Bellefonte Nuclear Plant, Units 3 & 4
COL Application
Part 3, Environmental Report

CHAPTER 3

PLANT DESCRIPTION

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CHAPTER 3

PLANT DESCRIPTION

3.0 PLANT DESCRIPTION

This chapter discusses the construction and operation of BLN. Chapter 3 is written for single unit operation 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 describes the interfaces of the units with the environment. For purposes of this ER, the site, vicinity, and region are defined in Section 2.0.

3.1 EXTERNAL APPEARANCE AND PLANT LAYOUT

The Bellefonte Nuclear Plant, Units 3 and 4 (BLN) is located on a site adjacent to the Tennessee River near Hollywood, Alabama. BLN is approximately 6 mi. northeast of Scottsboro, Alabama, and approximately 38 mi. east of Huntsville in Jackson County, Alabama, on a peninsula extending along the west bank of the Guntersville Reservoir. Further information related to site location is provided in Section 1.1. The site lies on the southeast side of Browns' Valley which separates Sand Mountain on the southeast from the remainder of the Cumberland Plateau on the northwest. The site is located in Jackson County in the northeastern corner of the state, bounded by the Tennessee state line, the Georgia state line, and by DeKalb, Marshall, and Madison counties. BLN is located behind a wooded ridge of hills on the southeastern edge of the peninsula that separates the plain from the Guntersville Reservoir. The north and northwestern edges are penetrated by natural inlets from Town Creek, while the southwestern boundary connects with the mainland.

The site boundary line is illustrated in Figure 1.1-3. The station property lines are the same as the site boundary lines. The exclusion area boundary is illustrated in FSAR Figure 2.1-205. The access highway and railroad to the site as well as, the highways, railways, and waterways in the vicinity of the BLN, are illustrated in Figure 1.1-2.

Site features and structures are depicted as follows:

- The gaseous release points and their elevations are discussed in Sections 3.5 and 3.6. Structure locations are depicted in Figure 3.1-6.
- The liquid release points and their elevations are discussed in Section 3.6. Structure locations are depicted in Figure 3.1-6.
- The location of the meteorological towers is illustrated in Figure 2.1-1.
- The wastewater retention basin (WWRB) is illustrated in Figure 3.1-6.
- The construction site plan is illustrated in Figure 3.1-6.
- The land to be cleared is illustrated in Figure 4.3-1.

The BLN site currently contains the main structures from Bellefonte Units 1 and 2. The state of these structures is discussed in Section 2.2. The site and plant layout are illustrated in Figure 2.1-1. Each unit is composed of five principle building structures: 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 is surrounded by a Seismic Category I reinforced concrete shield building. The shield building is a Seismic Category I reinforced concrete structure. 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 of reinforced concrete and steel-framed structure with insulated metal siding. The portion of the annex building adjacent to the nuclear island is a Seismic Category II structure.

The diesel generator building is a single-story, steel-framed structure with insulated metal siding. The radwaste building includes facilities for segregated storage of various categories of waste prior to processing, for processing by mobile systems, and for storing processed waste in shipping and disposal containers.

The turbine building is a steel column and beam structure. Additional plant structures include warehouses, administration/office buildings, and the existing switchyard and transmission towers.

The circulating water systems (CWS) for BLN use the two existing concrete natural draft hyperbolic cooling towers, one per unit. Tower locations are illustrated on Figure 3.1-6. A description of the cooling towers is located in Subsection 3.4.2.3. In addition to the CWS natural draft towers, BLN uses mechanical draft cooling towers for the service water system (SWS) cooling.

The overall plant arrangement for BLN 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 for the site, areas adjacent to the structures, and in the parking areas blend with the natural surroundings in order to reduce visual impacts.

Photographs which show the station from several vantage points where a visual impact can be expected are included in Figures 3.1-1, 3.1-2, 3.1-3, and 3.1-4. These photographs have been modified to depict the likeness of the BLN as described in this ER. Figure 3.1-1 illustrates the visual impact from a residential vantage point. Figure 3.1-2 illustrates the visual impact from a local transportation corridor. Figure 3.1-3 illustrates the visual impact from a local industrial site. Figure 3.1-4 illustrates the visual impact from a cultural vantage point. Figure 3.1-5 illustrates the appearance of the BLN site with the addition of Units 3 and 4. Figure 3.1-7 is an architectural rendering of the site with the addition of Units 3 and 4.

3.2 REACTOR POWER CONVERSION SYSTEM

BLN is a dual-unit site with Westinghouse AP1000 pressurized water reactors. The architect-engineer is addressed in 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. A single 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.

The rated thermal power of each reactor is 3400 MWt with a nuclear steam supply system rating of 3415 MWt (core plus reactor coolant pump heat).

The reactor contains a matrix of fuel rods assembled into 157 mechanically identical fuel assemblies along with control and structural elements. A fuel assembly consists of 264 fuel rods in a 17 x 17 square array. 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 psia. The fuel, internals, and coolant are contained within a heavy walled reactor pressure vessel.

The fuel rods consist of enriched uranium, in the form of cylindrical pellets of sintered uranium dioxide contained in ZIRLO™ tubing, with an initial enrichment of 2.35 to 4.45 wt. percent U-235. The average concentration of U-235 in reloads is 4.51 wt. percent. The total weight of uranium dioxide is 211,588 lbs. as shown in DCD Table 4.1-1. 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 MWD/MTU. The NRC has approved maximum fuel rod average burnup of 60,000 MWD/MTU. Extended burnup to 62,000 MWD/MTU has been established in the DCD Subsection 4.3.1.1.1.

The ZIRLO™ tubing is plugged and seal-welded at the ends to encapsulate the fuel. An axial blanket comprised 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 (CWS). 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 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 100. The following subsections define the 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. The following paragraph details this safety-related feature.

Passive Containment Cooling System: The function of the passive containment cooling system is to maintain the containment air temperature below a specified 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.

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 rpm machine. The turbine system includes stop, control, and intercept valves directly attached to the turbine and in the steam flow path, crossover and crossunder piping between the turbine cylinders and the moisture separator reheater. The design is provided as the reference design in DCD Chapter 10.

Each turbine generator has an output of approximately 1200 MWe for each reactor thermal output of 3415 MWt. The generator rating is 1,375,000 kVA with a power factor of 0.9. Plant electrical consumption (station and auxiliary service loads) is about 83 MWe or approximately 6.9 percent of generator output at rated power. 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 $\times 10^5$ ft^2 or 4.12 $\times 10^5$ 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 in the low pressure condenser shell drains through internal piping to the high pressure (hottest) shell where it is slightly heated and mixed with condensate of the high pressure shell. 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 FSAR Table 10.4-201.

3.3 PLANT WATER USE

The BLN requires water for both plant cooling and operational uses. The plant water consumption and water treatment are determined from the AP1000 Design Control Document, site characteristics, and engineering evaluations.

Raw water is required to support the needs of the facility during construction and operation, including the requirements of the normal heat sink main circulating water system and cooling water systems for plant auxiliary components (e.g., service water). Raw water also supplies the 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 Guntersville Reservoir.

Figure 3.3-1 is a water balance summary for the BLN. Table 3.3-1 provides estimates of water use and blowdown discharged to the Guntersville Reservoir. Average and maximum water consumption is given in Table 2.3-32 along with the average, maximum, and minimum stream flowrates. Monthly streamflow values are given in Table 2.3-7 for the South Pittsburg (Tennessee) USGS gauge station and Table 2.3-12 for the Guntersville USGS gauge station. The maximum and minimum streamflows are given in Tables 2.3-8 and 2.3-9 for the South Pittsburg (Tennessee) USGS gauge station and Tables 2.3-11 and 2.3-13 for the Guntersville USGS gauge station. The data presented in these tables indicate that the maximum water withdrawal from the Guntersville Reservoir is negligible even under conditions of minimum streamflow.

Detailed water use by operating mode is given in Table 3.4-2. Subsection 3.4.1.2 gives the anticipated duration of each normal operating mode (power operation, start up, hot standby, safe shutdown, cold shutdown, and refueling). Water use information is derived from the operating mode information provided in Section 3.4 and the flow rates provided in Section 2.3.

3.3.1 WATER CONSUMPTION

3.3.1.1 Normal Plant Heat Sink

Waste heat is transfered from the main condenser to the atmosphere through the circulating water system (CWS). Makeup water from the Guntersville Reservoir 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. This blowdown is directed to an outfall that discharges back to the Guntersville Reservoir.

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

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 Guntersville Reservoir to replace losses due to evaporation, drift, and blowdown. Flowrates are as shown on Figure 3.3-1 and are tabulated in Table 3.3-1.

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 that 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.

SWS blowdown is directed to the wastewater retention basin (WWRB). This blowdown is used to control levels of solids concentration in the SWS. Discharges are in accordance with applicable federal, state and local requirements (e.g., NPDES, CWA requirements). This is further detailed in Subsection 2.3.3.

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 Guntersville Reservoir, processes this water to remove ionic impurities, and provides demineralized water to the demineralized water transfer and storage system (DWS). Flowrates are as shown on Figure 3.3-1 and are tabulated 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 that require pure water, the demineralized water is used to sluice spent radioactive resins to the solid radwaste system from the ion exchange vessels in the chemical and volume control system, the spent fuel pool cooling system, and the liquid 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 Scottsboro Municipal Water System. Flowrates are as shown on Figure 3.3-1 and are tabulated in Table 3.3-1. Sanitary wastes are routed to the Scottsboro Wastewater Treatment Facility.

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 2 hrs. Make-up water for the FPS is provided by the Scottsboro Municipal Water System. The emergency fill to the fire protection system is from the granular media filter and is estimated to be 625 gpm.

3.3.2 WATER TREATMENT

A description of the treatment system is provided in Section 3.6. The frequency of treatment for each of the normal modes of operation are described in Section 3.6, as well as the quantities and points of addition of the chemical additives.

3.3.2.1 Circulating Water System

Circulating water chemistry 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. This formation 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. A sodium hypochlorite treatment system is provided for use as the biocide. The biocide application frequency may vary with seasons. The algaecide is applied, as necessary, to control algae formation on the natural draft cooling tower.

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 seasons. Algaecide is applied, as necessary, to control algae formation on the mechanical draft 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 source of potable water is the Scottsboro Municipal Water System. The water supplied by this municipal water system is in compliance with state drinking water quality standards and is not subject to additional treatment.

3.3.2.4 Demineralized Water System

Raw 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

Fire protection makeup water (potable water) is supplied by the Scottsboro Municipal Water System. The system does not normally require disinfecting or other treatment.

TABLE 3.3-1
PLANT WATER USE

Stream	Normal One Unit (gpm)	Maximum One Unit (gpm)
Circulating Water System		
Evaporation Rate	16,039	16,039[a]
Drift Rate	106	106[a]
Blowdown Rate	7,914	7,914[a]
CWS Makeup Flowrate	24,059	24,059[a]
Service Water System		
Evaporation Rate	183	624
Drift Rate	1	2
Blowdown Rate	61	205
SWS Makeup Flowrate	245	831
Demineralized Water Makeup Rate	175	540
Fire Water Makeup Rate	0.4	625
Potable Water	17	35

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a) Typically, the plant is at 100 percent power operation, which is at maximum makeup demand, therefore, the maximum is approximated to be the same as the normal need.

3.4 COOLING SYSTEM

BLN cooling systems and their anticipated modes of operation are described in Subsection 3.4.1. Design data and performance characteristics for these 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

BLN is provided with two cooling systems that transfer heat to the environment during normal modes of plant operation. These systems are the SWS and the CWS. There are six anticipated operational modes.

- Power operation
- Startup
- Hot standby
- Safe shutdown
- Cold shutdown
- Refueling

Heat generated during each operational mode is released to the atmosphere and to the Guntersville Reservoir from the CWS and SWS. The amount of heat released to the atmosphere and the Guntersville Reservoir during each mode of operation is documented in Table 3.4-1.

The CWS and SWS are supplied with water from the intake in order to makeup for that which has been consumed and discharged as part of the system operations. The quantities of water withdrawn, consumed, and discharged for the CWS and the SWS are documented in Table 3.4-2.

TVA holds a current NPDES permit for the Tennessee River and Town Creek at BLN, in compliance with the CWA and the Alabama Water Pollution Control Act. The permit number is AL0024635, and it is valid until November 30, 2009. The permit requires modification to support the new units prior to construction.

3.4.1.1 System Description

<u>Circulating Water System</u>

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. Circulating water from the cooling tower basin is pumped by three, 33 1/3-percent capacity, electric motor-driven, mixed-flow pumps, which provide a flow rate of 177,000 gpm each, into the main condensers and heat exchangers, then to the natural draft cooling tower. Once in the cooling tower, the water is cooled by natural convection and evaporation. The heat removed is rejected to the atmosphere, and the cooled water returns to the cooling tower basin. The system is provided with a blowdown capability to maintain the system performance by elimination of contaminates that buildup as a result of the evaporation process. The blowdown temperature is 95°F maximum and averages 91°F. The raw water system (RWS) supplies water to the CWS cooling tower to makeup for water consumed as the result of evaporation, drift and blowdown. The chemical concentration factor for the CWS cooling tower is three cycles of concentration. The basic system configuration is illustrated in Figure 3.4-1.

The RWS makeup to the CWS consists of three 50-percent capacity pumps for each unit. Two of these pumps are in operation whenever the CWS requires makeup water, the third is in standby and starts in the event that one of the operating pumps trips. At the intake pumping station, the raw water is first strained by trash rakes, then it passes through the traveling screens as described in Subsection 3.4.2.1. Once the water is in the RWS, each line is strained by a 50-percent capacity automatic strainer. A back-washing feature of the strainers removes debris and sends it back to the Guntersville Reservoir. A small portion of the raw water is used to supply two 100-percent capacity screen wash pumps. The remainder of the flow provides makeup to the CWS cooling tower. These features are illustrated in FSAR Figure 9.2-201.

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.

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 removal of heat. The temperature rise across the heat exchangers varies with each mode of operation. During normal operation the temperature rise is approximately 19.7°F, 33.1°F during cool down, 14.3°F during refueling, 7.3°F during plant startup, and 34.1°F during minimum to support safe shutdown cooling and spent fuel cooling. 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.

The service water blowdown flow is diverted to the wastewater retention basin (WWRB). This blowdown is used to control levels of solids concentration in the SWS. Water from the WWRB is discharged to Town Creek via a series of wastewater hold up impoundments.

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 allows either service water pump to supply either heat exchanger, and allows either heat exchanger to discharge to either cooling tower cell. The RWS supplies water to the SWS cooling tower to makeup for water consumed as the result of evaporation, drift and blowdown. The chemical concentration factor for the SWS cooling tower is four cycles of concentration. The basic system configuration is illustrated in Figure 3.4-1.

The RWS makeup to the SWS consists of two 100-percent capacity pumps for each unit. At the intake pumping station, the raw water is first strained by trash rakes, then it passes through the traveling screens as described in Subsection 3.4.2.1. Once the water is in the RWS, each line is strained by automatic duplex strainers. The water is then sent on to a granular media filter where remaining debris is removed and back to the river. The raw water then proceeds to the SWS cooling tower, where it provides the necessary makeup. These features are illustrated in FSAR Figure 9.2-201.

