10.12 HEATING, VENTILATING AND AIR-CONDITIONING SYSTEMS

10.12.1 Safety Objective

The safety objective of the Heating, Ventilating, and Air Conditioning Systems is to maintain the control bay environment required for protection of equipment and for occupancy throughout the life of the plant.

10.12.2 Power Generation Objective

The power generation objective of the Heating, Ventilating, and Air Conditioning Systems is to maintain all areas at the environmental conditions required for operation of equipment, to maintain all occupied areas at conditions required for comfort and safety of personnel, and to limit the spread of contamination during power and shutdown operation of the plant.

10.12.3 Safety Design Basis

The control bay ventilation and air conditioning systems shall maintain the temperature of the control and electrical board rooms within the acceptable limits for operation of instruments and for uninterrupted safe occupancy under all plant conditions.

The diesel generator building's HVAC systems shall be capable of maintaining the required conditions for safety-related equipment.

10.12.4 Power Generation Design Basis

1. The systems shall maintain all plant areas at the temperature conditions necessary for operation of equipment.

2. The systems shall maintain all occupied areas within the temperature and humidity range required for human occupancy.

3. The systems shall limit the spread of radioactive contamination and provide for the filtration of air before exhaust from areas where significant airborne activity is expected.

4. The systems shall provide for the safe disposal of combustible or otherwise undesirable vapors and gases.

5. The systems shall limit the spread of radioactive airborne contamination to the control bay by providing the capability for automatic control bay isolation and emergency pressurization.

10.12.5 Description

10.12.5.1 General

Reactor Building, Turbine Building, Radwaste Building, and Diesel Generator Buildings have separate systems for year-round ventilation. The Control Bay is equipped with an air conditioning system. A common plant heating system serves the Reactor, Turbine, and Radwaste Buildings. The Diesel Generator Buildings are equipped with electric resistance heaters. A separate, electric hot-water heating system serves the Control Bay. The plant heating system is a forced hot water system designed to maintain indoor temperatures necessary for the protection of equipment and for personnel comfort. It is also designed to preheat the fresh air supply to the buildings, as required, during winter conditions.

The following paragraphs of this FSAR section provide descriptions of the Ventilation systems for the Turbine Building, Radwaste Building, and Diesel Generator Buildings. In addition, a description is provided of the Control Bay HVAC system.

The Reactor Building ventilation system is described in paragraph 5.3.3.6.

The Drywell Ventilation and Cooling System is described in 5.2.3.7.

10.12.5.2 Turbine Building

The Turbine Building is heated, cooled, and ventilated during normal and shutdown operations by a circulating air system. Fresh air heating coils and unit space heaters are served by the building heating hot water system.

The building heating, ventilating, and cooling systems were designed to provide a summer maximum inside temperature of 105°F with outside conditions at 97°F, and a winter inside minimum temperature of 55°F when the outside temperature is 5°F. These systems are shared in the sense that the turbines are in a common ventilation zone.

All outside air enters the building through fan room roof hoods, is filtered, passes across hot water coils for winter heating, through evaporative coolers for summer cooling, and hence to the supply fans. Air flow is routed to areas of progressively greater radioactive contamination potential. In rooms where offgases might pose a potential health problem to personnel, a slight vacuum is created by the ventilation system so that any offgas, such as from the hydrogen analyzers in the offgas monitor panel, is carried out through the exhaust fans and checked for high radiation levels. The air passes through door grilles (with the exception of the offgas monitor cubicle which has a labyrinth entry arrangement and the offgas recombiner room which has a gap between door and room floor), with backflow or air-check dampers and adjustable dampers for manually balancing air flow quantities. Each plant unit has two 100-percent capacity Turbine Building exhaust fans located on the Reactor Building roof. These fans discharge through a fan stack with the top at El. 735. The air is monitored before release. The turbine room roof ventilator fans provide additional exhaust capacity in the summer season (see Figures 10.12-1, 10.12-7, and 10.12-8).

Per plant unit, the Turbine Building exhaust fan and the nine turbine room roof-ventilator exhaust fans are collectively capable of exhausting a maximum of approximately 269,000 CFM of building air to the outdoors. The Turbine Building discharge dampers and Reactor Building exhaust fans are pneumatically activated. These dampers are located on the Reactor Building roof. The turbine-spaces supply fan, the mechanical-spaces supply fan, the two electrical-spaces supply fan, and the five turbine room supply fans are collectively capable of supplying a maximum of approximately 255,000 CFM of outdoor air to the building. The building can thus be maintained at a slight negative pressure relative to the outdoors to minimize possible exfiltration of contaminated air.

During cold weather, the two-speed, building exhaust fan may be operated at half-speed and the roof-ventilator exhaust fans turned off, by groups, to maintain any of various building exhaust air flow rates to a minimum of 62,500 CFM. The two-speed, mechanical-spaces supply fan may be operated at half-speed; the two-speed supply fans may be reduced in speed or turned off; and the single-speed supply fans may be either operated or turned off, in various operating combinations, to maintain slightly less air-supply flow rate to the building than is exhausted.

