storage room is 1417 cubic feet per year at the expected rate and 2544 cubic feet per year at the maximum rate. The compactable and non-compactable dry wastes, packaged in drums or steel boxes, are stored with the mixed liquid and mixed solid wastes, volume reduced liquid chemical wastes, and the lower activity filter cartridges. The quantities of liquid radwaste stored in the packaged waste storage room of the radwaste building consists of 20 cubic feet of chemical waste and potentially 17 cubic feet of mixed liquid waste. The useful storage volume in the packaged waste storage room is approximately 3900 cubic feet (10 feet deep, 30 feet long, and 13 feet high), which accommodates more than one full offsite waste shipment using a tractor-trailer truck. The packaged waste storage room provides storage for more than two years at the expected rate of generation and more than a year at the maximum rate of generation. One four-drum containment pallet provides more than 8 months of storage capacity for the liquid mixed wastes and the volume reduced liquid chemical wastes at the expected rate of generation and more than 4 months at the maximum rate.

A conservative estimate of solid wet waste includes blowdown material based on continuous operation of the steam generator blowdown purification system, with leakage from the primary to secondary system. The volume of radioactively contaminated material from this source is estimated to be 540 cubic feet per year. Although included here for conservatism, this volume of contaminated resin is removed from the plant within the contaminated electrodeionization unit and not stored as wet waste.

The condensate polishing system includes mixed bed ion exchanger vessels for purification of the condensate as described in DCD Section 10.4.6. Should the resins become radioactive, the resins are transferred from the condensate polishing vessel directly to a temporary processing unit or to the temporary processing unit via the spent resin tank. The processing unit, located outside of the turbine building, dewaters and processes the resins as required for offsite disposal. Radioactive condensate polishing resin has very low activity. It is disposed in containers as permitted by DOT regulations. After packaging, the resins may be stored in the radwaste building. Based on a typical condensate polishing system operation of 30 days per refueling cycle with leakage from the primary system to the secondary system, the volume of radioactively contaminated resin is estimated to be 206 cubic feet per year (one 309 cubic foot bed per refueling cycle).

The parameters used to calculate the activities of the steam generator blowdown solid waste and condensate polishing resins are given in DCD Table 11.4-1. Based on the above volumes, the disposal volume is estimated to be 939 cubic feet per year.

DCD Tables 11.4-4 and 11.4-8 list the expected principal radionuclides in primary wastes and secondary wastes, respectively. These values represent the radionuclide content in these wastes as shipped.

There are no radiation sources stored on-site and outside the Lee Nuclear Station complex as solid waste.

3.6 NONRADIOACTIVE WASTE SYSTEMS

This section describes nonradioactive waste streams that are expected at the Lee Nuclear Station, Units 1 and 2. These include nonradioactive effluent treatment facilities that may contain water-treatment chemicals or biocides, water-treatment wastes, floor and equipment drains, storm water runoff and laboratory waste. The sanitary effluent systems are described for the time during plant construction, and during operation of the plant, and the method of disposal of the effluents. This section also describes miscellaneous gaseous, liquid, and solid effluents.

This section is divided into three subsections that evaluate these nonradioactive waste systems as follows:

- Subsection 3.6.1 Effluents containing chemicals or biocides.
- Subsection 3.6.2 Sanitary system effluents.
- Subsection 3.6.3 Other effluents.

3.6.1 EFFLUENTS CONTAINING CHEMICALS OR BIOCIDES

This section includes the identification and quantification of each chemical and biocide added to the receiving water by the discharge stream. These chemicals are typically used to control water quality, scale, corrosion and biological fouling in the various systems.

Table 3.6-1 lists the projected chemicals used in each system, the amount used per year, the frequency of use and the concentrations in the effluent streams to the Waste Water System (WWS). The waste streams are combined and processed within the WWS before discharge to the environment. Figure 3.1-1 shows the locations of the liquid discharges from the site.

The chemical concentrations within effluent streams from this facility are controlled through engineering and operational/administrative controls in order to meet the National Pollutant Discharge Elimination System (NPDES) requirements during operation. The NPDES permit for Lee Nuclear Station, Units 1 and 2 is discussed in Section 1.2.

The intake and the receiving water for the process and cooling water for Lee Nuclear Station is the Broad River.

The average, maximum, and seasonal variations of the principal constituents, including minor or trace materials, of the waters at the intake and effluent locations in the Broad River are provided in Subsection 2.3.3.

The average and maximum concentrations of the natural materials at the effluent location in the Broad River are also provided in Subsection 2.3.3.

The principal constituents, such as chemicals and trace materials, in the intake water is concentrated up to three times in the circulating water system (CWS).

3.6.1.1 Circulating Water, Service Water, Potable Water, Demineralized Water and Fire Protection Systems

Each unit has a CWS, SWS, potable water system (PWS), demineralized water treatment system (DTS) and fire protection system (FPS). The description of the chemicals injected into these systems and the effect on the effluent discharged to the Broad River are discussed below.

The operation of the CWS is described in Sections 3.3 and 3.4. The operating cycle for this system for normal modes of operation is described in Section 3.4. The chemicals that are needed to maintain proper operation of the system are injected by the turbine island chemical feed system (CFS) during the power operation, startup, hot standby and safe shutdown modes of operation. The chemicals injected into the CWS, the amount used per year, the frequency of use and the concentration in the waste stream are shown in Table 3.6-1. The chemical information is based on CWS water treatment at the Duke Energy Catawba Nuclear Station on a river drainage system adjacent to the Lee Nuclear Site. Water chemistry, cooling tower design, materials of construction, and operating parameters for both stations are similar in all respects. This information source was chosen to provide the most accurate information on the chemical treatments, inventories and effluent concentrations for the Lee Nuclear Site. The effluent is routed from the circulating water tower basin to the blowdown discharge where it enters the receiving water through a multi-port diffuser located on the reservoir side of the Ninety-Nine Islands Dam. The concentration factor for this evaporative cooling system is discussed in Subsection 5.3.3.1.3.

The operation of the SWS is described in Sections 3.3 and 3.4. The operating cycle for this system for normal modes of operation is described in Section 3.4. The chemicals that are needed to maintain proper operation of the system are injected by the CFS during the power operation, startup, hot standby, safe shutdown, cold shutdown and refueling modes of operation. The chemicals injected into the SWS, the amount used per year, the frequency of use and the concentration in the waste stream from two units are shown in Table 3.6-1. The SWS chemical data is based on the strategy developed for the CWS. The chemical amounts were developed by comparing the system volumes in the CWS and SWS. The blowdown effluent is discharged to the circulating water tower basin.

The operation of the PWS is designed to continuously furnish water for domestic use and human consumption. The operation of this system is not dependent on the modes of operation of the plant. The source of potable water is the Draytonville Water District. The water supplied by this municipal water system is treated at an offsite location to applicable drinking water quality standards. No further treatment is performed onsite. The water is discharged to the sanitary drainage system (SDS). The SDS is discharged offsite to the Gaffney Board of Public Works Wastewater Treatment Plant.