3.4.1.2 Operational Modes

Circulating Water System

The CWS provides cooling during the power operation mode. The power operation mode rejects the most heat as the CWS removes heat rejected from the turbine by way of the condenser. The BLN units are estimated to be in the power operation mode for 97.2 percent of the operating cycle (approximately 17.5 months). During startup and hot standby, a smaller amount of heat is rejected by way of the condenser. BLN units are estimated to be in the startup mode for less than 0.1 percent of the operating cycle (6 hrs.), the hot standby mode for 0.4 percent of the operating cycle (46 hrs.), and safe shutdown mode for 0.4 percent of the operating cycle (55 hrs.). These time estimates do not include forced outages as they cannot be predicted. The power operation mode is paramount, operating for 17.5 months out of an 18-month cycle and consuming the most flow. Therefore, all other modes are bounded by the power operation.

Service Water System

The SWS provides heat removal from the CCS during all six modes of normal operation: power operation, startup, hot standby, safe shutdown, cold shutdown, and refueling. During refueling, the SWS also supports a full core offload. BLN units are estimated to be in the power operation mode for 97.2 percent of the operating cycle (approximately 17.5 months). BLN units are estimated to be in the startup mode for less than 0.1 percent of the operating cycle (6 hrs.), the hot standby mode for 0.4 percent of the operating cycle (46 hrs.), safe shutdown mode for 0.4 percent of the operating cycle (55 hrs.), cold shutdown mode for 0.4 percent of the operating cycle (52 hrs.) and refueling mode for 1.4 percent of the operating cycle (181 hrs.). These time estimates do not include forced outages as they cannot be predicted. The power operation mode is paramount, operating for 17.5 months out of an 18-month cycle and consuming the most flow. Therefore, all other modes are bounded by the power operation.

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

Circulating Water System

In the power operation mode, heat is generated, dissipated to the atmosphere, and released in liquid discharges from the CWS. The CWS releases heat to the atmosphere via the CWS cooling tower and to the Guntersville Reservoir in liquid discharges via blowdown. The quantities of heat released are summarized in Table 3.4-1.

Service Water System

The SWS is operating in all six modes of operation and releases heat to the atmosphere via the SWS cooling tower, and in liquid discharges to Town Creek in the form of blowdown via the WWRB. The amount of heat released during each of these modes of operation in the CWS and the SWS is shown in Table 3.4-1.

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

Circulating Water System

During power operation, the CWS requires makeup water from the Guntersville Reservoir. This water is provided to the CWS by the RWS. To provide for the CWS requirements, the RWS must provide sufficient capacity to makeup for cooling tower losses due to evaporation, drift and blowdown. The CWS operation results in the release of this water back to the environment. Evaporation from the cooling tower to the atmosphere is the major consumptive water use. The blowdown operations provide a discharge path directly to the Guntersville Reservoir. The amount of water supplied by the system from the Guntersville Reservoir along with the discharge quantities for each of the six modes is provided in Table 3.4-2.

Raw Water

During normal operation, the Guntersville Reservoir provides 24,059 gpm makeup to the CWS, 250 gpm of blowdown for the strainers, 7 gpm of blowdown for the granular media filters, 175 gpm for demineralized water and 245 gpm as makeup for the SWS, for a total of 24,736 gpm. The estimated monthly average water need from the Guntersville Reservoir is 1.069 x 10^9 gal. Normal operation is at 10 percent power operation, which is at maximum makeup demand, therefore, the maximum is approximated to be the same as the normal need. The minimum demand is during an outage when the only flow being pulled from the Guntersville Reservoir is the SWS makeup (245 gpm), granular media filter blowdown (7gpm) and the demineralized water (175 gpm) for a total of 427 gpm. The estimated monthly minimum water demand from the Guntersville Reservoir is 1.845 x 10^7 gal. There is a diverse pump arrangement, five pumps, which allows for maintenance, while not stopping flow to those necessary plant systems.

During normal operation, the Scottsboro Municipal Water System supplies 17.4 gpm. This supplies flow to the potable water and makeup to the fire water tank. The estimated monthly average number of gallons needed from the municipal supply is 7.517 x 10^5 gal. The maximum need is 35 gpm, with the estimated monthly maximum being 1.512 x 10^6 gal. The minimum is approximated to be the same as the average need.

Service Water System

The SWS is operating in all six modes of operation and requires makeup water from the Guntersville Reservoir. The RWS must provide sufficient capacity to supply the SWS with makeup for cooling tower losses due to evaporation, drift and blowdown. Evaporation from the cooling tower to the atmosphere is the major consumptive water use. The blowdown operations provide a discharge path to Town Creek via the WWRB. The amount of water supplied by the system from the Guntersville Reservoir along with the discharge quantities for each of the modes is provided in Table 3.4-2.

3.4.2 COMPONENT DESCRIPTIONS

BLN is designed with one intake system that supplies the necessary raw water to the plant. The intake system consists of an intake canal, which connects the Guntersville Reservoir to the intake structure. The location is illustrated in Figure 2.1-1. This system is described in Subsection 3.4.2.1.

BLN is designed with two discharge systems. One system consists of a blowdown pipe which travels back to the Guntersville Reservoir where the CWS blowdown is discharged through a multiport diffuser. The second system also includes a blowdown pipe which travels to the WWRB, and eventually to Town Creek. The location is illustrated in Figure 2.1-1. The 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 intake channel connects the intake pumping station to the Guntersville Reservoir. The intake pumping station is located approximately 1200 ft. from the existing shoreline. A floating trash boom is located at the shoreline to protect the channel from floating debris. The intake pumping station is further protected by trash rakes, two per unit and two traveling screens per unit. The raw water provided to the SWS, DWS, and for emergency fire water is first sent through a granular media filter. The intake pumping station with respect to the water surface, bottom geometry, and shoreline is illustrated in Figures 3.4-2 and 2.3-24.

Ten pumps are located in the intake pumping station. These ten pumps include six pumps that supply makeup to the CWS, three per unit, and four for makeup to the SWS, two per unit. At any given time, no more than six pumps are operating, three per unit. Two of these are for the CWS makeup and one is for the SWS makeup. The flow rates for these pumps vary based on system demand, however during normal operating conditions, each of the operating pumps for the CWS provides 12,029.5 gpm or less, for a total of 24,059 gpm for each unit. Each of the pumps operating for the SWS provide 245 gpm per unit.

For the intake channel, the maximum water velocity of the cross-section is approximately 0.0174 fps for a water surface elevation of 593 ft., minimum normal pool elevation. The intake pumping station has four openings slightly over 10 ft. wide and approximately 36 ft. high. The top of the opening is at elevation 592.75 ft. and the bottom at elevation 557 ft. The maximum velocity of flow is less than 0.0157 fps through each of the openings at maximum normal pool elevation of 595 ft. The openings are followed by 9-ft.-wide vertical traveling screens which have a 3/8-in. opening mesh. The maximum velocities through clean screens are 0.13 fps at the minimum normal pool elevation of 593 ft. and 0.12 fps at the maximum normal pool elevation of 595 ft. These maximum velocities are well under the 0.50 fps requirement of Section 316(b) of the Clean

Water Act. (See Figure 3.4-2 for elevations.) All intake water taken from the Guntersville Reservoir passes through 1/32-in. strainers after passing through the traveling screens. Screen and strainer backwash water, are returned to the reservoir by means of a concrete sluice return. Screen wash water is supplied by the Guntersville Reservoir to the screen wash pumps, two 50-percent pumps which produce 250 gpm. Historical water temperatures show the average temperature of the Guntersville Reservoir is approximately 67°F, and never falls below freezing, therefore there is not significant icing at the intake structure.

During each operational mode, the raw water requirements vary. Therefore, the flow rates and intake velocities also vary. During power operation, both the CWS and the SWS require makeup water. The intake velocity is 0.0174 fps. For startup, hot standby, safe shutdown and cold shutdown, the intake velocity is 0.0017 fps. During refueling, the intake velocity is 0.0017 fps. Flow rates for all modes of operation are shown in Table 3.4-2.

3.4.2.2 Discharge

The primary purpose of the discharge system is to disperse cooling tower blowdown into the Guntersville Reservoir and Town Creek to limit the concentration of dissolved solids in the heat rejection system.

CWS

Each unit has a 54-in. blowdown pipe that runs from the natural draft cooling tower. These lines meet to form one 66-in. diameter blowdown pipe to the outfall structure. At the point this pipe reaches the Guntersville Reservoir, the pipe splits into two 54-in. diameter branches. This discharge system is illustrated in Figure 3.4-3. The location of the discharge (blowdown vault) relative to the intake structure and other major plant structures is illustrated in Figure 2.1-1.

At the end of the blowdown pipe is a submerged, multiport diffuser. The diffuser discharge is split into two pipes of different lengths, one 45 ft. long and the other 75 ft. long. The porting configuration is the same for both diffusers. The results of the CORMIX software simulations determines the discharge velocity for the diffusers, based on the diffuser configuration and the discharge flow. The 45-ft. diffuser is designed to handle maximum flow of 50 cfs (22,442 gpm) and the 75-ft. diffuser is designed for a maximum flow of 100 cfs (44,883 gpm). The ports are positioned to discharge at an angle of 22 degrees from the horizontal, which preclude scour problems.

An oblique diffuser positioned at an angle to the shoreline was chosen for this site due to its ability to remove the heated effluent from the vicinity of the diffuser. The two diffuser sections are 75 and 45 ft. long. The two approach pipes for each diffuser section are approximately 340 ft. long. Both the diffuser sections and the approach pipes are at an angle of 60° to the river channel centerline. The diffuser sections begin approximately 300 ft. offshore. Pipe diameter is approximately 3.5 ft. for the large leg, and 3.0 ft. for the small leg.

During each operational mode, the raw water requirements vary. Therefore, the discharge flow rates and velocities also vary. During the power operation the CWS is in operation and the discharge velocity is 3.39 fps. For startup and safe shutdown modes the velocity is 3.39 fps. Flow rates for all modes of operation are shown in Table 3.4-2.

Normal blowdown from the natural draft cooling towers is discharged into the Guntersville Reservoir through a diffuser at an approximate rate of 7,914 gpm per unit. The maximum blowdown temperature is conservatively assumed to be 95°F.

SWS

The SWS blows down to the WWRB which eventually empties into Town Creek via a series of ponds. The WWRB cascades to Pond A, on to the construction holding Pond, and then cascades to Town Creek.

3.4.2.3 Heat Dissipation

The CWS has one natural draft cooling tower per unit that discharges via the blowdown pipe to the outfall structure on the Guntersville Reservoir. The outfall structure is approximately 4770 ft. south of the intake canal. The natural draft cooling tower is a concrete tower that is 474 ft. high and has a basin with a diameter of 412 ft. The cooling tower is filled with PVC film fill SPX DF254. The rated heat-dissipation capacity of each cooling tower is 7,540 x 10^6 Btu/hr. For average monthly meteorological conditions, water enters the cooling tower at a temperature and flow rate of 121°F and 531,000 gpm, and discharges at 91°F and 531,000 gpm. The average discharge temperatures for each month are bounded by summer loading conditions. Drift rate of the plume coming off the tower is 106 gpm. The natural draft cooling tower noise is discussed in Subsection 5.3.3.2.5. The wet-bulb temperature is 77°F, the approach to wet-bulb is 10°F, and the range is 25°F. Performance curves for the natural draft cooling tower are in Figure 3.4-4 and Table 3.4-3.

The SWS has one mechanical draft cooling tower per unit, which blows down to the WWRB. The mechanical draft cooling tower is a stainless steel tower, which consists of a two cell arrangement, and a divided basin. The rated heat-dissipation capacity of each cooling tower is 346 x 10^6 Btu/hr. For average monthly meteorological conditions, water enters the cooling tower at a temperature and flow rate of 113.2°F and 10,500 gpm and discharges at 93.5°F and 10,255 gpm. The mechanical draft cooling tower uses fans to force convection within the cooling tower. The volumetric flow of air in the tower varies with the mode of operation. For power operation and refueling, the flow rate is 10,500 gpm. The power consumption for the fans is 120 kW for each cell's fan. Drift rate of the plume coming off the tower is approximately one gpm. It is estimated that the mechanical draft cooling tower produces 55 dba at 1000 ft. The wet-bulb temperature is 77°F, the approach to wet-bulb is 12°F, and the range is 19°F. [Performance curves for the mechanical draft cooling tower are not available at the time of submittal as they have not yet been procured.]

TABLE 3.4-1
HEAT TRANSFER TO THE ATMOSPHERE AND RELEASED IN LIQUID DISCHARGES (SINGLE UNIT OPERATION)

Modes of Operation	Total Heat Transferred 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)(b)
Power Operation	7.69×10^{9}	1.03×10^{8}	7.36×10^{6}	7.54×10^{9}	41.4×10^{6}
Startup	3.15×10^{9}	1.03×10^{8}	6.85×10^{6}	3.02×10^{9}(c)	1.66×10^{7}(c)
Hot Standby	7.60×10^{7}	7.46×10^{7}	1.37×10^{6}	0	0
Safe Shutdown	8.98×10^{7}	8.81×10^{7}	1.67×10^{6}	0	0
Cold Shutdown	8.98×10^{7}	8.81×10^{7}	1.67×10^{6}	0	0
Refueling (Full Core Offload)	7.05×10^{7}	6.91×10^{7}	1.41×10^{6}	0	0

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

b) Based on the following temperature and flowrates: CWS temperature = 91°F, CWS blowdown flowrate = 7914 gpm, SWS blowdown flowrate = 61 gpm.

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 dissipated during cooldown and startup.

TABLE 3.4-2
RAW WATER WITHDRAWN, CONSUMED, AND DISCHARGED (SINGLE UNIT OPERATION)

Modes of Operation	Water Source	RWS Withdrawn[(a)] (gpm)	CWS Consumed (gpm)	CWS Discharged (gpm)	SWS Consumed (gpm)	SWS Discharged (gpm)
Power Operation	Guntersville Reservoir	24,736	16,145	7,914	184	61
Startup	Guntersville Reservoir	677	0	0	184	61
Hot Standby	Guntersville Reservoir	677	0	0	184	61
Safe Shutdown	Guntersville Reservoir	677	0	0	184	61
Cold Shutdown	Guntersville Reservoir	677	0	0	184	61
Refueling (Full Core Offload)	Guntersville Reservoir	1263	0	0	626	205

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a) Consumptive usage values for screen wash, filter backwash, and water treatment are not included in this table due to their minimal impact on RWS withdrawal. These usage values are depicted on the water balance summary (Figure 3.3-1).

TABLE 3.4-3
NATURAL DRAFT COOLING TOWER PERFORMANCE
(USE WITH FIGURE 3.4-4)

Curve No.	Flow (gpm)	Range (°F)
C-1	450,000	24.13
C-2	450,000	30.16
C-3	450,000	36.19
C-4	500,000	24.13
C-5	500,000	30.16
C-6	500,000	36.19
C-7	550,000	24.13
C-8	550,000	30.16
C-9	550,000	36.19

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 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 the water passes 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 (RCS) and auxiliary systems, or by breaching of systems for maintenance. Therefore, each plant generates radioactive waste that can be liquid, solid, or gaseous.

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.