10.12.5.3 Control Building

Toxic Gas Protection

The evaluation of control room habitability included consideration of possible hazards created by the accidental release of potentially toxic chemicals. The evaluation considered chemicals stored both onsite and offsite within a 5-mile radius of BFN. Possible shipments of toxic chemicals by pipeline, barge, rail, or road routes within a 5-mile radius were also considered. Methods of analysis used were those outlined in NRC Regulatory Guide 1.78, "Assumptions for Evaluating the Habitability of a Nuclear Power Plant Control Room During a Postulated Hazardous Chemical Release."

All chemicals stored onsite which are considered to be potentially hazardous to the control room personnel were analyzed utilizing the approach outlined in NRC Regulatory Guide 1.78. The analysis (1) confirmed that these chemicals have no effect on the main control room habitability. Additional chemicals are stored onsite, however, it was assumed that these chemicals do not constitute a hazard to control room personnel due to the fact that they are stored in small quantities, are solids, are liquids with a very low vapor pressure at ambient temperatures, or the operators would have sufficient time to don protective equipment in the event of a release.

There are no industrial or military facilities located within a 5-mile radius of BFNP where stored chemicals could cause a potential hazard to the plant[1].

The only rail line or road passing within a 5-mile radius of the plant is Alabama State Route 20, which at its closest point, is 4-1/2 miles from the plant.

These analyses[1] indicated that the worst-case accident would be from nearby barge traffic transporting benzene, ethyl benzene, toluene, vinyl acetate, acrylonitrile, and chlorine. Analyses were performed utilizing the approach outlined in NRC Regulatory Guide 1.78. Major assumptions included Pasquill stability Class G and adverse wind direction. Wind speed was chosen to maximize the 2 minute concentration at the control room air intakes. The analysis[1] indicated that, upon a release of these chemicals from a barge accident, the concentration in the control room would pose a potential threat to the control room operators. With the exception of chlorine, these chemicals can be detected by smell by the control room operators in sufficient time to don protective equipment without experiencing any physical impairment. Upon a chlorine release from a barge accident, the concentration in the control room would impact control room habitability. However, the probability of a barge accident which results in a chlorine concentration in the control room which exceeds the concentration limits in NRC Regulatory Guide 1.78 is less than 1.0E-6 events per year. At this probability value, the chlorine release can be excluded from consideration in the control room habitability analysis.

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Control Building HVAC

The Control Building Heating, Ventilating, and Air Conditioning Systems serve the three floors in the control bay and the six shutdown electrical board rooms in the Reactor Building immediately adjacent to, and normally entered from, the control bay. There are several separate subsystems serving these areas.

The Control Building air conditioning is divided into eight general areas. Four of these areas have separate air supply systems, each serving a room or group of rooms with cooling and heating thermostatically controlled. These areas are the Units 1 and 2 Control Room, Units 1 and 2 elevation 593, relay room, Unit 3 Control Room. The Unit 3 elevation 593 area is heated and cooled with a separate air supply system, but it is not thermostatically controlled. The air supply systems for the remaining three areas serve a group of rooms with only cooling. These areas are the Unit 1 Electric Board Rooms, Unit 2 Electric Board Rooms, and the Unit 3 Electric Board Rooms. Three of the eight control building air conditioning systems are shared, in that one system serves the Units 1 and 2 Main Control Room, the second serves the Units 1 and 2 elevation 593, and the third serves the Switchyard Relay Room common to all three units. (For additional information refer Appendix F.) Each air supply system is equipped with two 100-percent capacity air handling units or air conditioning units (see Figures 10.12-2a and -2c).

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1 Calculation ND-Q0031-890038

The Control Room Emergency Ventilation System (CREVS) processes outside air needed to provide ventilation and pressurization for the Control Room Habitability Zone (CRHZ) during isolated conditions. When the CRHZ is isolated, a fixed amount of outside air is processed through a HEPA filter bank, air heater, charcoal adsorbers, and post filters. A seismically-qualified safety-related Control Room Emergency Ventilation System (CREVS), composed of two redundant trains, is provided (as shown in Figure 10.12-2b) in the Unit 2 control bay area. This system of filtered outside air aids in positive pressurization of the CRHZ with respect to the outdoors. Test facilities to conduct standard DOP and Freon leak tests are provided for this system. Carbon sample canisters are provided for Laboratory Carbon Sample Analysis.

The CREVS is started automatically by a primary containment isolation signal or high radiation signal, or it can be started manually at any time. The CREVS, once activated, continues to operate until shut down manually.