The clarification system provides makeup water to the SWS, DTS, and FPS. Raw water pumps take suction from the Broad River and discharge into the Make-Up Pond A for use as plant makeup for the cooling tower basins and on-site clarification system. The clarification system is used to clarify raw water pumped from the Make-Up Pond A. Influent raw water from the Broad River is monitored for turbidity and pH for use as makeup water to all site water systems.

Raw water entering the clarifier is treated with a coagulant and polymer to initiate the formation of settleable solids. Water chemistry is controlled by package equipment supplied with the clarifier. After settling, these solids are removed from the clarifier and dewatered in a filter press. The coagulant and polymer are consumed by the process and removed when the dewatered solids are transported to an offsite location for disposal as landfill. Liquids from the dewatering process are recycled back to the clarifier inlet. Therefore, the only chemicals processed through the clarification system are used for pH control and disinfection. Sulfuric acid is used for pH control and chemical information is provided in Table 3.6-1. Disinfection is performed downstream of the clarifier and a chlorine residual is maintained in the makeup water to the SWS, DTS and FPS systems. Chemical addition to the SWS, DTS, and FPS from disinfected clarified water makeup is described in the representative sections of Table 3.6-1.

The chlorine residual in the DTS makeup will be removed upstream of the reverse osmosis units by the addition of sodium bisulfite. The change to waste water effluent concentration of chlorine due to the actuation and drainage of FPS equipment is considered negligible. Therefore, the chlorine concentration in DTS and FPS waste streams is below detectable limits.

The operation of the DTS is described in Section 3.3. The capacity of the DTS is sufficient to supply the plant makeup demand during startup, shutdown, and power operation. The operation of the DTS is on an as needed basis. The injection of the chemicals by the CFS maintains proper operation of the DTS and does not depend on the modes of operation of the plant. The chemicals injected into the DTS, the amount used per year, the frequency of use and the concentration in the waste stream from two units are shown in Table 3.6-1. The effluent processed from the DTS is discharged into the turbine building sump. This waste water is then discharged to the WWRB.

The FPS provides the capability to extinguish fires in any plant area, to protect site personnel, limit fire damage, and enhance safe shutdown capabilities. Fire protection water is supplied by the Broad River, which is then clarified. Following an event that requires actuation of the fire protection system, FPS runoff is collected in the floor drain system. Based on location, this effluent would be processed in the WLS or WWS.

3.6.1.2 Steam Generator Blowdown System

Each unit has a steam generator blowdown system (BDS). The BDS assists in maintaining acceptable secondary coolant water chemistry during normal operation and during anticipated operational occurrences of main condenser inleakage. It does this by removing impurities that are concentrated in the steam generator.

During normal operation, the BDS is aligned to recycle purified water back to the main condenser. However, during outages, the BDS is used to drain the steam generators and feedwater piping. Waste effluent from the BDS that contain treatment chemicals consists of steam generator and feedwater piping inventory. This effluent is processed by the WWS.

The chemicals described in Table 3.6-1 are typical for operating plants with recirculating steam generators similar to the Lee Nuclear Site. The identified chemicals represent a volatile treatment strategy that conforms to current industry guidance. The chemical inventory and waste stream concentrations are based on operating experience at a plant with a slightly larger feedwater volume to provide conservatism.

The system consists of two blowdown trains, one for each steam generator. The blowdown water is extracted from each steam generator from a location just above the tube sheet. To recover the blowdown fluid, each blowdown train has an electrodeionization (EDI) demineralizing unit, that removes impurities from the blowdown flow. Downstream of the electrodeionization units, both trains combine into a common header that contains a relief valve for providing overpressure protection for the low-pressure portion of the system. A back-pressure control valve maintains pressure in the system between the flow control valve and the back-pressure control valve.

The effectiveness of the blowdown system in controlling water chemistry depends upon the blowdown rate. The blowdown fluid is processed through the electrodeionization units and is discharged to the condensate system (condenser hotwell) for reuse. In the event of main condenser tube leakage, when the concentration of impurities is high, the blowdown rate is increased. Normal operation is to recover the blowdown flow through the condensate system. However, blowdown with high levels of impurities can be discharged to the WWS.

The blowdown flow and the electrodeionization waste stream (brine) flow are both continuously monitored for radioactivity from steam generator primary to secondary tube leakage. If such radioactivity is detected, the liquid radwaste system (WLS) is aligned to process the blowdown and electrodeionization waste effluent. If radioactivity reaches a preset high level, the blowdown flow control valves and the isolation valves automatically close.

The system operates normally under automatic control, except for flow control adjustments or flow path changes.

The operation of the BDS is on an as needed basis. The injection of the chemicals by the CFS maintains proper operation of the BDS and does not depend on the mode of operation of the plant. The chemicals injected into the BDS, the amount used per year, the frequency of use and the concentration in the waste stream from two units are shown in Table 3.6-1.

The BDS can be operated to drain the steam generator using the recirculation/drain pump and bypassing the flow control valves and the electrodeionization units. During this mode of operation, the blowdown discharge may be sent to the WWS, the WLS or the condensate system.

Flow, pressure, temperature, and radioactivity indicators with alarms monitor BDS operation. If pressure, temperature, or radioactivity reach a high level setpoint, an alarm is annunciated and the blowdown flow control valves and upstream isolation valves are automatically closed.

Radioactivity detection instrumentation in the combined blowdown stream from both trains monitors for the presence of radioactivity . A radiation element is located in the common header upstream of the recovered blowdown three-way valve. This three-way valve normally directs the recovered blowdown flow to the condenser. When recovery of the blowdown fluid is not possible, the flow is diverted to the waste water system. Upon detection of significant levels of radioactivity via a radiation transmitter alarm, the steam generator blowdown flow is diverted to the liquid radwaste system for processing. A second radioactive detection instrument is located on the waste stream of the electrodeionization blowdown. Similarly, a three-way valve normally directs this electrodeionization brine blowdown to the waste water system. With detection of significant levels of radioactivity, the brine blowdown is diverted to the WLS.

3.6.1.3 Waste Water

For each unit, the WWS collects and processes equipment and floor drains from nonradioactive building areas.

The WWS:

- Removes oil and/or suspended solids from miscellaneous waste streams generated from the plant.
- Collects system flushing wastes during startup prior to treatment and discharge.
- Collects and processes fluid drained from equipment or systems during maintenance or inspection activities.
- Directs nonradioactive equipment and floor drains which may contain oily waste to the building sumps and transfers their contents for proper waste disposal.