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. The liquid radwaste system 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 liquid radwaste system 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 liquid radwaste system under normal conditions are identified in DCD Table 11.2-1.

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

- Borated, reactor-grade, wastewater -- This input is collected from the 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.
- 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 liquid radwaste system. Secondary-system effluent is normally handled by the steam generator blowdown processing system 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 liquid radwaste system for processing and disposal.

3.5.1.1 Waste Input Streams

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 liquid radwaste system vacuum degasifier before being stored in the effluent holdup tanks.

The liquid radwaste system degasifier can also be used to degas the RCS before shutdown by operating the CVS in an open loop configuration. 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 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 liquid radwaste system 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 route processed 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 for additional processing.

Normally, however, the radioactivity is well below the discharge limits, and the dilute boric acid is discharged for dilution to the circulating water blowdown. 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.

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. The monitor tank contents are sampled and, if necessary, returned to a waste holdup tank or recirculated directly through the filters and ion exchangers.

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.

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 is brought into one of the radwaste building mobile systems facility truck bays provided for this purpose.

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. Because the volume of these wastes is low, they can be treated by the use of mobile equipment or by shipment off-site.

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 liquid radwaste system 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.

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 Guntersville Reservoir.

The annual average release of radionuclides from the plant is determined using the PWR-GALE code. The PWR-GALE code models releases that 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.

The total releases include an adjustment factor of 0.16 curies per year to account for anticipated operational occurrences. The adjustment uses the same distribution of nuclides as the calculated releases.

Doses

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

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 because of a small number of fuel cladding defects. 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 do not build up to unacceptable levels when fuel defects are within normally anticipated ranges. If noble gas removal is required because of high RCS 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 WGS 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.

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 liquid radwaste system degasifier. The degasifier extracts both hydrogen and fission gases from the CVS letdown flow that is diverted to the liquid radwaste system 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 liquid radwaste system degasifier during RCS dilution and volume control operations. Because 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 liquid radwaste system 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 liquid radwaste system 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.

System Operation

The WGS is used intermittently. During normal operation, the WGS is usually not in operation. 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 liquid radwaste system degasifier, which processes the CVS letdown flow when diverted to the liquid radwaste system and the liquid effluent from the liquid radwaste system 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 liquid radwaste system degasifier is the full diversion of the CVS letdown flow, when the RCS is operating with maximum allowable hydrogen concentration. Because the liquid radwaste system degasifier is a vacuum type that operates without a purge gas, this input rate is very small, about 0.5 scfm.

The liquid radwaste system 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.

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.

These releases are on-going throughout normal plant operations. There is no gaseous waste holdup capability in the gaseous waste management system and thus no criteria are required for determining the timing of releases or the release rates to be used.

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 are provided in DCD Table 11.2-6. The expected annual releases for a single unit are presented in DCD Table 11.3-3.

Release Points

Airborne effluents are normally released through the plant vent or the turbine building vent. 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 811 ft. The turbine building vents are located at an approximate elevation of 773 ft.

Doses

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

Cost Benefit Analysis of Population Doses

The site-specific cost-benefit analysis regarding population doses due to gaseous effluents during normal plant 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

BLN operating procedures encourage plant operators to segregate wastes to keep mixed wastes at a minimum. 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. 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 off-site to a licensed disposal facility.

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 this subsection.

System Description

The WSS includes the spent resin system. The flows of wastes through the solid waste management system are shown in 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 solid waste management system are listed in DCD Table 11.4-1. BLN has sufficient radwaste storage capacity to accommodate the maximum generation rate.

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. BLN has no provisions for permanent storage of radwaste. Radwaste is stored ready for shipment. 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 ft^3/yr, respectively as shown in DCD Table 11.4-1. The wet wastes shipping volumes include 510 ft^3/yr of spent ion exchange resins and deep bed filter activated carbon, 20 ft^3 of volume reduced liquid chemical wastes and 17 ft^3 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 ft^3 high-integrity containers in anticipation of transport for off-site disposal. Liquid chemical wastes are reduced in volume and packaged into three 55-gal. drums per year (about 20 ft^3) 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 ft^3/yr) and are stored on containment pallets in the waste accumulation room of the radwaste building until shipped off-site for processing.

The two spent resin storage tanks (275 ft^3 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 10 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 percent fuel defects.
- The WGS activated carbon guard bed is replaced twice every refueling cycle.

- The WGS delay beds are replaced every 5 years.
- All wet filters are replaced based upon operation with 0.25 percent fuel defects.
- The expected rates of compatible and non-compatible radwaste, chemical waste, and mixed wastes are increased by about 50 percent.
- 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 ft^3/yr of compactable and non-compactable waste packed into about 14 boxes (90 ft^3 each) and 10 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 ft^3/yr of dry activated carbon and other solids such as broken tools and wood. Solid mixed wastes occupy 7.5 ft^3/yr (one drum). The low activity spent filter cartridges may be compacted to fill about 0.40 drums per year (3 ft^3/yr) and are stored in the packaged waste storage room. Compaction is performed by mobile equipment or is performed off-site. High activity filter cartridges fill three drums per year (22.5 ft^3/yr) and are stored in portable processing or storage casks in the rail car of the auxiliary building.

The total volume of radwaste to be stored in the radwaste building packaged waste storage room is 1417 ft^3/yr at the expected rate and 2544 ft^3/yr 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, 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 ft^3 of chemical waste and 17 ft^3 of mixed liquid waste. The useful storage volume in the packaged waste storage room is approximately 3900 ft^3 (10 ft. deep, 30 ft. long, and 13 ft. high), which accommodates more than one full off-site waste shipment using a tractor-trailer truck. The packaged waste storage room provides storage for more than 2 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 ft^3/yr. 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 off-site disposal. Radioactive condensate polishing resin has very low activity. It is disposed in containers as permitted by U.S. Department of Transporation (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 ft^3/yr (one 309-ft^3 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 ft^3/yr.

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 BLN complex as solid waste.

3.5.4 CONFORMANCE TO REGULATORY GUIDE 1.112, REV 1

This section provides the information requested in Appendix B of the NRC Regulatory Guide 1.112, Rev. 1, "Calculation of Releases of Radioactive Materials in Gaseous and Liquid Effluents from Light-Water-Cooled Power Reactors".

For each unit:

General

a. The Nuclear Steam Supply System at full power is rated at 3415 MW thermal. See DCD Section 10.1.

b. The quantity (Ci/yr) of tritium released in liquid effluents to the discharge canal is 1010 Ci/yr. See DCD Table 11.2-7.

   The quantity (Ci/yr) of tritium released in gaseous effluents is 350 Ci/yr. See DCD Table 11.3-3.

Primary System

a. The total mass (lb) of coolant in the primary system, excluding the pressurizer and primary coolant purification system, at full power is 388,072.

b. The nominal primary system purification system flow rate is 100 gal/min based on 130°F and 2300 psia.

c. The design flow rate (gal/min) through the primary coolant purification system cation demineralizer is 100 gal/min. One cation resin bed demineralizer is located downstream of the mixed bed demineralizers and is used intermittently to control the concentration of lithium-7 (pH control) in the RCS. The demineralizer is sized to accommodate maximum purification flow when in service, which is adequate to control the lithium-7 and/or cesium concentration in the reactor coolant.

d. The normal boration flow rate is 100 gal/min.

See DCD Sections 5.1 and 9.3 for system information.

Secondary System

a. There are two steam generators, model Delta-125. Each unit employs an all-volatile treatment (AVT) method to minimize general corrosion in the feedwater system, steam generators, and main steam piping. A pH adjustment chemical and an oxygen scavenger are the two chemicals to be injected into the condensate pump discharge header, downstream of the condensate polishers. The maximum moisture carryover (weight percent) maximum is 0.25.

b. The total steam flow (lb/hr) in the secondary system is 14.97×10^6.

c. The nominal secondary water mass (lbm) for each steam generator is 175,758 lbm.

d. The primary-to-secondary leakage rate used in the evaluation is 52.14 lb/hr.

e. The blowdown system consists of two blowdown trains, one for each steam generator. A crosstie is provided to process blowdown from both steam generators through both heat exchangers during high capacity blowdown from one steam generator.

The blowdown water is extracted from each steam generator from a location just above the tube sheet. The blowdown from each steam generator is cooled by a regenerative heat exchanger, and flow is controlled and pressure reduced by a blowdown flow control valve. To recover the thermal energy, the condensate system provides cooling for the heat exchangers. 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 normal blowdown flowrate varies from a minimum of about 0.06 percent to a maximum of about 0.6 percent of maximum steaming rate. During normal operation, the average blowdown rate from the steam generators is approximately 42,000 lb/hr.

f. The condensate polishing system is sized for one-third of the condensate flow. The condensate flow is 20,700 gpm at 110°F. Therefore the design flow capacity for the condensate demineralizers is 6900 gpm at 110° F.

The decontamination factor (DF) for the condensate demineralizers varies based on several parameters, such as the specific impurity and the condition of the resin. The following design DFs for the demineralizers are representative of the values that can be used to characterize the resin performance at full rated power:

- Iron: DF = 2.5 to 6.7
- Copper DF = 4 to 14
- Nickel DF = 3.3 to 10

g. Condensate demineralizers:

The design flow rate for the condensate demineralizers is 6900 gpm.

The condensate demineralizer type is a deep bed mixed resin ion exchange vessel.

The number of condensate polishing vessels required is expected to be two. Approximate sizing information for each of the condensate polisher vessels is as follows:

- Total volume: 904 ft^3
- Resin volume: 309 ft^3
- Resin bed depth: 3 ft.
- Resin bed ID: 12 ft.

It is required that the resin in the condensate polisher be regenerated when the resin is exhausted. The process of regenerating the condensate polishing resin which may include ultrasonic resin cleaning can be performed on-site or off-site. It is anticipated that the regeneration process is conducted externally to the plant by a contractor and carried out at an off-site location. This eliminates on-site waste handling by the WLS and reduces the need for site personnel.

Most likely, both polisher vessels are discharged for regeneration sequentially at the same time for convenience of the plant operators, but the option exists to discharge only one of the two vessels for regeneration. The resin transfer operation is expected to generate approximately 10,000 gal. of wastewater for each polisher vessel which is discharged. The water is discharged to the WWS.

During off-site regeneration, the exhausted resin is transported from the site to an external regeneration facility. At the time of exhausted resin removal from the site, a fresh bed of resin is often delivered ensuring the system remains operational.

At the off-site treatment facility, the resin is first scrubbed of suspended matter, then the cation and anion resin is separated and isolated. Next the cation resin is regenerated with acid and the anion resin regenerated with caustic. Finally the resins are rinsed and then mixed together for delivery to the site. The contracted party would assume responsibility for the storage, handling and disposal of the resin.

The frequency of replacement or regeneration varies with the circulating water quality and the integrity of the condenser tubes. The regeneration frequency is expected to be quite frequent, possibly weekly, but should not be particularly burdensome given the above description of operations relying on off-site/mobile operations to remove and regenerate the resins.

The activity of the resin removed is not known at this time, and depends on the performance of the fuel and the integrity of the steam generator tubes, the steam generator moisture carryover, and the operation of the steam generator blowdown system. Steam generator blowdown which is normally directed to the condenser is first passed through electrodeionization units, and is diverted to the liquid waste processing system if radioactivity is detected. Higher radiation levels isolate steam generator blowdown. Therefore, the activity of the resin is expected to be limited by these design and operational procedures.

There are currently no provisions to perform ultrasonic cleaning of the resin.

See DCD Sections 5.1, 5.4, 10.3, 10.4 and 15.1 for system information.

Liquid Waste Processing System

a. For each liquid waste processing system (including the shim bleed, steam generator blowdown and detergent waste processing systems) the following information is provided:

   1. The sources, flow rates (gal/day) and expected activities (fraction of primary coolant activity (PCA) for all inputs to each system) are provided in DCD Table 11.2-1.

   2. In operation of the WLS effluent holdup tanks, the collection, processing, and discharge times vary depending upon radwaste operator preferences and the time in cycle. For example, during startup from a refueling outage the operator may be filling and processing an effluent holdup tank simultaneously, while early in the cycle (when burnup dilution requirements are low) the effluent holdup tanks may in theory sit for weeks or even months without being processed.

      In DCD Table 11.2-1, the average annual input to the effluent holdup tanks is 159,000 gal. (for an 18-month fuel cycle, averaged between outage years and non-outage years) from reactor effluents plus 290 gpd from equipment drains, totaling about 725 gpd. With an effluent holdup tank size of 28,000 gal., the average time to fill a tank is about 38 days. In reality, this time varies from much shorter (potentially hours) to much longer. As shown in DCD Table 11.2-6, a representative collection time of 30 days is used for input to the GALE computer code.

Similarly, inputs to the 15,000-gal. waste holdup tank are estimated at 1200 gpd in DCD Table 11.2-1, for an average tank fill time of 12.5 days; in DCD Table 11.2-6, an average of 10 days collection time is conservatively assumed.

In the input to the PWR-GALE code, zero time for processing and discharge for both of these waste streams is assumed. This is obviously conservative; although the processing time might be very short, the discharge time at a minimum includes the time to fill a monitor tank, collect and analyze a sample, and discharge the monitor tank.

There is no contribution for detergent waste; an off-site laundry is assumed, and other inputs (mostly hand wash) have negligible contribution to radioactive effluents (i.e., all individual isotopes are expected to be less than 1E-5 Ci/year). If significant radioactivity is found, processing through modular equipment in the radwaste building can be used.

The steam generator blowdown system (BDS) uses electro deionization (EDI) units for processing. The majority of the blowdown flow is directed back to the condenser, and the EDI reject flow directed to the wastewater system (WWS). The BDS flowrate can be varied; for maximum flowrate of 186 gpm (total of both steam generators) the EDI reject flow is about 20 gpm. Various other options, including the liquid waste system, are available for routing the blowdown flow. In the GALE input, DCD Table 11.2-6, it is assumed that there is no effective discharge from the blowdown system.

3. The capacities of all tanks (gal.) and processing equipment (gal/day) considered in calculating holdup times are provided in DCD Table 11.2-2.

4. The decontamination factors for each processing step are provided in DCD Table 11.2-5.

5. The fraction of each processing stream expected to be discharged over the life of the plant is provided as follows:

   DCD Table 11.2-8 lists the annual average nuclide release concentrations and the fraction of the effluent concentration limits using base GALE code assumptions. As shown in DCD Table 11.2-8, the overall fraction of the effluent concentration limit is 0.11, which is well below the allowable value of 1.0.

   DCD Table 11.2-9 lists the annual average nuclide release concentrations and the fractions of the effluent concentration limits for the maximum defined fuel defects. As shown in DCD Table 11.2-9, the overall fraction of the effluent concentration limit for the maximum defined fuel defect level is 0.53, which is well below the allowable value of 1.0.

6. Demineralizer (ion exchanger) regeneration is not performed. The initial and. subsequent fill of ion exchange media is made through a resin fill nozzle on the top of the ion exchange vessel. When the media are spent and ready to be

transferred to the solid radwaste system, the vessel is isolated from the process flow. The flush water line is opened to the sluice piping and demineralized water is pumped into the vessel through the normal process outlet connection upward through the media retention screen. The media fluidize in the upward, reverse flow. When the bed has been fluidized, the sluice connection is opened and the bed is sluiced to the spent resin tanks in the solid radwaste system (WSS).

7. The liquid source term by radionuclide (Ci/yr) for normal operation, including anticipated operational occurrences is shown in DCD Table 11.2-7.

b. The piping and instrumentation diagrams and process flow diagrams for the liquid radwaste systems and for all other systems influencing the source term calculations are shown in DCD Figure 11.2-1.

See DCD Section 11.2 for system information.

Gaseous Waste Processing System

a. The volume of hydrogen gas stripped annually from the reactor coolant has been calculated. It is assumed that hydrogen comprises nearly all of the gas volume stripped from the coolant, as the volume of radioactive gas that is stripped along with hydrogen is of negligible amount in comparison.

   With an annual effluent flowrate of 159,000 gal/year in DCD Table 11.2-1, the calculation resulted in a range of 318 to 1,060 standard cu ft/yr (9.02 to 30.1 standard cubic meters/yr) of hydrogen released. This range correlates to the range of values of hydrogen added to the primary coolant via the CVS of 15 to 50 ccH_2/kgH_2O.

b. A description of the process used to hold up gases stripped from the primary system during normal operations and reactor shutdown are discussed in Subsection 3.5.2 above.

c. A description of the normal operation of the system is provided in Subsection 3.5.2 above.

d. There are no HEPA filters used in this system.

e. A description of the charcoal system is provided in Subsection 3.5.2 above.

f. The piping and instrumentation diagrams and process flow diagrams for the WGS and for other systems influencing the source term calculations are shown in DCD Figure11.3-1.

See DCD Section 11.3 for system information.

Ventilation and Exhaust Systems

For the turbine building, there are eight roof ventilatiors that exhaust to the weather. Each ventilator has an airflow of 95,000 cfm for a total combined airflow of 760,000 cfm. These ventilators are mounted on the turbine building roof that is at an approximate elevation of 773 ft.

These ventilators are located within the edges of the roof of the bulding as seen in DCD Figure 1.2-28 and Figure 1.2-30. The ventilators have no radiation reduction provisions and there are not orifices or volume control dampers. The outlet velocity is approximately 775 ft/min. The expected temperature of the discharge in the winter is 50°F and the expected temperature of the discharge in the summer is 105°F.

The plant vent has an air flow of 84,750 cfm and has an approximate average velocity of 1630 ft/min. The expected temperature of the discharge in the winter is 54°F and the expected temperature of the discharge in the summer is 101°F. The plant vent is located next to the containment building on the southeast side and discharges at an approximate elevation of 811 ft. See Figures APP-1070-P2-001, Rev 0 and APP-1000-P2-902, Rev 0 for location. The plant vent discharge is approximately 200 ft. above the auxiliary building roof. The auxiliary/annex building exhaust (VAS) exhausts to the plant vent, but stops on a high radiation level and the exhaust goes to the VFS. The VFS exhausts to the plant vent and has HEPA filters 99.97 percent efficient on 0.3 micron DOP smoke. The VFS has a charcoal adsorber that is 4 in. deep. There is a post charcoal filter that is 95 percent efficient on 0.3 micron DOP smoke. The health physics and hot machine shop general exhaust fan exhausts into the plant vent with no radiation reduction provisions. However, the machine tools exhaust fan, which exhausts into the general exhaust fan, has a high efficiency filter rated at 80 percent. There are no orifices in the plant vent.

For the containment building:.

1. The building free volume is 2.06 X 10^6 ft^3.

2. The internal recirculation system is called the Containment Recirculation Cooling System (VCS).

   The VCS controls building air temperature and humidity to provide a suitable environment for equipment operability during normal operation and shutdown. The VCS is composed of two 100-percent capacity skid-mounted fan coil unit assemblies with a total of four 50-percent capacity fan coil units which connect to a common duct ring header and distribution system. Each fan coil unit contains a fan and associated cooling coil banks. The two fan coil unit assemblies are located on a platform at elevation 681 ft., approximately 180 degrees apart to provide a proper return air and mixing pattern through the ring header. The top of the ring header is approximately at elevation 704.5 ft. The ring header and the fan assemblies are designed to provide uniform air and temperature distribution inside the containment, considering the possibility that one fan coil assembly may be out of service.

   The cross-connections between the central chilled water system piping for containment cooling and hot water heating system piping for containment heating are located outside the containment. The water piping inside containment is common to both the central chilled water system and hot water heating system.

   During normal plant operation, one of the two 50-percent capacity fans in each fan coil unit assembly draws air from the upper levels of the operating floor and delivers cooling air through the ring duct and the secondary ductwork distribution system to the cubicles, compartments, and access areas above and below the operating floor. In addition, cooling air is delivered to the reactor cavity and reactor support areas to maintain appropriate local area and concrete temperatures. The normal supply temperature is 60°F in order to meet the environmental design requirements during various modes of operation.

As the supply air absorbs the heat released from various components inside containment, return air rises through vertical passages and openings due to its lower density to the upper containment level where it is again drawn into the fan coil units, cooled, dehumidified, and recirculated.

The containment air filtration system (VFS) serves the containment, the fuel handling area and the other radiologically controlled areas of the auxiliary and annex buildings, except for the hot machine shop and health physics areas which are served by a separate ventilation system.

The VFS consists of two 100-percent capacity supply air handling units, a ducted supply and exhaust air system with containment isolation valves and piping, registers, exhaust fans, filtration units, automatic controls and accessories. The supply air handling units are located in the south air handling equipment room of the annex building at elevation 686 ft. The supply air handling units are connected to a common air intake plenum, located at the south end of the fan room. The common air intake plenum #3 is located at the extreme south end of the annex building between elevation 686 ft. and about 708 ft. This plenum supplies air for the radiologically control area ventilation system, and the VFS. The intake is not protected from tornado missiles. The VFS supply air handling units discharge the supply air towards the east VCS recirculation unit to distribute the purge air within the containment.

The exhaust air filtration units are located within the radiologically controlled area of the annex building at elevation 663.25 ft. and 674.25 ft. The filtration units are connected to a ducted system with isolation dampers to provide HEPA filtration and charcoal adsorption of exhaust air from the containment, fuel handling area, auxiliary and annex buildings. A gaseous radiation monitor is located downstream of the exhaust air filtration units in the common ductwork to provide an alarm if abnormal gaseous releases are detected. The plant vent exhaust flow is monitored for gaseous, particulate and iodine releases to the environment. During containment purge, the exhaust air filtration units satisfy 10 CFR Part 50 Appendix I guidelines for off-site releases and meets 10 CFR Part 20 allowable effluent concentration limits when combined with gaseous releases from other sources. During conditions of abnormal airborne radioactivity in the fuel handling area, auxiliary and/or annex buildings, the filtration units provide filtered exhaust to minimize unfiltered off-site releases.

The VCS is assumed to be operating continuously. The recirculation rate is approximately 124,600 acfm with a mixing factor of 70 percent. There are no charcoal filters in the VCS.

3. The expected containment purge rate is approximately 4000 acfm and the frequency is approximately 20 hrs. per week.

See DCD Section 9.4 for system information.

3.6 NONRADIOACTIVE WASTE SYSTEMS

This section describes non-radioactive waste streams that are expected at BLN, including cooling water and auxiliary boiler blowdown that may contain water-treatment chemicals or biocides, water-treatment wastes, floor and equipment drains, storm water runoff, laboratory waste, trash, hazardous waste, effluents from the sanitary sewer system, and miscellaneous gaseous, liquid, and solid effluents.

This section is divided into three subsections that evaluate these non-radioactive waste systems as follows:

3.6.1 Effluents containing chemicals or biocides.

3.6.2 Sanitary system effluents.

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.

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 at the time of construction and operation.

The NPDES Permit for the Tennessee Valley Authority (TVA) Bellefonte Nuclear Plant is discussed in Section 1.2.

Table 3.6-1 shows the chemicals used in each system, the amount used per year, the frequency of use and the concentration in the waste stream discharged from two units.

The intake water for the process and cooling water for BLN is the Guntersville Reservoir.

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 Guntersville Reservoir are provided in Section 2.3.3.

The average and maximum concentrations of natural materials at the effluent location in the Guntersville Reservoir are also provided in Section 2.3.3.

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

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 Guntersville Reservoir and Town Creek is discussed below.

The operation of the CWS is described in Section 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 effluent is extracted from the circulating water tower basin and is returned directly to the Guntersville Reservoir through a system of multiport diffusers at approximate elevation of 570 ft. In addition, sedimentation flows through a small line into the sedimentation ponds. From there, pumps discharge the sedimentation to the blowdown line that discharges to the Guntersville Reservoir. The concentration factor for this evaporative cooling system is provided in Section 3.4.1.

The operation of the SWS is described in Section 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 modes of operation that include power operation, startup, hot standby, safe shutdown, cold shutdown and refueling. The chemicals injected into the SWS, the amount used per year, the frequency of use and the concentration in the waste stream are shown in Table 3.6-1. The blowdown effluent and the backwash strainer effluent are discharged to the wastewater retention basin (WWRB). This basin cascades to Town Creek as described in Section 3.4.2. The concentration factor for this evaporative cooling system is provided in Section 3.4.1.

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 Scottsboro Municipal Water System. The water supplied by this municipal water system is treated, at an off-site location, to applicable drinking water quality standards. No further treatment is performed on-site. The water is discharged to the sanitary drainage system (SDS). The SDS is discharged off-site to the Scottsboro Wastewater Treatment Facility.

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 chemicals that are needed to maintain proper operation of the system are injected by the CFS and are not dependent 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 are shown in Table 3.6-1. The effluent processed from the DTS is discharged into 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. The FPS normally operates in an active standby mode. The fire water supply piping is kept full and pressurized by operation of the jockey pump. Fire protection water is supplied by the Scottsboro Municipal Water System. The water supplied by this municipal water system is treated, at an off-site location, to applicable drinking water quality standards. No further treatment is performed on-site.

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.

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.

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 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 wastewater system (WWS). The chemicals that are needed to maintain proper operation of the system are injected by the CFS on an as-needed basis and is not dependent on the modes 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 are shown in Table 3.6-1.

The BDS can be operated to drain the steam generator. During this mode of operation, the blowdown discharge may be sent to the WWS. This mode of operation is expected to occur only during a refueling outage where the discharge concentration to the WWS is shown in Table 3.6-1.

3.6.1.3 Wastewater

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.

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 wastewater is diverted from the sumps to the liquid radwaste system (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 wastewater. The radiation monitor also trips the sump pumps on detection of radioactivity to isolate the contaminated wastewater. Provisions are included for sampling the sumps. The turbine building sump pumps route the wastewater from either of the two sumps to the oil separator for removal of oily waste. The diesel fuel oil area sump pump also discharges wastewater 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 off-site disposal. The wastewater from the oil separator flows by gravity to the WWRB for settling of suspended solids and treatment, if required, prior to discharge. The WWS is capable of handling the anticipated flow of wastewater during normal plant operation and during plant outages. The wastewater is collected in the WWRB which cascades into the Town Creek at an approximate elevation of 594.5 ft.

3.6.2 SANITARY SYSTEM EFFLUENTS

This section describes the nature and quantity of the sanitary waste contribution and the treatment facilities during construction and operation of the plant.

Sanitary systems needed at BLN during the preconstruction and construction activities of the plant include primarily portable toilets with a smaller number of administration and management personnel using a temporary trailer-type restroom facility that are supplied and serviced by an off-site contracted vendor licensed by the Alabama Onsite Wastewater Board (AOWB) (Reference 1). There is no sanitary system discharge from the portable toilets at the construction site into the effluent stream.

For each unit, the permanent sanitary drainage system (SDS) provided for the operational phase of the plant is designed to treat domestic waste. The system collects sanitary waste from plant restrooms and locker room facilities in the turbine building, auxiliary building, and annex building, and carries this waste to the treatment plant where it is processed. The SDS does not service facilities in radiologically controlled areas. For each unit, the system is designed to accommodate 25 gallons/person/day for up to 500 persons during a 24-hr. period.

The SDS for each unit is combined into a common discharge and the sanitary waste is discharged off-site to the Scottsboro Wastewater Treatment Facility where it is processed in the city treatment plant.The sanitary waste is not treated on-site and is not discharged onto the site.

3.6.3 OTHER EFFLUENTS

This section includes the identification and quantification of other miscellaneous non-radioactive 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 and one diesel-driven fire pump. 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 the diesel-driven 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 on-site standby diesel generator units, each furnished with its own support subsystems, provide power to the selected plant nonsafety-related ac loads. See FSAR Figure 1.1-202 for the location of the diesel generator building. The diesel generator building houses the two diesel generators and their associated heating, ventilation and air conditioning equipment. Each engine's 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 664 ft. Each standby diesel generator is tested to verify the capability to provide 4000 kW.

Two fuel oil storage tanks are provided, one for each of the standby diesel generators. The two fuel oil storage tanks are located on grade. Each tank is erected on a continuous concrete slab totally contained within a concrete dike to contain spills and prevent damage to the environment and seepage into the ground water. 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 662 ft.

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 diesel generators is through a set of double doors at an approximate elevation of 635 ft. Each ancillary diesel generator is tested to verify the capability to provide 35 kW. The fuel for the ancillary generators is stored in a tank located in the same room as the generators. The tank is Seismic Category II and holds sufficient fuel for 4 days of operation. The ancillary 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 642 ft. The fuel tank for the diesel-driven pump holds enough fuel to operate the pump for at least 8 hrs. The vent for the diesel-driven fire pump oil storage tank has an emissions release point at an approximate elevation of

642 ft. 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 northwest of the maintenance 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 635 ft. The fuel tank holds enough oil to allow the generator to operate for 7 days.

Table 3.6-2 shows the annual emissions (lbs/yr) from the diesel generators and the diesel-driven fire pumps. Table 3.6-3 shows the annual hydrocarbon emissions (lbs/yr) from the associated diesel fuel oil storage tanks.

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.

Applicable procedures, by which effluents to the atmosphere are treated, controlled and discharged to meet the applicable emissions standards, are completed prior to turn-over of the applicable plant system. FSAR Section 13.5 provides guidance on development of these procedures.

3.6.3.2 Stormwater

FSAR Subsection 2.4.2 discusses floods, including the probable maximum precipitation (PMP) event and the flood design consideration for the site. Stormwater generally flows into Pond A and in a northwesterly direction into Town Creek.

Stormwater to surface water discharges associated with land disturbance, construction and industrial operation are in accordance with the Stormwater Permit.

3.6.3.3 Other Wastes

For each unit, the turbine building sump pumps route the wastewater 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 off-site disposal.

The debris from the intake screens, for each unit, at the cooling water intake structure is sluiced back to the Guntersville Reservoir.

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 in a permitted landfill as discussed in Section 1.2. It is estimated that the plant will generate approximately 800 tons of non-hazardous, non radiological solid waste (i.e., trash) during each year of plant operation. The amount of trash generated during construction is expected to exceed the operations period amount, but has not been estimated because there is no recent nuclear construction upon which to base such an estimate.