The WWS is capable of handling the anticipated flow of waste water during normal plant operation and during plant outages. Wastes from the turbine building floor and equipment drains (which include laboratory and sampling sink drains, oil storage room drains, the main steam isolation valve compartment, auxiliary building penetration area and the auxiliary building HVAC room) are collected in the two turbine building sumps. Drainage from the diesel generator building sumps, the auxiliary building sump – north (a nonradioactive sump) and the annex building sump is also collected in the turbine building sumps. The turbine building sumps provide a temporary storage capacity and a controlled source of fluid flow to the oil separator. In the event radioactivity is present in the turbine building sumps, the waste water is diverted from the sumps to the WLS for processing and disposal. A radiation monitor located on the common discharge piping of the sump pumps provides an alarm upon detection of radioactivity in the waste water. The radiation monitor also trips the sump pumps on detection of radioactivity to isolate the contaminated waste water. Provisions are included for sampling the sumps.

The turbine building sump pumps route the waste water from either of the two sumps to the oil separator for removal of oily waste. The diesel fuel oil area sump pump also discharges waste water to the oil separator. A bypass line allows for the oil separator to be out of service for maintenance. The oil separator has a small reservoir for storage of the separated oily waste which flows by gravity to the waste oil storage tank. The waste oil storage tank provides temporary storage prior to removal by truck for offsite disposal. The waste water from the oil separator flows by gravity to the waste water retention basin (WWRB) for settling of suspended solids and treatment, if required, prior to discharge. Besides the turbine building sump, miscellaneous wastes from the SWS and the TCS are discharged to the WWRB. The waste water basin transfer pumps route the basin effluent to the Blowdown Sump. The blowdown from the cooling towers also discharges to the Blowdown Sump. From there the waste water combines with the WLS discharge and discharges to the Broad River upstream of the Ninety-Nine Islands Dam.

3.6.2 SANITARY SYSTEM EFFLUENTS

This section describes the quantity of the sanitary waste and the transfer of waste to the Gaffney sewer system.

Sanitary systems needed at Lee Nuclear Station during the pre-construction and construction activities of the plant are discussed in Chapter 4. During construction the permanent sanitary drainage system (SDS) will be installed and placed into service.

The SDS for each unit is combined into a common discharge and the sanitary waste is discharged offsite to the Gaffney Board of Public Works Wastewater Treatment Plant where it is processed. The sanitary system is not treated onsite and is not discharged onto the site.

3.6.3 OTHER EFFLUENTS

This section includes the identification and quantification of other miscellaneous nonradioactive gaseous, liquid and solid effluents that are discharged to the environment.

3.6.3.1 Gaseous Effluents

Each unit contains two standby diesel generators, two ancillary diesel generators, one secondary diesel driven fire pump (the primary fire pump is electric). During normal operation of the plant, the operation of this equipment is infrequent and typically limited to periodic testing. There is no treatment of the gaseous emissions from this equipment.

In addition, there is one Technical Support Center (TSC) diesel generator on the site for both units. There is no treatment of the gaseous emissions from this diesel driven equipment.

Two onsite standby diesel generator units, each furnished with its own support subsystems, provide power to the selected nonsafety-related ac loads. See FSAR Figure 1.1-202 for location of the diesel generator building. The diesel generator building houses the two standby diesel generators and their associated heating, ventilation and air conditioning equipment. Each engine exhaust gas circuit consists of the engine exhaust gas discharge pipes from the turbocharger outlets to a single vertically mounted outdoor silencer which discharges to the atmosphere at an approximate elevation of 626 feet.

The standby diesel fuel oil system consists of two fuel oil storage tanks, a diesel generator fuel oil transfer system, and an ancillary diesel generator fuel oil supply system. See FSAR Figure 1.1-202 for location of the diesel generator fuel oil storage tanks. The vent for each fuel oil storage tank has an emissions release point at an approximate elevation of 624 feet.

Power for Class 1E post-accident monitoring, main control room (MCR) lighting, MCR and divisions B and C I&C room ventilation and for refilling the PCS water storage tank and the spent fuel pool when no other sources of power are available is provided by two ancillary ac diesel generators located in the annex building. The release point of the exhaust of the ancillary diesel generators is through a set of double doors at an approximate elevation of 597 feet. The fuel for the ancillary diesel generators is stored in a tank located in the same room as the generators. The ancillary diesel generators fuel oil tank is small capacity, self contained and normally not vented to the atmosphere. See FSAR Figure 1.1-202 for location of the annex building that houses the ancillary diesel generators and the fuel oil tank.

Two 100-percent capacity fire pumps are provided. Each pump is rated for 2000 gpm. The lead pump is electric motor-driven and the second pump is diesel engine-driven. The exhaust for the diesel driven pump is located at an approximate elevation of 604 feet. The fuel tank for the diesel-driven pump holds enough fuel to operate the pump for at least eight hours. The vent for the diesel driven fire pump oil storage tank has an emissions release point at an approximate elevation of 604 feet. See FSAR Figure 1.1-202 for location of the diesel driven fire pump and the oil storage tank.

The TSC diesel generator, which provides backup power for the site TSC, is located approximately east of the maintenance support building. The diesel generator produces an output of 750 kW. The diesel engine exhaust and fuel oil tank vent are at an approximate elevation of 598 ft. The fuel tank holds enough oil to allow the generator to operate for 7 days.

Table 3.6-2 lists the annual emissions (lbs/yr) from the diesel generators and the diesel driven fire pumps for two units.

Table 3.6-3 lists the annual hydrocarbon emissions (lbs/yr) from the associated diesel fuel oil storage tanks for two units.

No source of gaseous emissions other than the diesel generators and the diesel driven fire pumps is planned for the site.

The applicable regulations, permits, and consultations required by federal, state, regional, local, and potentially affected American Indian tribal agencies were addressed, and the results are presented in Section 1.2.

3.6.3.2 Storm Water

FSAR Subsection 2.4.2 discusses floods including the probable maximum precipitation (PMP) event and the flood design considerations for the site. Storm water generally flows in a westerly direction into the Make-Up Pond B and in an easterly direction into Make-Up Pond A.

Storm water to surface water discharges associated with land disturbance, construction and industrial operation are typically monitored under NPDES permit requirements, in accordance with the facility’s storm water pollution prevention plan (SWPPP). See Subsection 5.2.3.5 for details. Spills from the diesel systems are controlled as discussed in Subsection 5.2.3.5.

3.6.3.3 Other Wastes

For each unit, the turbine building sump pumps route the waste water from either of the two sumps to the oil separator for removal of oily waste. Waste oil from the oil separator reservoir and other plant areas is stored in a waste oil storage tank. A sampling connection is provided on the tank to verify that the oil does not require handling and disposal as a hazardous material. A truck connection on the tank allows for removal of the waste oil from the tank for offsite disposal.

The debris collected from the intake trash racks and traveling screens at the river intake structure is collected and disposed of as solid waste by contract with a permitted offsite facility.

Non-radioactive solid wastes include typical industrial wastes such as metal, wood and paper, as well as process wastes such as non-radioactive resins, filters and sludge. These non-radioactive wastes are disposed of offsite by contract at a licensed permitted facility.