The BLN site is classified as a small quantity generator of hazardous waste. Any waste is presently disposed of off-site by contract at an Alabama Department of Environmental Management permitted facility. During the construction period, approximately 5000 lbs/year of hazardous, non-radiological solid waste is expected to be generated. A combined two-unit average of 4000 lbs/year of hazardous, non radiological solid waste is expected to be generated during plant operation. There are no polychlorinated biphenyl (PCB) transformers on-site; however, there are other PCB-containing items/equipment/articles on-site but not in service. Existing on-site equipment containing PCBs is limited to the switchyard. As the station is upgraded, existing equipment and components containing PCBs are replaced with ones that do not contain PCBs. The equipment and components containing PCBs are disposed of in accordance with applicable State and Federal regulations and industry guidelines. PCB information is reported annually in the PCB Annual Document Log.

There are no other hazardous wastes stored on-site. There are no other hazardous wastes discharged from the site. Applicable procedures for off-site disposal of wastes are completed prior to turn-over of the applicable plant system. FSAR Section 13.5 provides guidance on development of procedures.

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

3.6.4 REFERENCE

1. Alabama Onsite Wastewater Board, Code of Alabama Law 1975, Section 34-21A-12, Website, http://www.aowb.alabama.gov/Downloads.htm, accessed June 3, 2008.

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

System	Chemical-Type/Specific	Amount Used per Year	Frequency of Use	Concentrations in Waste Stream
CWS	Biocide/sodium hypochlorite (NaClO)	360,000 gal.	continuous	0.2 ppm residual chlorine or 0.36 ppm sodium hypochlorite
CWS	Algaecide/quarternary amine (ammonium chloride, NH_4Cl)	362,000 gal.	continuous	0.2 ppm residual chlorine or 0.303 ppm ammonium chloride
CWS	pH adjustment/sulfuric acid (H_2SO_4)	8260 gal.	continuous	2.237 ppm H_2SO_4
CWS	Corrosion Inhibitor/ortho-polyphosphate	148,000 gal.	continuous	30 ppm ortho-polyphosphate
CWS	Silt Dispersant/polyacrylate	1,000,000 gal.	continuous	150 ppm polyacrylate
CWS	Antiscalant/phosphonate	108,000 gal.	continuous	20 ppm phosphonate
CWS	Molluskicide/quaternary amine (ammonium chloride, NH_4Cl)	2200 gal.	3-4 times/year, ~24 hours per treatment	Below detectable limits
SWS	Biocide/sodium hypochlorite (NaClO)	4140 gal.	approximately 1 hour per day	0.2 ppm residual chlorine or 0.36 ppm sodium hypochlorite
SWS	Algaecide/quarternary amine (ammonium chloride, NH4Cl)	4156 gal.	approximately 1 hour per day	0.2 ppm residual chlorine or 0.303 ppm ammonium chloride
SWS	pH adjustment/sulfuric acid (H_2SO_4)	72 gal.	approximately 1 minute of every 24 hour day	2.24 ppm H_2SO_4

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

System	Chemical-Type/Specific	Amount Used per Year	Frequency of Use	Concentrations in Waste Stream
SWS	Corrosion Inhibitor/ortho-polyphosphate	1266 gal.	approximately 1.3% of the time	30 ppm ortho-polyphosphate
SWS	Silt Dispersant/polyacrylate	8600 gal.	approximately 9% of the time	150 ppm polyacrylate
SWS	Antiscalant/phosphonate	920 gal.	approximately 0.91% of the time	20 ppm phosphonate
SWS	Molluskicide/quaternary amine (ammonium chloride, NH_4Cl)	680 gal.	3-4 times/year, ~24 hours per treatment	Below detectable limits
DTS	pH adjustment/sulfuric acid (H_2SO_4)	37.5 gal.	Intermittent	2.254-6.762 ppm H_2SO_4
DTS	Coagulant/Polyaluminum Chloride	238 gal.	Intermittent	5-15 mg/liter (0.000042 - 0.00013 lb/gal.)
DTS	Anti-scalant/polyacrylate	4500 gal.	Intermittent	150-450 ppm polyacrylate
BDS	Oxygen Scavenging/Hydrazine (N_2H_4)	106 gal.	2.5 hours per year or 1.25 hours per shutdown	200 ppm hydrazine (If steam generator is drained to the WWS.)
BDS	pH adjustment/ammonium hydroxide (NH_4OH)	414 gal.	20.7 hours per year or 10.4 hours per shutdown	100 ppm ammonia (If steam generator is drained to the WWS.)

TABLE 3.6-2
ANNUAL EMISSIONS 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

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a) Based on 4 hrs/mo operation for each 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 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]	12.72	1.0	1.0	1.0

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a) Based on total fuel throughput of 12,672 gal/yr for each tank.

b) Based on total fuel throughput of 1584 gal/yr for each tank.

c) Based on total fuel throughput of 2592 gal/yr for each tank.

d) Based on total fuel throughput of 384 gal/yr 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

This COL application is for a license for the construction and operation of two units at the BLN site with a rated net electrical output capacity of 1117 megawatts electric (MWe) each. Figure 3.7-1 illustrates the existing 500-kV and 161-kV corridors and transmission lines for BLN. The transmission infrastructure, including corridors and switchyards, to support operation of a two-unit nuclear plant at the BLN site was identified, reviewed, and evaluated in the earlier environmental review documents of the TVA and Atomic Energy Commission (AEC)(predecessor to the Nuclear Regulatory Commission) for the original facility encompassing Bellefonte Units 1 and 2. This review and evaluation included siting data for the potential corridors identified by TVA. The AEC subsequently approved and issued a construction license for Bellefonte Units 1 and 2 and its supporting transmission infrastructure into and at the site. TVA plans to use the existing Bellefonte Units 1 and 2 transmission lines and switchyards for the planned two Westinghouse AP1000 reactors.

BLN is connected to an existing network supplying large load centers. The two generating units are tied into the TVA 500-kV transmission system via a 500-kV switchyard and four 500-kV transmission lines. Each 500-kV transmission line is connected to the respective substations as shown in FSAR Figure 8.2-201. There are also two 161-kV transmission lines that supply a 161-kV switchyard to provide construction and maintenance power. TVA owns and operates the regional transmission system.

A Widows Creek – Miller 500-kV line was looped into Bellefonte Units 1 and 2 in 1976 to create a Widows Creek – Bellefonte line and a Bellefonte – Miller 500-kV line. The line was energized as described in the discussion of the BLN 500-kV switchyard below. In 2001, TVA de-energized the loop facilities (two, 3.3-mi. 500-kV line sections) and returned to operating a single line which by then was terminated at TVA's East Point 500-kV Substation instead of Alabama Power Company's Miller Steam Plant.

In 1977, the Widows Creek – Madison 500-kV line was also looped into the Bellefonte Units 1 and 2 switchyard to create another Widows Creek – Bellefonte and a Bellefonte – Madison 500-kV line. The line was energized as described in the discussion of the BLN 500-kV switchyard below. In 1987, TVA de-energized the loop facilities (two 12.4-mi. line sections) and returned to operating only a Widows Creek – Madison 500-kV Line. A portion of the 500-kV line has a 161-kV line underbuild.

TVA energized the 161-kV switchyard at Bellefonte Units 1 and 2 in June of 1978; and the on-site 500-kV switchyard in April of 1979. As a consequence of the above-described subsequent de-energization of the 500-kV loop lines into Bellefonte Units 1 and 2, TVA partially de-energized the 500-kV yard in 1987, and completely de-energized it in 2001. The BLN 500-kV switchyard and the two existing 500-kV loop lines into the BLN site are currently de-energized. TVA has subsequently removed and utilized some of the breakers and switches from the BLN 500-kV switchyard to use at other TVA facilities.

The loop into BLN off the Widows Creek – East Point 500-kV transmission line is situated on a corridor approximately 300 ft. in width. The loop into BLN off the Widows Creek – Madison 500-kV transmission line is also situated on a corridor approximately 300 ft. in width, but only up to the point where this line crosses over the Widows Creek – Scottsboro 161-kV transmission line, which is also looped into BLN as an underbuilt on the 500-kV loop. From this intersection, the 500-kV and the 161-kV loops are situated on a corridor approximately 350 ft. in width. The 500-kV connections consist of two lines 29.71 and 21.31 mi. long to the Widows Creek Steam Plant, one line 40.82 mi. long to the Madison 500-kV Substation, and one line 72.15 mi. long to the East Point Substation.

[

]Withheld per Statute

The 161-kV system into the BLN switchyard is currently energized and operating. The 161-kV switchyard is supplied by two physically separate lines. One line is 17.2 mi. long and connects to the Widows Creek Steam Plant, and the other is 7.47 mi. long and connects to the Scottsboro, Alabama, 161-kV Substation. This transmission line has a customer tap owned by North Alabama Electric Co-op, 5.42 mi. from Bellefonte, called South Hollywood. The Scottsboro 161-kV Substation is, in turn, connected to the Goose Pond 161-kV Substation which has direct connections to the Guntersville Hydro Plant, the Widows Creek Steam Plant and the Madison 500-kV Substation.

The 161-kV line segments and the portion of the 500-kV lines with 161-kV underbuilt have been maintained as described in Subsection 3.7.2.2 below. The remainder of the de-energized segments of the 500-kV loop lines has been maintained by landowners consistent with the underlying land uses of the corridors. It is likely that TVA would have to engage in more extensive re-clearing and removal of danger trees along some portion of the 500-kV lines than would routinely be necessary if the lines had undergone the normal cycle of maintenance in intervening years (see Subsection 3.7.2.3). However, the types of activities and techniques used would be consistent with those identified, and occasionally necessary, for even the routine maintenance activities of such transmission lines.

3.7.1 DESIGN PARAMETERS

No new transmission lines are needed for this project. The four transmission lines connected to the 500-kV switchyard, or the two transmission lines connected to the 161-kV switchyard have sufficient capacity to supply the total required power to the plant electric system. Auxiliary electrical power during startup and shutdown for BLN is supplied from the transmission network to the plant electrical distribution system. The normal source is the existing 500-kV switchyard.

The National Electrical Safety Code (NESC) has been adopted by TVA as the official standard. The NESC provides the rules for electrical safety, electrical clearances, structural design loadings, and material strength factors. The transmission line structures are self-supporting steel towers. This self-supporting aspect of the structures eliminates the need for guy wires. The 500-kV and 161-kV transmission line structures are designed to withstand medium loading conditions as specified in ANSI C2.2-1976 (Reference 1). These design requirements consider wind and icing conditions in excess of those that would be expected in this area. The phase conductor and shield wire design tensions are selected to avoid vibration problems. Transmission lines in the 500-kV and 161-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 100 mi. of 500-kV and 161-kV lines respectively. The use of circuit breakers with automatic reclosing circuits results in the majority of these interruptions being momentary.

The transmission lines that were constructed to connect BLN to the transmission system conform to the NESC provisions for preventing electric shock from induced current, with the exception of the Widows Creek – Madison 500-kV loop into BLN. This loop was designed before the NESC adopted the present-day induced current provisions. Under the current NESC, the induced current resulting from electrostatic effects that causes a short circuit between the largest anticipated vehicle parked under the lines and ground is limited to 5 milliamperes (mA). There are a few spans on this 500-kV loop for which the calculated short circuit current would exceed the 5 mA limit. However, this 500-kV loop is de-energized and remains so until new generation is established at BLN. Physical adjustment options to these few spans may be necessary to comply with the 5 mA limit. The two 500-kV lines that comprise this loop are generally parallel, are spaced 125 ft. centerline to centerline, and are configured such that the C-phase conductors of the two lines are adjacent to each other, which acts to simplify the electric field strengths. These options include adding tower extensions to elevate the 500-kV conductors in the problem spans, adding shield wires to the problem spans, and re-phasing of the loop line conductors. Prior to re-energizing the 500-kV loop, TVA plans to assess these options to ascertain the optimum approach for reducing the induced current to satisfy the NESC criterion.

TVA standard clearances to rigid buses are maintained as follows: the 500-kV lines are 20 ft. live part to live part and 13 ft. live part to ground while the 161-kV lines are 8.3 ft. live part to live part and 5 ft. live part to ground. Maximum pull-off angles for phase are 30 degrees from normal to the pull-off strut.

3.7.2 TRANSMISSION LINE RIGHT OF WAY (CORRIDORS)

3.7.2.1 Field Surveys

The engineering surveys for the transmission facilities into Bellefonte Units 1 and 2 were 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 Alabama Historical Commission. The Commission concurred that no cultural resources or areas of historic significance would be adversely affected by the transmission facilities. Additional information relating to cultured surveys and properties is provided in Sections 4.1.3.1 through 4.1.3.2.

3.7.2.2 Actions Necessary to Re-energize the Existing 500-kV Transmission Lines

The 161-kV system into the BLN switchyard is currently energized and operating; however, as noted above, the 500-kV lines and switchyard are presently de-energized. The 161-kV lines and the portions of the 500-kV lines with 161-kV underbuilds, undergo the normal cycles of routine maintenance as described below. Actions necessary to re-energize the existing 500-kV transmission lines and switchyard at BLN would include the following:

- Performing an aerial inspection of the transmission corridors to check for cracked insulators or other equipment needing replaced, buzzard roosts that need removed, and to assist in developing an up-to-date vegetation management plan. Utilizing “ground truthing” as needed to verify issues and resolve discrepancies.
- Replacement of damaged or defective equipment identified in the inspection.
- Replacement of many, if not all, of the breakers and switches in the existing 500-kV switchyard at BLN (up to two and one-half years including design and procurement of long-lead items).
- Upgrading of relays at the BLN switchyard.
- Re-setting of relay settings at Widows Creek, Madison, and East Point switchyards.
- Jumper work to re-connect each 500-kV loop line back into service (estimated at about one day of work at each site).
- A Sensitive Area Review would be conducted for the pertinent transmission line segments per TVA procedures described below.
- Re-clearing of 500-kV ROW where determined to be needed by the aerial inspection. This effort would involve any of the activities as described below for routine maintenance (i.e., primarily re-clearing of ROW and removal of danger trees.). The ROW would be mowed with a rotor-type head machine that would chew up wood debris and leave it where vehicles could access up and down the ROW. Access would be gained through existing access points and roads. A need to conduct ground-disturbing work (i.e., digging, grubbing or bulldozing) for re-clearing to allow re-energizing the lines is not anticipated.

3.7.2.3 Routine Maintenance of the Existing TVA Transmission System

The TVA Transmission and Power Supply – Transmission Operations and Maintenance (TPS-TOM) organization routinely conducts maintenance activities on transmission lines in the TVA system (TVA Power Service Area). These activities include, but are not restricted to, right-of-way re-clearing (removal of vegetation), pole replacements, installation of lightning arrestors and counterpoise, and upgrading of existing equipment.

The 500-kV transmission lines are inspected by aerial surveillance using a helicopter, at six-month intervals and by ground observation every one to two years. These inspections are conducted to locate damaged conductors, insulators, structures, and to report any abnormal conditions which might hamper the normal operation of the line or adversely impact the surrounding area. During these inspections, the condition of vegetation within the ROW, as well as immediately adjoining the ROW is noted. These observations are then used to plan corrective maintenance or routine vegetation management.