The Lee Nuclear Station is classified as a small quantity generator of hazardous waste. Any waste is disposed of offsite by contract at a licensed permitted facility.

There are no other hazardous wastes stored on site. There are no other hazardous wastes discharged from the site.

Applicable procedures for offsite disposal of wastes are completed prior to turnover of the applicable plant system. FSAR Section 13.5 provides information on development of these procedures.

Applicable procedures, by which effluents are treated, controlled and discharged to meet state and EPA effluent limitation guidelines, are completed prior to turnover of the applicable plant system. FSAR Section 13.5 provides information on development of these procedures.

TABLE 3.6-1 (Sheet 1 of 2)
PROJECTED CHEMICALS ADDED TO LIQUID EFFLUENT STREAMS FROM TWO UNITS

System	Chemical-Type/specific	Amount Used per year	Frequency of Use	Concentrations in Waste Streams to WWS
CWS	Biocide/Sodium Hypochlorite	165,000 gallons	2-4 times per week	Non-detectable. Consumed in system.
CWS	Biocide/Sodium Bromide (oxidized to hydrobromous acid by hypochlorite)	36,000 gallons	2-4 times per week	Non-detectable. Consumed in system.
CWS	pH adjustment/sulfuric acid	500 gallons	Intermittent	Non-detectable. Consumed in system.
CWS	Silt dispersant/polyacrylate	121,000 gallons	Continuous	<10 ppm
SWS	Biocide/Sodium Hypochlorite	24,000 gallons	2-4 times per week	Non-detectable. Consumed in system.
SWS	Biocide/Sodium Bromide (oxidized to hydrobromous acid by hypochlorite)	5200 gallons	2-4 times per week	Non-detectable. Consumed in system.
SWS	pH adjustment/sulfuric acid	100 gallons	Intermittent	Non-detectable. Consumed in system.
SWS	Silt dispersant/polyacrylate	200 gallons	Continuous	<10 ppm
DTS	De-Chlorination/sodium bilsulfite	5240 gallons	Continuous	Non-detectable. Consumed in system.
DTS	pH adjustment/sulfuric acid	37.5 gallons	Intermittent	2.3-6.8 ppm H_2SO_4
DTS	Anti-scalant/polyacrylate	4500 gallons	Intermittent	150-450 ppm polyacrylate

TABLE 3.6-1 (Sheet 2 of 2)
PROJECTED CHEMICALS ADDED TO LIQUID EFFLUENT STREAMS FROM TWO UNITS

System	Chemical-Type/specific	Amount Used per year	Frequency of Use	Concentrations in Waste Streams to WWS
BDS	Oxygen Scavenging/hydrazine	5400 gallons	Continuous	<100 ppb
BDS	Oxygen Scavenging/carbohydrazide	500 gallons	Intermittent (Used during steam generator wet lay-up)	<100 ppb
BDS	pH adjustment/methoxypropylamine	600 gallons	Continuous	<9 ppm
BDS	pH adjustment/dimenthylamine	1700 gallons	Continuous	<100 ppb
Clarifier	pH adjustment/sulfuric acid	100 gallons	Intermittent	Non-detectable. Consumed in system.
Clarifier	Biocide/Sodium Hypochlorite	5822 gallons	Continuous	0.2 ppm

TABLE 3.6-2
ANNUAL EMISSIONS (LBS/YR) FROM DIESEL GENERATORS AND DIESEL DRIVEN FIRE PUMPS FOR TWO UNITS

	Emissions[a]			
Pollutant Discharged	Four 4000 kW Standby DGs (lbs/yr)	Four 35 kW Ancillary DGs (lbs/yr)	Two Diesel Driven Fire Pumps (lbs/yr)	One 750 kW TSC DG (lbs/yr)
Particulates[b]	2168	33	136	111
Sulfur Oxides[b],[c]	2029	31	127	104
Carbon Monoxide[b]	6645	101	415	340
Hydrocarbons[b]	2518	38	157	129
Nitrogen Oxides[b]	30,848	467	1928	1578
Carbon Dioxide[b]	1,147,171	17,381	71,698	58,662

a) Based on 4 hrs/mo operation for each Diesel Generator and Diesel Driven Fire Pump.

b) Emission factors for Diesel Generators and Diesel Driven Fire Pumps from AP-42 Chapter 3 - Stationary Internal Combustion Sources; Section 3.3 - Gasoline And Diesel Industrial Engines, Table 3.3-1.

c) Assumes sulfur content of Number 2 Diesel Fuel burned is 1%.

TABLE 3.6-3
ANNUAL HYDROCARBON EMISSIONS (LBS/YR) FROM DIESEL FUEL OIL STORAGE TANKS FOR TWO UNITS

Pollutant Discharged	Four 60,000 Gallon Standby DG Fuel Oil Tanks[(a)] (lbs/yr)	Two 240 Gallon Diesel Driven Fire Pump Fuel Oil Tanks[(b)] (lbs/yr)	One 15,000 Gallon TSC DG Fuel Oil Tank[(c)] (lbs/yr)	Two 650 Gallon Ancillary DG Fuel Oil Tanks[(d)] (lbs/yr)
Hydrocarbons[(e)]	12.88	1.0	1.0	1.0

a) Based on total fuel throughput of 12,672 gallons per year for each tank.

b) Based on total fuel throughput of 1,584 gallons per year for each tank.

c) Based on total fuel throughput of 2,592 gallons per year for each tank.

d) Based on total fuel throughput of 384 gallons per year for each tank.

e) Hydrocarbon emissions for Fuel Storage Tanks calculated using the EPA's TANKS Computer Program (Version: 4.0.9d; October 3, 2005).

3.7 POWER TRANSMISSION SYSTEM

Duke Energy is an investor-owned utility serving the Piedmont region of North Carolina and South Carolina. The Duke Energy transmission system consists of transmission lines and substations which link various generation facilities, load centers, and grid interties within the Duke Energy Control area at various voltages up to 525 kilovolts (kV). As shown in final safety analysis report (FSAR) Section 8.1, the transmission system is interconnected with neighboring utilities, and together they form the Virginia-Carolina (VACAR) subregion of the Southeastern Electric Reliability Council (SERC).

Duke Energy is using the Westinghouse Advanced Passive pressurized water reactor (AP1000) design, with a two-unit plant configuration, for the Lee Nuclear Station. Each reactor has a rated core thermal power of 3400 Megawatts thermal (MWt) and a nuclear steam supply system (NSSS) thermal output of 3415 MWt. The rated gross electrical power is 1,199.5 Megawatts electric (MWe). The rated net electrical power is at least 1000 MWe. Although the off-site power system is designed and constructed with sufficient capacity and capability to assure that specified acceptable fuel design limits and conditions are not exceeded as a result of anticipated operational occurrences, off-site power has no safety-related function due to the passive design of the AP1000. The design provides a reliable off-site power system that minimizes challenges to the passive safety system.

The environmental impacts associated with the construction and operation of the facility transmission system are discussed and evaluated in Subsections 4.1.2, 5.1.2, and Section 5.6, respectively.

The 525 kV and 230 kV switchyards are described in FSAR Subsection 8.2.1. Duke Energy transmission line construction, including right-of-way (ROW) access (Reference 2) and maintenance activities, is discussed in Subsections 3.7.1 and 3.7.5.

3.7.1 TRANSMISSION SYSTEM

Lee Nuclear Station Units 1 and 2 are located in the eastern portion of Cherokee County in north central South Carolina, approximately 35 miles southwest of Charlotte, North Carolina, approximately 25 miles northeast of Spartanburg, South Carolina and approximately 7.5 miles southeast of Gaffney, South Carolina. The power from Unit 1 is transmitted via an overhead transmission line to a 525 kV switchyard. Similarly, the power from Unit 2 is transmitted via an overhead transmission line to a 230 kV switchyard.

The 525 kV switchyard is located south of Unit 1 and is tied to the Duke Energy 525 kV network by two single circuit overhead lines, namely Asbury East (northeast to Newport) and Asbury West (southwest to Oconee). The 525 kV switchyard is also connected to the 230 kV switchyard through autotransformers.

The 230 kV switchyard is located east of the 525 kV switchyard and is tied to the Duke Energy Carolinas 230 kV network by two double circuit overhead lines, namely Roddey East (northeast to Catawba) and Roddey West (southwest to Pacolet).

The 525 kV substation connects Unit 1 to the 525 kV transmission system. The 230 kV substation connects Unit 2 to the 230 kV transmission system. Both substations utilize a “breaker and a half” bus configuration with a “red” and “yellow” bus. All breakers are in the closed position with red and yellow buses energized under normal operation. The two substations are connected by two 230 kV to 525 kV autotransformers.

The 525 kV switchyard is configured to accommodate two incoming transmission lines, two autotransformer connections, the Unit 1 GSU, and three spare circuit positions.

The 230 kV switchyard is configured to accept a maximum of four 230 kV lines interconnecting the transmission grid by two 230 kV double circuit lines. There are two terminals dedicated to accommodate the two autotransformers, one terminal for the Unit 2 GSU connection, one terminal for connection to the Unit 1 RATs, one terminal for connection to the Unit 2 RATs, and three spare circuit positions. The configuration of the switchyard is shown in FSAR Figure 8.2-202.

The substation structure is tubular steel design with all power circuit breakers and switches fully rated for the ultimate load and fault current levels to which the substation might be exposed. The nominal continuous current ratings of the installed equipment (based on a nominal operating temperature of key elements at 90 Deg C) is 4000 amperes for the 525 kV switchyard and 3000 amperes for the 230 kV switchyard. Circuit breakers are equipped with an appropriate compliment of current transformers to support relay, control and metering functions.

Failure Analysis

The design of the offsite power system provides for a robust system that supports reliable power production. Offsite power is not required to meet any safety function and physical independence is obviated by this lack of safety function and by the AP1000’s partial exemption to GDC 17 granted by the NRC during design certification. Nevertheless, multiple, reliable transmission circuits are provided to support operation of the facility. Neither the accident analysis nor the Probabilistic Risk Assessment has identified the non-safety related offsite power system as risk significant for normal plant operation.

The 525 kV switchyard is connected to two transmission lines and the 230 kV switchyard is connected to four transmission lines. No single transmission line to either switchyard is designated as the preferred circuit, but each line has sufficient capacity and capability from the transmission network to power the safety-related systems and other auxiliary systems under normal, abnormal, and accident conditions.

A failure modes and effect analysis (FMEA) of the Lee Nuclear Station switchyard confirms that a single initiating event, such as an offsite transmission line fault, plus a single breaker failure still provides the availability of at least one offsite transmission source to the switchyards. This evaluation recognizes that a single failure of some switchyard components could directly cause the loss of switchyard feed to the GSU, such as a fault on this main busline feed.

Evaluated events in the FMEA include a breaker not operating during a fault on a offsite transmission line; fault on a switchyard bus; fault on an autobank; a spurious relay trip; and a loss of control power supply. Some possible component outage combinations that can occur as a result of a single faulted zone and a breaker failure to trip are: 1 line and a bus, 1 line and a unit’s RATs, 1 bus and an autobank or 2 autobanks. No combination results in an outage on a GSU and the associated unit’s RATs.

Transmission System Provider/Operator (TSP/TSO):

Duke Energy is a regulated, vertically integrated utility with regards to its electric generation and transmission operations. Duke Energy's Nuclear Generation Department (NGD) has a formal agreement titled a "service level agreement" (SLA) with the TSO, which is Duke Energy's Power Delivery (PD) department. The PD department includes the Transmission Control Center (TCC), transmission System Operation Center (SOC), and transmission Planning and Grid Operations (PGO). The SLA and associated Department Directives serve as the communications protocol with the TSO. These documents facilitate adequate and prompt communications between the TSO and the plant operators.

Duke Energy is also the transmission system provider. The TSP/TSO establishes a voltage schedule for the 525 kV & 230 kV switchyard. The nuclear power plant, while generating, is expected to supply or absorb reactive power to help regulate voltage in the 525/230 kV switchyard in accordance with TSP/TSO voltage schedule criteria. The TSP/TSO also maintains switchyard voltage such that voltage on the 26 kV isophase bus is within 0.95 – 1.05 p.u. of its nominal value.

The plant's operator workstations monitor switchyard voltage, frequency, and other offsite power system parameters. The operator workstations are set to alert the nuclear plant operator if the grid may not be able to supply offsite power of sufficient voltage. Procedures direct the plant operators to contact the TSO and request a status of the most current contingency analysis for existing grid conditions. If the results of the contingency analysis indicate that insufficient voltage would exist in the switchyard, the procedures direct the plant operators to take appropriate actions.

The SLA between NGD and PD sets the requirements for transmission system studies and analyses. These analyses demonstrate the capability of the offsite provider of supporting plant start up and normal shutdown.

PD is the approving grid organization for reliability studies performed on the area bulk electric system. PD conducts planning studies of the transmission grid on an ongoing basis. Model data used to perform simulation studies of projected future conditions is maintained and updated as load forecasts and future generation / transmission changes evolve. Studies are performed annually to assess future system performance in accordance with North American Electric Reliability Corporation (NERC) reliability standards. These studies form a basis for identifying future transmission expansion needs.

New large generating units requesting to connect to the area bulk electric system are required to complete the Large Generator Interconnection Procedure (LGIP). The studies performed by Duke Energy TSO as part of this procedure, examine the generating unit (combined turbine-generator-exciter) and the main step-up transformer(s).

The SLA between NGD and PD demonstrates protocols in place for the plant to remain cognizant of grid vulnerabilities and make informed decisions regarding maintenance activities critical to the electrical system.