Regular maintenance activities for vegetation control that result from the described inspections typically occur on a cycle of 3 - 5 years. This periodic vegetation management is conducted along the ROW because of the need to maintain adequate clearance between tall vegetation and transmission line conductors. This would consist of two different activities: felling of “danger trees” adjacent to the cleared ROW, and control of vegetation within the cleared ROW. Any trees which are located off the ROW which are tall enough to pass within 10 ft. of a conductor or structure (if they were to fall toward the line) are designated as danger trees and would be removed.

Management of vegetation within the cleared ROWs would use an integrated vegetation management (VM) approach designed to encourage low-growing plant species and discourage tall-growing plant species. A vegetation re-clearing plan would be developed for each transmission line segment based upon the periodic inspections described above. The two principle management techniques are mechanical mowing using tractor-mounted rotary mowers, and herbicide application. Herbicides would be selectively applied form the ground with backpack sprayers, or for larger areas, particularly in rugged terrain, by broadcast aerial spraying from helicopter.

Any herbicides used would be applied in accordance with applicable state and federal laws and regulations. Only herbicides registered with the U.S. Environmental Protection Agency would be used. TVA maintains a complete list of the herbicides and adjuvants (ingredients added to the herbicide solution to increase its effectiveness) currently approved for use by TVA in ROW management. This list may change over time as new herbicides are developed or new information on presently approved herbicides becomes available. The herbicides most commonly used at this times are formulations of glyphosate (trade name Accord) mixed with imazapyr (trade name Arsenal) or ammonium salt of fosamine (trade name Krenite) mixed with imazapyr. Metsulfuron methyl is also occasionally added to the glyphosate or ammonium fosamine to help control certain species.

3.7.3 NOISE IMPACT

Community noise impacts are usually judged in reference to the existing background sound levels and the increase the facility noise would have on this background. Sources of noise levels generated by BLN include plant equipment and power line hum. Noise level measurements taken at BLN ranged from day-night average sound levels (Ldn) of 50 to 55 dB, well within the Housing and Urban Development (HUD) defined acceptable category. The HUD guidelines are divided into three general categories: "acceptable," "normally unacceptable," and "unacceptable" for residential settings. In the acceptable category, the Ldn does not exceed 65 dB. If Ldn exceeds 65 dB, the site is normally unacceptable. Above Ldn of 75 dB, the site is unacceptable for residential areas. The Ldn at locations near BLN are typical of a quiet rural community.

Transmission lines and substations can produce noise from corona discharge, the electrical breakdown of air into charged particles. This noise, referred to as corona noise, occurs when air ionizes near irregularities, such as nicks, scrapes, dirt, and insects on the conductors. Corona noise is composed of both broadband noise, characterized as a crackling noise, and pure tones, characterized as a humming noise. Corona noise, which is greater with increased voltage, is also affected by the weather. During dry weather, the noise level is low and often indistinguishable off the right-of-way from background noise. In wet conditions, water drops collecting on conductors can cause louder corona discharges.

For 500-kV transmission lines, this corona noise, when present, is typically in the range of 40 to 55 dBA; however, corona noise levels as high as 60 to 61 dBA have been recorded. During rain showers, the corona noise would likely not be readily distinguishable from background noise. During very moist, non-rainy conditions, such as heavy fog, the resulting small increase in the background noise levels is not expected to result in annoyance to adjacent residents.

Periodic maintenance activities, particularly vegetation management, would produce noise from mowing, bush-hogging, and tree and limb trimming and grinding. This noise, particularly from bush-hogging or helicopter operation, would be loud enough to cause some annoyance. It would, however, be of short duration and infrequent occurrence.

Additional information regarding noise levels resulting from transmission system operation is discussed in Subsections 4.4.1.5 and 5.8.1.4. TVA has made every effort to keep noise disturbances to a minimum.

3.7.4 REFERENCES

1. ANSI C2.2-1976, “National Safety Code,” 1976.

3.8 TRANSPORTATION OF RADIOACTIVE MATERIALS

This section addresses issues associated with the transportation of radioactive materials from the Tennessee Valley Authority (TVA) Bellefonte Nuclear Plant Units 3 and 4 (BLN) and alternative sites, i.e., Phipps Bend Nuclear (PBN), Yellow Creek Nuclear (YCN), Hartsville Nuclear (HVN), and Murphy Hill. Postulated accidents due to transportation of radioactive materials are discussed in Section 7.4.

3.8.1 TRANSPORTATION ASSESSMENT

The NRC regulations in 10 CFR 51.52 state that:

> *"Every environmental report prepared for the construction permit stage or early site permit stage or combined license stage of a light-water-cooled nuclear power reactor and submitted after February 4, 1975 shall contain a statement concerning transportation of fuel and radioactive wastes to and from the reactor. That statement shall indicate that the reactor and this transportation either meet all of the conditions in paragraph (a) of this section or all of the conditions in paragraph (b) of this section."*

The NRC evaluated the environmental effects of transportation of fuel and waste for light-water reactors (LWRs) in the Environmental Survey of Transportation of Radioactive Materials to and from Nuclear Plants in Reference 1 and Reference 2 and found the impacts to be SMALL. These NRC analyses provided the basis for Table S-4 in 10 CFR 51.52 (see Table 3.8-1), which summarizes the environmental impacts of transportation of fuel and radioactive wastes to and from a reference reactor. The table addresses two categories of environmental considerations: (1) normal conditions of transport and (2) accidents in transport.

The advanced LWR technology being considered for the BLN site is the Westinghouse AP1000. The proposed configuration for this new plant is two units. The standard configuration (a single unit) for the AP1000 is used to evaluate transportation impacts relative to the reference reactor.

To compare the impacts of transporting AP1000 fuel to and from the BLN site to the Reference Reactor presented in Table S-4, the fuel and characteristics for the AP1000 were normalized to a reference reactor-year (See Tables 3.8-2 and 3.8-3). The reference reactor is an 1100 MWe reactor that has an 80 percent capacity factor, for an electrical output of 880 MWe per year. One AP1000 reactor is assumed to provide a net electric power to the grid of approximately 1115 MWe, with an annual capacity factor of 93 percent. One AP1000 reactor operating at 1115 MWe, with an annual capacity factor of 93 percent, yields an effective electric output of 1037 MWe.

Subparagraphs 10 CFR 51.52(a)(1) through (5) delineate specific conditions the reactor licensee must meet to use Table S-4 as part of its environmental report. For reactors not meeting all of the conditions in paragraph (a) of 10 CFR 51.52, paragraph (b) of 10 CFR 51.52 requires a further analysis of the transportation effects.

The conditions in paragraph (a) of 10 CFR 51.52 establishing the applicability of Table S-4 are reactor core thermal power, fuel form, fuel enrichment, fuel encapsulation, average fuel irradiation, time after discharge of irradiated fuel before shipment, mode of transport for unirradiated fuel, mode of transport for irradiated fuel, radioactive waste form and packaging, and mode of transport for radioactive waste other than irradiated fuel. The following sections describe the characteristics of the AP1000 relative to the conditions of 10 CFR 51.52 for use of Table S-4. Information for the AP1000 fuel is taken from the AP1000 Design Control Document and supporting documentation prepared by the Idaho National Engineering and Environmental Laboratory (Reference 3).

3.8.1.1 Reactor Core Thermal Power

Subparagraph 10 CFR 51.52(a)(1) requires that the reactor have a core thermal power level not exceeding 3800 MW.

> The 3400 MWt rating of the AP1000 meets this requirement, as reported in the DCD.

The core power level was established as a condition because, for the LWRs being licensed when Table S-4 was promulgated, higher power levels typically indicated the need for more fuel and therefore more fuel shipments than was evaluated for Table S-4. This is not the case for the new LWR designs due to the higher unit capacity and higher burnup for these reactors. The annual fuel reloading for the reference reactor analyzed in WASH-1238 was 30 metric tons of uranium (MTU) while the average annual fuel loading for the AP1000 is approximately 24 MTU. When normalized to equivalent electric output, the annual fuel requirement for the AP1000 is approximately 20 MTU or two-thirds that of the reference LWR.

3.8.1.2 Fuel Form

Subparagraph 10 CFR 51.52(a)(2) requires that the reactor fuel be in the form of sintered UO2 pellets.

> As presented in the DCD, the AP1000 uses a sintered UO2 pellet fuel form.

3.8.1.3 Fuel Enrichment

Subparagraph 10 CFR 51.52(a)(2) requires that the reactor fuel have a uranium-235 enrichment not exceeding 4 percent by weight.

For the AP1000, the enrichment of the initial core varies by region from 2.35 to 4.45 percent and the average for reloads is 4.51 percent. The AP1000 fuel exceeds the 4 percent U-235 condition.

3.8.1.4 Fuel Encapsulation

Subparagraph 10 CFR 51.52(a)(2) requires that the reactor fuel pellets be encapsulated in Zircaloy rods. Regulation 10 CFR 50.46 also allows use of ZIRLO™.

> The AP1000 uses ZIRLO™ clad fuel rods, which are equivalent to Zircaloy clad fuel rods evaluated in Table S-4 and, therefore, meets this subsequent evaluation condition.

3.8.1.5 Average Fuel Irradiation

Subparagraph 10 CFR 51.52(a)(3) requires that the average burnup not exceed 33,000 megawatt-days per MTU.

> The AP1000 has an average maximum burnup of 60,000 MWd/MTU for the peak rod. The extended burnup is 62,000 MWd/MTU. Therefore, the AP1000 does not meet this subsequent evaluation condition.

3.8.1.6 Time after Discharge of Irradiated Fuel before Shipment

Subparagraph 10 CFR 51.52(a)(3) requires that no irradiated fuel assembly be shipped until at least 90 days after it is discharged from the reactor. The supporting basis (Reference 1) for Table S-4 assumes 150 days of decay time prior to shipment of any irradiated fuel assemblies. NUREG/CR-6703, Environmental Effects of Extending Fuel Burnup above 60 Gwd/MTU, (Reference 4), which updated this analysis to extend Table S-4 to burnups of up to 62,000 megawatt-days per MTU, assumes a minimum of 5 years between removal from the reactor and shipment.

Five years is the minimum decay time before shipment of irradiated fuel assemblies. The 5-year minimum time is supported additionally by the following three conditions.

- Five years is the minimum cooling time specified in 10 CFR 961.11, within Appendix E of the standard U.S. Department of Energy (DOE) contract for spent fuel disposal with existing reactors.
- In NUREG-1437, Generic Environmental Impact Statement for License Renewal of Nuclear Plants (Reference 5), the NRC specifies 5 years as the minimum cooling period when it issues certificates of compliance for casks used for shipment of power reactor fuel.
- The NRC has generically considered the environmental effects of spent nuclear fuel with U-235 enrichment levels up to 5 percent and irradiation levels up to 62,000 megawatt-days per metric ton, and found that the environmental effects of spent nuclear fuel transport are bounded by the effects listed in Table S-4, provided that more than 5 years has elapsed between removal of the fuel from the reactor and shipment of the fuel off-site (Reference 6).

In addition to the minimum fuel storage time, NUREG-1555, Environmental Standard Review Plan, Section 3.8, identifies the reviewers' information need regarding the capacity of the on-site storage facilities to store irradiated fuel.

As discussed in the DCD:

> The new spent fuel storage facilities (one for each unit) constructed to support the BLN units has enough storage capacity to store 889 total fuel assemblies per unit.

Based on this capacity, the BLN spent fuel storage facility provides more than enough capacity for 5 years of spent fuel storage.

3.8.1.7 Transportation of Unirradiated Fuel

Subparagraph 10 CFR 51.52(a)(5) requires that unirradiated fuel be shipped to the reactor site by truck. Fuel for the AP1000 will be shipped to the BLN site via truck shipments.

Table S-4 includes a condition that the truck shipments not exceed 73,000 lbs. as governed by federal or state gross vehicle weight restrictions. The fuel shipments to BLN and the alternative sites comply with Federal or state weight restrictions.

3.8.1.8 Transportation of Irradiated Fuel

Subparagraph 10 CFR 51.52(a)(5) allows for truck, rail, or barge transport of irradiated fuel.

For the impacts analysis described in Subsection 3.8.2, it was assumed that all spent fuel shipments are made using legal weight trucks. DOE is responsible for spent fuel transportation from reactor sites to the repository and makes the decision on transport mode (10 CFR 961.1).

3.8.1.9 Radioactive Waste Form and Packaging

Subparagraph 10 CFR 51.52(a)(4) requires that, with the exception of spent fuel, radioactive waste shipped from the reactor is to be packaged and in a solid form.

As reported in the DCD, waste is packaged in a solid form for shipment.

DAW is placed in an approved transport container, surveyed to ensure it meets all applicable DOT criteria, and shipped off-site for disposal.

3.8.1.10 Transportation of Radioactive Waste

Subparagraph 10 CFR 51.52(a)(5) requires that the mode of transport of low-level radioactive waste be either truck or rail. Radioactive waste is shipped from BLN and the alternative sites by truck.

Radioactive waste shipments are subject to a weight limitation of 73,000 lbs. per truck and 100 tons per cask per rail car. Radioactive waste from the AP1000 is shipped in compliance with Federal or state weight restrictions.

3.8.1.11 Number of Truck Shipments

Table S-4 limits traffic density to less than one truck shipment per day or three rail cars per month. Assuming that all radioactive materials (fuel and waste) are received at the site or transported offsite via truck, the required number of truck shipments has been estimated and a discussion follows.

Table 3.8-2 summarizes the number of truck shipments of unirradiated fuel. The table also normalizes the number of shipments to the electrical output for the reference reactor analyzed in WASH-1238. When normalized for electrical output, the number of truck shipments of unirradiated fuel for the AP1000 is less than the number of truck shipments estimated for the reference LWR.

For the AP1000, the initial core load is estimated at 84.5 MTU per unit and the annual reload requirements are estimated at 24 MTU/yr per unit. This equates to about 157 fuel assemblies in the initial core (assuming 0.5383 MTU per fuel assembly) and 43 fuel assemblies per year for refueling. The vendor is designing a transportation container that to accommodate one 14-ft. fuel bundle. Due to weight limitations, the number of such containers is limited to 7 to 8 per truck shipment. For the initial core load, the trucks are assumed to carry 7 containers to allow for shipment of core components along with the fuel assemblies. Truck shipments are expected to accommodate 8 containers per shipment for refueling. The number of new fuel truck shipments equates to 23 for the initial core loading and 5.3 for annual reloads. After normalizing for electrical capacity the number of shipments to support annual reload is 4.9.

The numbers of spent fuel shipments were estimated as follows. For the reference LWR analyzed in WASH-1238, NRC assumed 60 shipments per year, each carrying 0.5 MTU of spent fuel. This amount is equivalent to the annual refueling requirement of 30 MTU per year for the reference LWR. For this transportation analysis, it was assumed that AP1000 spent fuel is also shipped at a rate equal to the annual refueling requirement. The shipping cask capacities used to calculate annual spent fuel shipments were assumed to be the same as those for the reference LWR (0.5 MTU per legal weight truck shipment). This results in 46 shipments per year for one AP1000. After normalizing for electrical output, the number of spent fuel shipments is 39 per year for the AP1000. The normalized spent fuel shipments for the AP1000 are less than the reference reactor that was the basis for Table S-4.