In the operations horizon, the Duke Energy TSO continuously monitors real-time power flows and assesses contingency impacts. Operational planning studies are also performed using offline power flow study tools to assess near term operating conditions under varying load, generation, and transmission topology patterns.

A detailed description of the offsite power system is included in FSAR Section 8.2.

The 525 kV and 230 kV switchyards each have two main buses for each voltage level. All of the 525 kV and 230 kV lines and each of the GSUs are connected to both buses. This switchyard scheme is referred to as a “breaker and a half” scheme. This arrangement is used for reliability and flexibility, and allows for isolation of components and buses, while preserving the plant’s connection to the grid.

Under normal operating conditions, all circuit breakers and all bus sectionalizing motor operated disconnects are closed, and all bus sections are energized.

The transmission line relay protection circuits continuously monitor the conditions of the offsite power system and are designed to detect and isolate the faults with maximum speed and minimum disturbance to the system. The principal features of these schemes are described below:

Each of the 525 kV and 230 kV lines are protected by two independent pilot systems to clear for a fault anywhere on the line. The two autotransformers each have primary and secondary protective relaying.The primary and secondary relaying use separate instrument current transformers for monitoring, and separate DC power supplies.

The breaker failure relays operate after a preset time delay. Should a breaker fail to trip within the time setting, the associated breaker failure trip relay will trip and lock out all breakers necessary to isolate the failed breaker from all local sources. A breaker failure relay operation will also isolate the remote sources through a direct transfer trip operation for all 525/230 kV switchyard breakers connected to a GSU, RAT, and Autobank transformer.

A control building is erected to serve the needs of the switchyard. The size of this building is approximately 40 ft x 60 ft. The control building houses the switchyard batteries (redundant battery systems are housed in separate battery rooms and appropriately ventilated) and is capable of accommodating a sufficient number of relay/control panels. A primary and backup heat pump is installed to keep electronic equipment at an acceptable temperature.

525 kV and 230 kV breakers associated with the GSUs (yellow bus and mid-tie breakers) are under operational control of the plant. Engineering and maintenance is the responsibility of PD. The controls for these breakers will be located inside the plant. Manual controls will be duplicated in the switchyard control building as well.

TCC will have operational control over all the other breakers in the 525 kV and 230 kV switchyards (including those associated with the RATS) with manual controls located in the switchyard control building.

The Lee Nuclear Station Unit 1 transmission lines are connected to the Duke Energy transmission system via the Asbury 525 kV line. The existing Asbury line runs from Newport Tie to Oconee Nuclear Station. The new configuration of the 525 kV line consists of a section of line, 34 miles (mi.) in length, from Lee Nuclear Station to the Newport Tie and a section of line, 103 mi. in length, from Lee Nuclear Station to Oconee Nuclear Station. Approximately 30 mi. of the new configuration are on a new ROW. The 525 kV line is constructed on a 200-ft.-wide ROW with single-circuit lattice steel towers, varying in height from 120 ft. to 150 ft. but with a nominal height of 140 ft. The towers as illustrated in Figures 3.7-2 and 3.7-4 vary in weight from 35,000 pounds (lbs.) for the nominal suspension structure to 150,000 lbs. for the heaviest strain structure. The tower foundations and leg designs are illustrated in Figures 3.7-5 and 3.7-6. Conductors are two per phase in a horizontal bundle 18 in. center to center. The conductors are sized as 2515AWG, aluminum-clad steel reinforced (ACSR) (76/19 stranding) with horizontal phase spacing of 35 ft. to 49.5 ft. The minimum ground clearance for maximum sag condition is 45 ft. The maximum operating temperatures of the line are 212ºF normal and 248ºF emergency. The average ruling span is 1300 ft. The lines are designed to meet or exceed the requirements of ANSI C2-2002, National Electrical Safety Code (NESC) (Reference 1). The 525 kV line is designed to keep the electric field at the conductor surface significantly below corona inception (Reference 2).

The Lee Nuclear Station Unit 2 transmission lines are connected to the Duke Energy transmission system via the Roddey 230 kV line. The existing Roddey line runs from Catawba Nuclear Station to Pacolet Tie. The new configuration of the 230 kV line consists of a section of line, 32 mi. in length, from Lee Nuclear Station to Catawba Nuclear Station and a section of line, 25 mi. in length, from Lee Nuclear Station to the Pacolet Tie. Approximately 15 mi. of the new configuration is on a new ROW. The 230 kV line is constructed on a 150-ft.wide ROW with double-circuit lattice steel towers, varying in height from 120 ft. to 190 ft. but with a nominal height of 150 ft. The towers as illustrated in Figure 3.7-2 and 3.7-3 vary in weight from 40,000 lbs. for the nominal suspension structure to 160,000 lbs. for the heaviest strain structure. The tower foundations and leg designs are illustrated in Figures 3.7-5 and 3.7-6. Conductors are two per phase in a horizontal bundle 18 in. center to center. The conductors are 1272 AWG, ACSR (54/19) with horizontal phase spacing of 36.5 ft. to 56 ft. The vertical phase spacing is 19.5 ft. to 22.5 ft. The minimum ground clearance for maximum sag condition is 35 ft. The maximum operating temperatures of the line are 212ºF normal and 248ºF emergency. The average ruling span is 1000 ft. The lines are designed to meet or exceed the requirements of the NESC (Reference 1). The 230 kV line is designed to keep the electric field at the conductor surface significantly below corona inception (Reference 2).

3.7.2 DESIGN PARAMETERS

The existing 525 kV and 230 kV transmission line system designed configurations are described in Subsection 2.2.2. The new transmission line system design configuration is described in Subsection 3.7.1. Auxiliary electrical power during startup and shutdown for Lee Nuclear Station is supplied from the transmission network to the plant electrical distribution system.

The normal ac power supply to the main ac power system is provided from the main generator. When the main generator is not available, plant auxiliary power is provided from the switchyard by backfeeding through the main stepup and unit auxiliary transformers. This is the preferred power supply. When neither the normal nor the preferred power supply is available due to an electrical fault at either the main stepup transformer, unit auxiliary transformer, isophase bus, or 6.9kv nonsegregated bus duct, fast bus transfer will be automatically initiated to transfer the loads to the reserve auxiliary transformers powered by maintenance sources of power (the transmission network). In addition, two non-Class 1E onsite standby diesel generators supply power to selected plant loads in the event of loss of the normal, preferred, and maintenance power sources. The reserve auxiliary transformers also serve as a source of maintenance power.

The main generator is connected to the offsite power system via three single-phase main stepup transformers. The normal power source for the plant auxiliary ac loads is provided from the isophase generator bus through the two unit auxiliary transformers of identical ratings. In the event of a loss of the main generator, the power is maintained without interruption from the preferred power supply by an auto-trip of the main generator breaker. Power then flows from the transformer area to the auxiliary loads through the main and unit auxiliary transformers.

The transmission line structures associated with the plant are designed to withstand standard loading conditions for the specific site, as provided in Reference 1. The transmission line structures are self-supporting steel towers. This self-supporting aspect of the structures eliminates the need for guy wires. The 525 kV and 230 kV transmission line structures are designed to withstand medium loading conditions, as specified in Reference 1. Designing to these requirements ensures the adequacy of lines to withstand wind and icing conditions in excess of those expected in this area. The phase conductor and shield wire design tensions are selected to avoid vibration problems. Transmission lines in the 525 kV and 230 kV voltage class have two overhead ground wires provided for lightning protection. This shielding has been effective for an area isokeraunic level of 60 and is reflected in the average operating record of only 0.8 and 2.8 flashover interruptions annually as a result of lightning per 9100 mi. of 525 kV and 230 kV lines, respectively. The use of circuit breakers with automatic reclosing circuits results in the majority of these interruptions being momentary. Electrical design parameters for the transmission system are provided in FSAR Sections 8.1 and 8.2, and Subsection 3.7.1 of this report.

Automatic load dispatch is not used at the site and does not interface with the safety-related action required of the reactor protection system.

3.7.3 TRANSMISSION LINE RIGHT OF WAY (CORRIDORS)

Selection of the transmission right of ways is discussed in Subsection 9.4.3. Subsection 9.4.3 discusses the requirements for the State of South Carolina Certification of Environmental Compatibility and Public Convenience and Necessity including a discussion of the environmental reviews, siting procedures, right of way dimensions, resources that may be impacted, and general construction methods.

The engineering surveys for the transmission facilities into Lee Nuclear Station will be completed with field reconnaissance of the routes made by qualified archaeologists. In addition to the engineering field surveys, inventories of structures in the vicinity of the transmission lines were evaluated and sent to the State of South Carolina Department of Archives and History (Subsection 4.1.3 and Reference 2). Reference 2 indicates that no adverse impacts on any cultural resources or areas of historic significance are expected to result from construction of the transmission lines. Maintenance of the corridors, including vegetation control, is provided by a herbicide program that is in effect to control vegetation within the boundaries of the transmission line ROW. Where herbicides cannot be applied, vegetation is cut and removed as described in Subsection 3.7.5. The proposed transmission corridors are described in Subsection 9.4.3 (Reference 2).

3.7.4 NOISE AND EMF IMPACT

Duke Energy recognizes there is public concern about noise levels that result from generation, transmission, distribution, and use of electricity. Community noise impacts are usually judged in reference to the existing background sound levels and the increase the facility noise has on this background. Noise levels and EMF generated by Lee Nuclear Station power lines are not measurable directly because the new system has not been constructed. However, studies of similar power line noise at ROW edges have been measured for other systems as described in Reference 2.

The ground level electric field for the double-circuit 230 kV line is highest almost directly under conductors. This is influenced by the vertical configuration of the conductors. There is a significant cancellation of the electric field compared to single-circuit construction because of the flipping of the phase sequence that is a standard with Duke Energy designs. The ground level electric field starts decreasing as the horizontal distance from the conductors increases. The ground level electric field for the 525 kV line is much higher than for the 230 kV line because of two main factors - higher operating voltage and single-circuit construction (i.e., no opportunity for phase cancellation effects). The ground level electric field peaks at a distance of about 15 ft. horizontally on the opposite side of the outside phase (50 ft. from center of line). The electric field decreases from that point away from the line as distance increases.

Both the 525 kV and 230 kV lines are designed to be corona free during fair weather. Corona causes the audible noise. The components of these lines are designed so the conductor surface gradient is below the corona inception level for fair weather conditions. For mainly the 525 kV lines, corona occurs if there are water droplets on the conductor or if contamination, such as bugs, impacts the conductors. This forces the surface gradient at the point of contamination to exceed the corona inception level and causes audible noise.

3.7.5 TESTING AND MAINTENANCE PLANS FOR THE TRANSMISSION SYSTEM AND THE INTERCONNECTION SUBSTATION

Duke Energy owns and operates the interconnection facilities, which includes the interconnecting substation yard, two 525 kV transmission lines, and two 230 kV transmission lines, has ongoing inspection and maintenance programs to assure the continuous reliable operation of those facilities. The maintenance and inspection programs use a combination of best utility practices, operating experience, and equipment manufacturers' recommendations to determine the types of maintenance and their respective frequency.

All transmission lines in Duke Energy's transmission system are currently inspected twice per year through an aerial inspection program. The inspection has a specific focus on ROW encroachments, vegetation management, conductor and line hardware condition assessment, and supporting structures. A herbicide program is in effect to control vegetation within the boundaries of the transmission line ROW. Where herbicides cannot be applied, vegetation is cut and removed. This cutting and removal effort is extended beyond the formal ROW limit to address the presence of any danger trees which may adversely impact the operation of the transmission line (Reference 2).

The interconnecting switchyard, as well as other substation facilities, have multiple levels of inspection and maintenance. Those include the following:

- Walk through and visual inspection of the entire substation facility.
- Relay functional tests.

- Oil sampling of large power transformers. Oil samples are evaluated through the use of gas chromatography and dielectric breakdown analysis.
- Power circuit breakers are subjected to three levels of inspection and maintenance. The frequency of each is a function of number of operations and time. Maintenance leverages the use of external visual inspection of all functional systems, an external test, and an internal inspection. Frequency of the various maintenance/inspection efforts is based on a combination of operating history of the type of breaker, industry practice and manufacturer's recommended maintenance requirements.
- A power test (Doble Test) is typically performed on oil filled equipment.
- Thermography is used to identify potential thermal heating issues on bus, conductors, connectors and switches.

3.7.6 REFERENCES

1. Institute of Electrical and Electronics Engineers, *National Electrical Safety Code*, ANSI C2-2002.

2. Duke Energy Carolinas LLC, *W.S.Lee III Nuclear Station Siting and Environmental Report for the 230 kV and 525 kV Fold-In Lines*, Cherokee and Union Counties, SC, November 2007.

3.8 TRANSPORTATION OF RADIOACTIVE MATERIALS

This section describes the impacts of transporting radioactive materials to and from the Lee Nuclear Station. Postulated accidents due to transportation of radioactive materials are discussed in Section 7.4.

The Lee Nuclear Station design and operational characteristics that demonstrate compliance with the requirements of 10 CFR 51.52, Table S-4, "Environmental Impact of Transportation of Fuel and Waste To and From One Light-Water-Cooled Nuclear Power Reactor," are discussed. Information on the unit design fuel is that presented in the AP1000 DCD.