Table 3.8-3 presents estimates of annual waste volumes and numbers of truck shipments. The values are normalized to the reference LWR analyzed in WASH-1238. The normalized annual waste volumes and waste shipments for the AP1000 are less than the reference reactor that was the basis for Table S-4.

The total numbers of truck shipments of fuel and radioactive waste to and from the reactor are estimated at 65 per year for the AP1000. These radioactive material transportation estimates are well below the one truck shipment per day condition given in 10 CFR 51.52, Table S-4.

Doubling the estimated number of truck shipments to account for empty return shipments still results in number of shipments well below the one-shipment-per-day condition.

3.8.1.12 Summary

Table 3.8-4 summarizes the reference conditions in paragraph (a) of 10 CFR 51.52 for use of Table S-4, and the values for the AP1000. The AP1000 does not meet the conditions for average fuel enrichment or average fuel irradiation. Therefore, Subsection 3.8.2 and 7.4 present additional analyses of fuel transportation effects for normal conditions and accidents, respectively. Transportation of radioactive waste meets the applicable conditions in 10 CFR 51.52 and no further analysis is required.

3.8.2 INCIDENT-FREE TRANSPORTATION IMPACTS ANALYSIS

Environmental impacts of incident-free transportation of fuel are discussed in this section. Transportation accidents are discussed in Section 7.4.

NRC analyzed the transportation of radioactive materials in its assessments of environmental impacts for the proposed Early Site Permit (ESP) sites at North Anna, Clinton, and Grand Gulf. The NRC analyses were reviewed for guidance in assessing transportation impacts for BLN and the alternative sites.

In many cases, the assumptions used by NRC are "generic" (i.e., independent of the reactor technology). For example, the radiation dose rate associated with fuel shipments is based on the regulatory limit rather than the fuel characteristics or packaging. The same generic assumptions were used in assessing transportation impacts for unirradiated fuel shipments to BLN and the alternative sites.

3.8.2.1 Transportation of Unirradiated Fuel

Table S-4 of 10 CFR 51.52 includes conditions related to radiological doses to transport workers and members of the public along transport routes. These doses, based on calculations in WASH-1238, are a function of the radiation dose rate emitted from the unirradiated fuel shipments, the number of exposed individuals and their locations relative to the shipment, the time of transit (including travel and stop times), and the number of shipments to which the individuals are exposed.

The transportation risk assessment computer code, RADTRAN 5, calculations estimated worker and public doses associated with annual shipments of unirradiated fuel. One of the key assumptions in WASH-1238 for the reference LWR unirradiated fuel shipments is that the radiation dose rate at 3.28 ft. from the transport vehicle is about 0.1 millirem/hr. This assumption was also used by NRC to analyze advanced LWR unirradiated fuel shipments for proposed ESP sites (References 7, 8, and 9). This assumption is reasonable for the other advanced LWR types because the fuel materials are expected to be low-dose rate uranium radionuclides and this fuel is expected to be packaged similarly (inside a metal container that provides little radiation shielding). The per-shipment dose estimates are "generic" (i.e., independent of reactor technology) because they were calculated based on an assumed external radiation dose rate rather than the specific characteristics of the fuel or packaging. Thus, the results can be used to evaluate the impacts for any of the advanced LWR designs.

For shipments from fuel fabrication facility sites, highway routes were analyzed using the Transportation Routing Analysis Geographic Information System (TRAGIS) routing computer code (Reference 10) and 2000 Census data.

Routes were estimated by minimizing the total impedance of a route, which is a function of distance and driving time between the origin and destination. TRAGIS also can estimate routes that maximize the use of interstate highways. For unirradiated fuel the commercial route setting was used to generate highway routes generally used by commercial trucks. However, the routes chosen may not be the actual routes used in the future. The population summary module of the

TRAGIS computer code was used to determine the exposed populations within 0.5 mi. on either side of the route.

It is likely that unirradiated fuel for the AP1000 will initially be manufactured at the Westinghouse fuel fabrication facility in Columbia, South Carolina; however this fuel could also be manufactured at facilities located in Wilmington, North Carolina, Columbia, South Carolina, or Lynchburg, Virginia. Because it is currently unknown which of these facilities would be used, to bound the radiological impacts the Lynchburg facility was evaluated because the distances to that facility would be greater than the other facilities.

In addition to the proposed BLN site in Hollywood, Alabama, four alternate sites were evaluated. These sites and starting locations are provided in Table 3.8-5. Summary data produced by TRAGIS is provided in Table 3.8-6 for unirradiated fuel.

Other input parameters used in the radiation dose analysis for advanced LWR unirradiated fuel shipments are summarized in Table 3.8-6. The results for this "generic" fresh fuel shipment based on the RADTRAN 5 analyses are provided in Table 3.8-7.

These unit dose values were used to estimate the impacts of transporting unirradiated fuel to the BLN and alternative sites. Based on the parameters used in the analysis, these per-shipment doses are expected to conservatively estimate the impacts for fuel shipments. For example, the average shipping distance of 2000 mi. used in the NRC analyses exceeded the shipping distance for fuel deliveries to BLN and the alternative sites (221 mi. to 512 mi.)

The unit dose values were combined with the average number of annual shipments of unirradiated fuel to calculate annual doses to the public and workers that can be compared to Table S-4 conditions.

The number of unirradiated fuel shipments was normalized to the reference reactor analyzed in Reference 1. The number of shipments per year was obtained from Table 3.8-2. The results are presented in Table 3.8-8. As shown, the calculated radiation doses for transporting unirradiated fuel to BLN and the alternative sites are within the Table S-4 conditions.

Although radiation may cause cancers at high doses and high dose rates, currently there are no data that unequivocally establish the occurrence of cancer following exposures to low doses and dose rates, below about 1E+02 mSv (1E+04 mrem). However, radiation protection experts conservatively assume that any amount of radiation may pose some risk of causing cancer or a severe hereditary effect and that the risk is higher for higher radiation exposures. Therefore, a linear, no-threshold dose response relationship is used to describe the relationship between radiation dose and detriments such as cancer induction. Simply stated, any increase in dose, no matter how small, results in an incremental increase in health risk. This theory is accepted by the NRC as a conservative model for estimating health risks from radiation exposure, recognizing that the model may over-estimate those risks. A recent review by the National Academy of Sciences Committee to Assess Health Risks from Low Levels of Ionizing Radiation supports the linear no-threshold model.

Based on this model, the risk to the public from radiation exposure is estimated using the nominal probability coefficient for total detriment (730 fatal cancers, nonfatal cancers, and severe hereditary effects per 1E+04 person-Sv (1 E+06 person-rem) from International Commission on Radiation Protection (ICRP) Publication 60. All the public doses presented in Table 3.8-8 are less than 1E-03 person-Sv (1E-01 person-rem per year); therefore, the total detriment estimates associated with these doses are all less than 1E-04 fatal cancers, nonfatal cancers, and severe hereditary effects per year. These risks are very small compared to the fatal cancers, nonfatal cancers, and severe hereditary effects that the same population incurs annually from exposure to natural sources of radiation.

3.8.2.2 Transportation of Spent Fuel

This section provides the environmental impacts of transporting spent fuel from BLN and the alternative sites to a spent fuel disposal facility using Yucca Mountain, Nevada, as a possible location for a geologic repository. The impacts of the transportation of spent fuel to a possible repository in Nevada provides a reasonable bounding estimate of the transportation impacts to a monitored retrievable storage facility because of the distances involved and the representative exposure of members of the public in urban, suburban, and rural areas.

Incident-free transportation refers to transportation activities in which the shipments reach their destination without releasing any radioactive cargo to the environment. Impacts from these shipments are from the low levels of radiation that penetrate the heavily shielded spent fuel shipping cask. Radiation doses would occur to (1) persons residing along the transportation corridors between BLN (or the alternative sites) and the proposed repository; (2) persons in vehicles passing a spent-fuel shipment; (3) persons at vehicle stops for refueling, rest, and vehicle inspections; and (4) transportation crew workers.

This analysis is based on shipment of spent fuel by legal-weight trucks in casks with characteristics similar to casks currently available (i.e., massive, heavily shielded, cylindrical metal pressure vessels). Each shipment is assumed to consist of a single shipping cask loaded on a modified trailer. These assumptions are consistent with assumptions made in evaluating environmental impacts of spent fuel transportation in Addendum 1 to NUREG-1437. As discussed in NUREG-1437, these assumptions are conservative, because the alternative assumptions involve rail transportation or heavy-haul trucks, which reduces the overall number of spent fuel shipments.

Routing and population data used in the RADTRAN 5 for truck shipments were obtained from the TRAGIS routing code (Reference 10). The population data in the TRAGIS code were based on the 2000 census.

For fresh fuel, the commercial routing option was used with the following constraints:

- Prohibit use of links prohibiting truck use
- Prohibit use of ferry crossing
- Prohibit low height clearance
- Prohibit narrow width clearance

- Prohibit use of roads with hazardous materials prohibition
- Prohibit use of roads with radioactive materials prohibition
- Prohibit use of roads with tunnels

For spent fuel, the Highway Route controlled option was selected with the following constraints:

- Prohibit use of links prohibiting truck use
- Prohibit use of ferry crossing
- Prohibit low height clearance
- Prohibit narrow width clearance
- Prohibit use of roads with Radioactive materials prohibition
- Prohibit use of roads with tunnels
- Las Vegas Beltway is considered a preferred route

Although shipping casks have not been designed for the advanced LWR fuels, the advanced LWR fuel designs are not significantly different from existing LWR designs. Current shipping cask designs were used for analysis.

Radiation doses are a function of many parameters, including vehicle speed, traffic count, dose rate at 3.3 ft from the vehicle, packaging dimensions, number in the truck crew, stop time, and population density at stops.

The transportation route selected for a shipment determines the total potentially exposed population and the expected frequency of transportation-related accidents. For truck transportation, the route characteristics most important to the risk assessment include the total shipping distance between each origin-destination pair of sites and the population density along the route.

Representative shipment routes for BLN and the alternative sites were identified using the TRAGIS routing model (Reference 10) for the truck shipments. The Highway data network in Web-TRAGIS is a computerized road atlas that includes a complete description of the interstate highway system and other U.S. highways. Input parameters used in the radiation dose analysis for advanced LWR spent nuclear fuel shipments are summarized in Table 3.8-9. The population densities along a route are derived from 2000 census data from the U.S. Bureau of the Census. This transportation route information is summarized in Table 3.8-10. The results for the incident free spent fuel shipments are presented in Table 3.8-11.

These per-shipment dose estimates were calculated based on an assumed external radiation dose rate emitted from the cask, which was fixed at the regulatory maximum of 10 millirem per hour at 6.6 ft. For purpose of this analysis, the transportation crew consists of two drivers. Stop times were assumed to accrue at the rate of 30 minutes per 4-hour driving time.

The number of spent fuel shipments for the transportation impacts analysis was derived as described in Subsection 3.8.1. The normalized annual shipment values and corresponding population dose estimates per reactor-year are presented in Table 3.8-12. The population doses were calculated by multiplying the number of spent fuel shipments per year for the AP1000 by the per-shipment doses. For comparison to Table S-4, the population doses were normalized to the reference LWR analyzed in WASH-1238.

As shown in Table 3.8-12, population doses to the transport crew and the onlookers for both the AP1000 and the reference LWR exceed Table S-4 values. Two key reasons for these higher population doses relative to Table S-4 are the number of spent fuel shipments and the shipping distances assumed for these analyses relative to the assumptions used in WASH-1238.

- The analyses in WASH-1238 used a "typical" distance for a spent fuel shipment of 1000 mi. The shipping distances used in this assessment were between 2486 mi. and 2610 mi., as presented in Table 3.8-10.

- The numbers of spent fuel shipments are based on shipping casks designed to transport shorter-cooled fuel (i.e., 150 days out of the reactor). This analysis assumed that the shipping cask capacities are 0.5 MTU per legal-weight truck shipment. Newer cask designs are based on longer-cooled spent fuel (i.e., 5 years out of reactor) and have larger capacities. For example, spent fuel shipping cask capacities used in the analysis were approximately 1.8 MTU per legal-weight truck shipment.

Use of the newer shipping cask designs reduces the number of spent fuel shipments and decreases the associated environmental impacts (because the dose rates used in the impacts analysis are fixed at the regulatory limit, rather than actual dose rates based on the cask design and contents).

If the population doses in S-4 were adjusted for the longer shipping distance and larger shipping cask capacity, the population doses from incident-free spent fuel transportation from BLN and the alternative sites would likely fall within Table S-4 requirements.

Other conservative assumptions in the spent fuel transportation impacts calculation include:

- The shipping casks discussed in the Yucca Mountain Environmental Impact Statement (Reference 12) transportation analyses were designed for spent fuel that has cooled for 5 years. In reality, most spent fuel will have cooled for much longer than 5 years before it is shipped to a possible geologic repository. NRC developed a probabilistic distribution of dose rates based on fuel cooling times that indicates that approximately three-fourths of the spent fuel to be transported to a possible geologic repository will have dose rates less than half of the regulatory limit (Reference 13). Consequently, the estimated doses in Table 3.8-12 could be divided in half if more realistic dose rate projections are used for spent fuel shipments from BLN and the alternative sites.

- For these analyses, a 30-minute rest stop every 4 hours was used as the average stop time. Many stops made for actual spent fuel shipments are short duration stops (i.e., 10 minutes) for brief visual inspections of the cargo (checking the cask tie-downs). These stops typically occur in minimally populated areas, such as an overpass or freeway ramp in an unpopulated area. Based on data for actual truck stops, NRC concluded that the assumption of a 30-minute stop for every 4-hours of driving time used to evaluate other potential ESP sites overestimates public doses at stops by at least a factor of two (References 7, 8 and 9).

Consequently, the doses to onlookers given in Table 3.8-12 could be reduced by a factor of two to reflect more realistic truck shipping conditions.

The environmental impact of incident free transportation of unirradiated and spent fuel is considered to be SMALL and does not warrant additional mitigation.

3.8.3 REFERENCES

1. U.S. Atomic Energy Commission (AEC), *Environmental Survey of Transportation of Radioactive Materials to and from Nuclear Power Plant,* WASH-1238, Washington, D.C., December 1972

2. Nuclear Regulatory Commission (NRC), *Environmental Survey of Transportation of Radioactive Materials to and from Nuclear Power Plants,* Supplement 1, NUREG-75/038, April 1975

3. Idaho National Engineering and Environmental Laboratory (INEEL), *Early Site Permit Environmental Report Sections and Supporting Documentation,* Design File Number 3747, Idaho Falls, Idaho, July 2003

4. U.S. Nuclear Regulatory Commission (NRC), *Environmental Effects of Extending Fuel Burnup above 60 Gwd/MTU,* NUREG/CR-6703, January 2001

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TABLE 3.8-1
SUMMARY TABLE S-4 – ENVIRONMENTAL IMPACT OF TRANSPORTATION OF FUEL AND WASTE TO AND FROM ONE LIGHT-WATER-COOLED NUCLEAR POWER REACTOR(a)

Normal Conditions of Transport			
		Environmental Impact	
Heat (per irradiated fuel cask in transport)		250,000 Btu/hr	
Weight (governed by federal or State restrictions)		73,000 lbs. per truck; 100 tons per cask per rail car	
Traffic density:			
Truck		Less than 1 per day	
Rail		Less than 3 per month	
Exposed Population	Estimated Number of Persons Exposed	Range of Doses to Exposed Individuals (per reactor year)[b]	Cumulative Dose to Exposed Population (per reactor year)[c]
Transportation workers	200	0.01 to 300 millirem	4 man-rem.
General public:			
Onlookers	1100	0.003 to 1.3 millirem	3 man-rem.
Along route	600,000	0.0001 to 0.06 millirem	
Accidents in Transport			
Types of Effects		Environmental Risk	
Radiological effects		Small[d]	
Common (nonradiological) causes		1 fatal injury in 100 reactor years 1 nonfatal injury in 10 reactor years $475 property damage per reactor year	

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a) Data supporting this table are given in the Commission's "Environmental Survey of Transportation of Radioactive Materials to and from Nuclear Power Plants," WASH-1238, December 1972, and Supp. 1 NUREG-75/038, April 1975.