3.8.1 TRANSPORTATION OF UNIRRADIATED FUEL

New fuel assemblies are transported to the Lee Nuclear Station by truck, from a fuel fabrication facility, in accordance with U.S. Department of Transportation (DOT) and U.S. Nuclear Regulatory Commission (NRC) regulations. The initial fuel loading consists of 157 fuel assemblies for one AP1000. Every 18 months, refueling requires an average of 68 fuel assemblies for one AP1000. The fuel assemblies are fabricated at a fuel fabrication plant and shipped by truck to the Lee Nuclear Station shortly before they are required. The details of the container designs, shipping procedures, and transportation routings depend on the requirements of the suppliers providing the fuel fabrication services.

3.8.2 TRANSPORTATION OF IRRADIATED FUEL

Spent fuel assemblies are discharged from each unit during refueling outages and are placed into the spent fuel pool. The spent fuel pool has the capacity to store 889 fuel assemblies. Each refueling offload is 68 fuel assemblies. Therefore, the spent fuel storage pool has the capacity for ten refueling offloads, representing approximately 15 years storage plus a full core offload. Spent fuel remains on-site for a minimum of 5 years between removal from the reactor and shipment off-site.

Spent fuel is packaged for shipment off-site in a manner that complies with the applicable U.S. DOT and NRC regulations for transportation of radioactive material. Department of Energy (DOE) is responsible for spent fuel transportation from reactor sites to a repository (Reference 1), and DOE determines the transport mode.

The following subsections describe Lee Nuclear Station's compliance with 10 CFR 51.52(a) requirements for determining the environmental impacts of radioactive materials transport to and from the site.

3.8.2.1 Reactor Core Thermal Power

As stated in Section 3.2, the AP1000 reactor core has a thermal power rating of 3400 megawatts and meets the requirements of 10 CFR 51.52(a)(1).

3.8.2.2 Fuel Form

The AP1000 uses a sintered uranium dioxide pellet fuel form and meets the requirements of 10 CFR 51.52(a)(2).

3.8.2.3 Fuel Enrichment

The AP1000 initial load fuel enrichment varies by region from 2.35 to 4.45 weight (wt.) percent, and the average enrichment for reloads is 4.51 wt. percent. The AP1000 fuel exceeds the 4 wt. percent uranium 235 (U-235) enrichment requirement of 10 CFR 51.52(a)(2). The results of the required additional analysis are presented below.

In NUREG-1437, "Generic Environmental Impact Statement for License Renewal of Nuclear Power Plants" and NUREG-1437, Vol. 1, Addendum 1, "Generic Environmental Impact Statement for License Renewal of Nuclear Power Plants, Main Report, Section 6.3 - Transportation, Table 91, Summary of findings on NEPA issues for license renewal of nuclear power plants," the NRC states that spent nuclear fuel with U-235 enrichment levels up to 5 wt. percent and irradiation levels up to 62,000 megawatt-days per metric ton (MWD/MTU) do not increase the environmental risks associated with spent nuclear fuel transport listed in 10 CFR 51.52, Table S-4, provided that more than 5 years elapses between removal of the fuel from the reactor and shipment of the spent fuel off-site.

Five years is the minimum decay time before shipment of irradiated fuel assemblies from Lee Nuclear Station. The DOE's contract for acceptance of spent fuel, as set forth in 10 CFR 961, Appendix E, requires a minimum five-year cooling time. In addition, in NUREG-1437, Addendum 1, "Generic Environmental Impact Statement for License Renewal of Nuclear Plants," the NRC specifies five years as the minimum fuel cooling period when it issues certificates of compliance for spent fuel casks. Lee Nuclear Station's storage capacity exceeds that needed to accommodate a five-year cooling period for irradiated fuel prior to transport off-site. Therefore, Lee Nuclear Station meets the requirement because the higher percentage of fuel enrichment, combined with the minimum five-year decay time prior to shipment for disposal, does not increase the environmental risk.

3.8.2.4 Fuel Encapsulation

The AP1000 uses ZIRLO™ cladding, which is not identified as an approved fuel encapsulation medium in 10 CFR 51.52(a)(2). The NRC has approved use of ZIRLO™ in 10 CFR 50.44. The staff has determined that use of ZIRLO™ presents no significant increase in the amounts of effluent or significant change in the types of effluents that may be released off-site. The staff also concluded that no significant increases in individual doses or cumulative occupational radiation exposure occur. Therefore, use of ZIRLO™ meets the environmental impact requirement because its use as a fuel encapsulation medium does not increase the environmental risk.

3.8.2.5 Average Fuel Irradiation

The average burnup exceeds the requirement of 10 CFR 51.52(a)(3). As stated in Subsection 3.8.2.3, the NRC considers up to 62,000 MWD/MT as bounded by the impacts listed in 10 CFR 51.52, Table S-4, provided that more than 5 years elapses between removal of the fuel from the reactor and shipment of the fuel off-site. Lee Nuclear Station is bounded by the 62,000 MWD/MTU average burnup limit as considered by the NRC.

For the reasons presented in Subsection 3.8.2.3, the average fuel burnup for the Lee Nuclear Station fuel assemblies meets the requirement and does not increase the environmental risk.

3.8.2.6 Transportation of Irradiated Fuel

In accordance with the requirements of 10 CFR 51.51(a)(5) for spent fuel transportation from a nuclear power site to a disposal repository, irradiated fuel is transported from the Lee Nuclear Site by truck or rail. DOE is responsible for spent fuel transportation from reactor sites to the repository and will make the decision on transport mode as stated in 10 CFR 961.1. The heat load of the spent fuel shipping casks and the dose to the general public are bounded by the conditions of Table S-4, as discussed in Subsection 7.4.2.

3.8.2.7 Summary

The Lee Nuclear Station units meet the NUREG-1555 guidance for average fuel enrichment or average fuel irradiation, as well as the requirements of 10 CFR 51.52(a). Therefore, no additional analyses of fuel transportation effects for normal conditions and accidents, respectively, are required.

3.8.3 TRANSPORTATION OF RADIOACTIVE WASTE

Subparagraph 10 CFR 51.52 (a)(4) requires that, with the exception of spent fuel, radioactive waste shipped from the reactor be packaged and in solid form. As described in Subsections 3.5.3 and 5.5.2, low-level radioactive waste is packaged to meet transportation and disposal site acceptance requirements. Transportation of low-level radioactive waste from the Lee Nuclear Station is by truck or rail. The weight and frequency of shipments are bounded by the conditions of Table S-4, as discussed in Subsection 7.4.1. Processing and packaging of radioactive waste are performed using mobile systems in the auxiliary building rail car bay and in the mobile systems facility part of the radwaste building.

Administrative controls that govern the treatment and packaging of waste for off-site shipment comply with DOT and NRC regulations for transportation of radioactive material.

The packaged waste is stored in the auxiliary and radwaste buildings until it is shipped off-site for disposal. Lee Nuclear Station has no provisions for permanent storage of radwaste.

3.8.4 REFERENCES

1. Nuclear Waste Policy Act of 1982, Public Law No. 97-425, 96 Stat. 2201, January 7, 1983.