TABLE 3.8-2
NUMBER OF TRUCK SHIPMENTS OF UNIRRADIATED FUEL (ONE AP1000)

	Number of Shipments/Unit			Unit Electric		Normalized	Normalized
Reactor Type	Initial Core[(a)]	Annual reload	Total[(b)]	Generation MWe[(c)]	Capacity Factor[(c)]	Shipments Total[(d)]	Shipments Annual[(e)]
Reference LWR	18[(f)]	6.0	252	1100	0.8	252	6.3
AP1000	23[(g)]	5.3[(g)]	230	1115	0.93[(h)]	196	4.9

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a) Shipments of the initial core have been rounded up to the next highest whole number.

b) Total shipments of fresh fuel over 40-year plant lifetime (i.e., initial core load plus 39 years of average annual reload quantities).

c) Unit generating capacities from the AP1000 DCD and an assumed capacity factor.

d) Normalized to electric output for WASH-1238 reference plant (i.e., 1100 MWe) plant at 80 percent or an electrical output of 880 MWe).

e) Annual average for 40-year plant lifetime.

f) The initial core load for the reference BWR in WASH-1238 was 150 MTU. The initial core load for the reference PWR was 100 MTU. Both types result in 18 truck shipments of fresh fuel per reactor.

g) Initial core load of 157 assemblies required and 43 per year for refueling. Assume 7 assemblies/shipment for initial loading and 8 assemblies/shipment for annual reload.

h) Capacity factor was assumed.

TABLE 3.8-3
NUMBER OF RADIOACTIVE WASTE SHIPMENTS (ONE AP1000)

Reactor Type	Waste Generation, ft^3/yr, per unit	Annual Waste Volume, ft^3/yr, per site	Electrical Output, MWe, per site	Capacity Factor	Normalized Waste Generation Rate, ft^3/ reactor-year(a)	Normalized Shipments/ reactor-year(b)
Reference LWR	3800	3800	1100	0.80	3800	46
AP1000	1964	3928	2230(c)	0.93	1667	21

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a) Annual waste generation rates normalized to equivalent electrical output of 880 MWe for reference LWR (1100-MWe plant with an 80 percent capacity factor) analyzed in WASH-1238.

b) The number of shipments was calculated assuming the average waste shipment capacity of 83 ft^3 per shipment (3800 ft^3/yr divided by 46 shipments/yr) used in WASH-1238.

c) The AP1000 site includes two reactor units at net 1115 MWe per unit.

TABLE 3.8-4
AP1000 COMPARISONS TO TABLE S-4 REFERENCE CONDITIONS

Characteristic	Table S-4 Condition	AP1000 Single Unit 1115 MWe
Reactor Power Level (MWt)	Not exceeding 3800 per reactor	3415
Fuel Form	Sintered UO_2 pellets	Sintered UO_2 pellets
U235 Enrichment (%)	Not exceeding 4	Initial Core Region 1: 2.35 Region 2: 3.40; Region 3: 4.45 Reload Average 4.51
Fuel Rod Cladding	Zircaloy rods; NRC has also accepted ZIRLO^{TM} per 10 CFR 50.46	Zircaloy or ZIRLO^{TM}
Average burnup (MWd/MTU)	Not exceeding 33,000	Peak-62,000
Unirradiated Fuel		
Transport Mode	Truck	Truck
No. of shipments for initial core loading[(a)]		23
No. of reload shipments per year[(a)]		5.3
Irradiated Fuel		
Transport mode	Truck, rail, or barge	Truck, rail
Decay time prior to shipment	Not less than 90 days is a condition for use of Table S-4; 5 years is per contract with DOE	Minimum of 5 years
No. of spent fuel shipments by truck[(a)]		39 per year
No. of spent fuel shipments by rail		Not analyzed
Radioactive Waste		
Transport mode	Truck or rail	Truck
Waste form	Solid	Solid
Packaged	Yes	Yes
No. of waste shipments by truck[(a)]		21 per year
Traffic Density		
Trucks per day[(b)]	Less than 1	<1
(normalized total)		(65 per year)
Rail cars per month	Less than 3	Not analyzed

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a) The table provides the total numbers of normalized truck shipments of fuel and waste for the AP1000, based on electric output. These values are then summed for comparison to the traffic density condition in Table S-4

b) Total truck shipments per year calculated after normalization of estimated fuel and waste shipments for equivalent electrical output to the reference reactor analyzed in WASH-1238.

TABLE 3.8-5
PRIMARY AND ALTERNATIVE SITES FOR THE BLN COL APPLICATION

Site	Location	TRAGIS Origin Location
Bellefonte Units 3 and 4 (BLN)	Hollywood, AL	BLN
Phipps Bend (PBN)	Surgoinsville, TN	Kingsport, TN
Yellow Creek (YCN)	Iuka, MS	Muscle Shoals, AL
Hartsville (HVN)	Hartsville, TN	Lebanon, TN
Murphy Hill	Guntersville Reservoir, Langston, AL	Guntersville, AL

TABLE 3.8-6 (Sheet 1 of 2)
RADTRAN 5 INPUT PARAMETERS FOR THE ANALYSIS OF UNIRRADIATED FUEL SHIPMENTS FOR BLN AND ALTERNATIVE SITES

Parameter	Parameter Value	Comments and Reference
Package		
Package dimension	38.58 ft.	Approximate length of two LWR Traveller XLs at 226 inches each.
Dose rate at 1 meter from vehicle	0.1 mrem/hr	Reference 1
Fraction of emitted radiation that is gamma	0.5	Assumed the same as for spent nuclear fuel Reference 14
Fraction of emitted radiation that is neutrons	0.5	Assumed the same as for spent nuclear fuel Reference 14
Crew		
Number of crew	2	Reference 1 and 16
Distance from source to crew	10.2 ft.	Reference 16
Crew shielding factor	1.0	No shielding - Analytical assumption
Route-specific parameters		
Rural	55 mph	Average speed in rural areas given in Reference 15. Conservative in-transit speed of 55 mph assumed: predominately interstate highways used.
Suburban		
Urban		
Number of people per vehicle sharing route	1.5	Reference 16
One-way traffic volumes		
Rural	Varies by state	Reference 11(a)
Suburban	Varies by state	Reference 11(a)
Urban	Varies by state	Reference 11(a)
Minimum and maximum distances to exposed resident off-link population	33 to 2625 ft.	Reference 13
Distances (mi.)/Population densities (persons per square mi.)		
BLN		
Rural	282.5/48.8	Reference 10
Suburban	225.5/809.7	Reference 10
Urban	10.9/4988.8	Reference 10
PBN		
Rural	143.4/45.2	Reference 10
Suburban	108.1/811.5	Reference 10
Urban	3.6/5282.3	Reference 10
YCN		
Rural	360.0/47.3	Reference 10
Suburban	256.0/828.1	Reference 10
Urban	13.8/5107.7	Reference 10

TABLE 3.8-6 (Sheet 2 of 2)
RADTRAN 5 INPUT PARAMETERS FOR THE ANALYSIS OF UNIRRADIATED FUEL SHIPMENTS FOR BLN AND ALTERNATIVE SITES

Parameter	Parameter Value	Comments and Reference
HVN		
Rural	289.8/49.5	Reference 10
Suburban	202.6/776.3	Reference 10
Urban	7.7/5031.8	Reference 10
Murphy Hill		
Rural	300.6/49.2	Reference 10
Suburban	237.3/801.2	Reference 10
Urban	11.6/4963.3	Reference 10
Truck Stop Parameters		
Min/Max radii of annular area around vehicle at stops	3.3 to 33 ft.	Reference 13
Population density at stops	77,700 persons/mi^2	Reference 13
Shielding factor applied to annular area around vehicle at stops	1.0	Reference 13
Min/Max radii of annular area around truck stop	33 to 2625 ft.	Reference 13
Population density surrounding truck stops	881 persons/mi^2	Reference 13
Shielding factor applied to area around truck stop	0.2	Reference 13
Stop time	30 minutes per 4 hour driving time	Reference 13
Shipments per year	4.9 Normalized	Table 3.8-2

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a) Appendix D, Table D-3 and D-7

TABLE 3.8-7
RADIOLOGICAL IMPACTS OF TRANSPORTING UNIRRADIATED FUEL BY TRUCK TO BLN AND THE ALTERNATIVE SITES

	Dose person-rem/shipment				
Population Component	BLN	PBN	YCN	HVN	Murphy Hill
Transport workers	4.54E-04	2.23E-04	5.51E-04	4.38E-04	4.81E-04
General public (Onlookers – persons at stops and sharing the highway)	1.49E-03	7.27E-04	1.56E-03	1.47E-03	1.51E-03
General public (Along Route – persons living near a highway)	4.94E-05	2.37E-05	5.77E-05	4.33E-05	5.16E-05

TABLE 3.8-8
RADIOLOGICAL IMPACTS OF TRANSPORTING UNIRRADIATED FUEL BY TRUCK TO BLN AND THE ALTERNATIVE SITES (ONE AP1000)[(a)]

Reactor Type	Normalized Average Annual Shipments	Cumulative Annual Dose, person-rem per reference reactor year		
		Transport Workers	General Public-Onlookers	General Public-Along Route
Reference LWR	6.3	1.10E-02	4.20E-02	1.00E-03
AP1000 - BLN	4.9	2.20E-03	7.30E-03	2.42E-04
AP1000 - PBN	4.9	1.09E-03	3.56E-03	1.16E-04
AP1000 - YCN	4.9	2.70E-03	7.63E-03	2.83E-04
AP1000 - HVN	4.9	2.15E-03	7.21E-03	2.12E-04
AP1000 – Murphy Hill	4.9	2.36E-03	7.40E-03	2.53E-04
10 CFR 51.52	365	4	3	3
Table S-4 Condition	< 1 per day			

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a) AP1000 values calculated by multiplying Table 3.8-7 values by the total normalized amount of shipments.

TABLE 3.8-9
RADTRAN 5 INPUT PARAMETERS FOR THE BLN ANALYSIS OF SPENT NUCLEAR FUEL SHIPMENTS

Parameter	Parameter Value	Comments and Reference
Package		
Package dimension	19.0 ft.	The AP1000 spent nuclear fuel is shipped in a Traveller XL that is 226.0 in. (approximately 19 ft)
Dose rate at 1 meter from vehicle	14 mrem/hr	Approximate dose at 1 meter that is equal to the legal limit of 10 mrem/hr at 2 meters (Reference 1)
Fraction of emitted radiation that is gamma	0.5	Reference 14
Fraction of emitted radiation that is neutrons	0.5	Reference 14
Crew		
Number of crew	2	Reference 1 and 15
Distance from source to crew	10.2 ft.	Reference 16
Crew shielding factor	1.0	Analytical assumption. Results in dose rate to crew greater than legal limit. Crew dose rate reset by RADTRAN to 2 mrem/hr
Route-specific parameters		
Rural Suburban Urban	55 mi. per hour	Average speed in rural areas given in Reference 15. Conservative in-transit speed of 55 mph assumed: predominately interstate highways used.
Number of people per vehicle sharing route	1.5	Reference 15
One-way traffic volumes		
Rural	Varies by state	Reference 11[(a)]
Suburban	Varies by state	Reference 11[(a)]
Urban	Varies by state	Reference 11[(a)]
Minimum and maximum distances to exposed resident off-link population	33 to 2,625 feet	Reference 13
Shipments per year per reactor	46 Average 39 normalized	Table 3.8-2

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a) Appendix D, Table D-3 and D-7

TABLE 3.8-10
TRANSPORTATION ROUTE INFORMATION FOR SPENT FUEL SHIPMENTS FROM BLN AND THE ALTERNATIVE SITES TO THE POTENTIAL YUCCA MOUNTAIN DISPOSAL FACILITY

	One-way Shipping Distance, mi.				Population Density, persons per square mi.			Stop Time per trip, hr
Reactor Site	Total	Rural	Suburban	Urban	Rural	Suburban	Urban	
BLN	2249.1	1878.8	326.7	43.7	22.4	821.7	5893.3	4.5
PBN	2399.0	1950.6	401.4	47.2	24.2	815.1	5743.5	4.5
YCN	2271.8	1901.6	328.4	42.0	22.7	816.1	5773.1	4.5
HVN	2146.1	1800.7	302.6	43.0	21.7	836.3	5829.0	4.0
Murphy Hill	2343.6	1939.6	358.7	45.4	23.3	817.1	5849.7	4.5

TABLE 3.8-11
RADIOLOGICAL IMPACTS OF TRANSPORTING SPENT FUEL FROM BLN AND THE ALTERNATIVE SITES BY TRUCK TO THE POTENTIAL YUCCA MOUNTAIN DISPOSAL FACILITY (ONE AP1000)

	Dose person-rem/shipment				
Population Component	BLN	PBN	YCN	HVN	Murphy Hill
Transport workers	1.65E-01	1.76E-01	1.67E-01	1.57E-01	1.72E-01
General public (Onlookers – persons at stops and sharing the highway)	3.93E-01	4.04E-01	3.96E-01	3.55E-01	4.00E-01
General public (Along Route – persons living near a highway)	5.10E-03	6.12E-03	5.10E-03	4.79E-03	5.54E-03

TABLE 3.8-12
POPULATION DOSES FROM SPENT FUEL TRANSPORTATION, NORMALIZED TO REFERENCE LWR

Reactor Site	Exposed Population	Cumulative Dose Limit Specified in Table S-4 Person-rem/RRY	Reactor Type	
			Reference LWR	One AP1000
			Number of Spent Fuel Shipments/year	
			60	39(a)
			Environmental Effects Person-rem/RRY(b)	
BLN	Crew	4	5.9	6.4
	Onlookers	3	21	15.3
	Along Route	3	0.60	0.20
PBN	Crew	4	5.9	6.9
	Onlookers	3	21	15.8
	Along Route	3	0.60	0.24
YCN	Crew	4	5.9	6.5
	Onlookers	3	21	15.4
	Along Route	3	0.60	0.20
HVN	Crew	4	5.9	6.1
	Onlookers	3	21	13.9
	Along Route	3	0.60	0.19
Murphy Hill	Crew	4	5.9	6.7
	Onlookers	3	21	15.6
	Along Route	3	0.60	0.22

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a) Normalized

b) For the AP1000 values, the number of shipments were multiplied times Table 3.8-11 values