The control bay HVAC flow diagrams are shown in Figures 10.12-2a, 10.12-2b, and 10.12-2c. Cooling of the atmosphere in the Main Control Room is provided by a recirculation air system with refrigeration units. During normal operation, a small stream of makeup air drawn through NBS dust filters is used to maintain a slight positive pressure in the control room. Upon receipt of a primary containment isolation signal or high radiation signal, the normal control room pressurization and makeup network is automatically isolated from the CRHZ. This same signal automatically starts the operation of the CREVS. The trip setting for the Control Building intake duct radiation monitors is based on the Technical Specifications Section 3.3.7.1 allowable value of 270 cpm above background, which is a radiation level corresponding to about 10^{-5} mci/cc of Xenon-133 (about 1 mRem/hr). The nominal trip setpoints are determined to account for appropriate instrument errors (e.g., drift) and are specified in the setpoint calculations. The initial setpoint was based on manufactures empirical formulas.

Outside air for the CREVS is drawn from both of the main outside air intake ducts supplying ventilation tower 1 and ventilation tower 3. Outside air pulled from these two intakes passes through a HEPA filter bank located in ventilation tower 2.

The CREVS is activated by a primary containment isolation signal or high radiation signal from the Control Building intake duct radiation monitors, the same signals also initiates the isolation of the CRHZ. The two 100 percent redundant filter trains are safety-related and are powered from separate divisions of normal and emergency diesel power. Only one train operates following auto actuation with the other train on standby.

In each train, a Class 1E electric duct air heater is mounted upstream of charcoal adsorber filters to maintain the incoming air's relative humidity to below 70 percent for high charcoal adsorption efficiency. The CREVS is designed to process outside air post DBA for 30 days without danger of saturation.

The control room air handling units provide ventilation to the main control room area. Two 100-percent capacity air handling units are provided, each containing: heating and cooling coils, a humidifier, controls, and motor-operated dampers. The dampers isolate the air handling unit when on standby. The air handling cooling coils are equipped with vent and drain valves. Room return air is proportionally mixed with fresh air by manual dampers and filtered by renewable media filter cells rated at 85-percent NBS.

Fresh air is mechanically supplied for makeup to air-conditioning systems, for ventilating system requirements, and for pressurizing the Control Building. Fresh air supply systems separately serve the Units 1 and 2 air-conditioned spaces except the Electric Board Rooms, the Unit 3 air-conditioned spaces except the electric board rooms and spreading rooms. Each of the air-conditioned spaces has two 100-percent capacity supply fans.

Each spreading room is ventilated by one 100-percent capacity fresh-air supply fan. Two 100-percent capacity exhaust fans serve both spreading rooms. The fresh air is filtered. The air flow is balanced with the exhaust flow exceeding the total supply flow in order to prevent a positive pressure in the spreading rooms in relation to the Control Bay Habitability Zone (CBHZ) thus precluding the possibility of unfiltered air inleakage into the CBHZ. Dampers exist in the ventilation exhaust lines from the spreading rooms. Manual provisions exist to restart one spreading room ventilation system independent of the other.

Two 100-percent capacity, air-cooled, water-chilling units, located on the Unit 1 and 2 Diesel Generator Building roof, provide essential cooling for the Units 1 and 2 control bay air-conditioning systems.

Two 100-percent capacity chilled water pumps for Unit 3 are each designed to circulate water through a water cooled water chilling unit. Chilled water is then circulated through a chilled water piping loop to each air-handling unit's cooling coil. The system is equipped with test wells for temperature monitoring.

Two 100-percent capacity hot water pumps are each designed to circulate water that is heated by a hot water generator located in the Unit 1 mechanical equipment room. The hot water is circulated through a hot water piping loop to various air-handling unit heating coils and reheat coils mounted in branch air supply ducts.

To prevent overheating of essential electrical equipment as a result of loss of cooling due to failure of both water chillers serving Units 1 and 2, or by the rupture of the chilled water loops, supplementary cooling is provided. Water-cooled condensing units are connected to direct-expansion cooling coils mounted in each air-conditioning system return air separate duct. Condenser cooling water is taken from the Emergency Equipment Cooling Water System.

The Unit 3 control bay ventilation and heating instruments are strategically located to sense a mixture of return and supply air for optimum system performance.

The rooms containing the Unit 1 shutdown boards and the rooms containing the Unit 2 shutdown boards, and the rooms containing the Unit 3 480V shutdown boards are each cooled by two 100-percent capacity air-conditioning units or air handling units located in each of the Reactor Buildings. The air distribution system and damper configuration allows each room to be independently isolated and cooled. Fire dampers allow each board room to be independently isolated when an excessively high temperature is detected. Smoke detectors in the return ducts of the Unit 2 board rooms alarm in the main control room.

The 4-kV electric boards for Unit 3 are located in rooms within the Unit 3 Diesel Generator Building. The Unit 3 electric board rooms are cooled by redundant air-conditioning units. Induced fresh air and the recirculated air are filtered by NBS-rated filters. Fire dampers allow each board room to be independently isolated when an excessively high temperature is detected.

The Unit 3 electric board room air conditioning units described above are seismically qualified and are powered from emergency electric power sources. Condenser cooling water is supplied by the EECW System.

The battery rooms, motor-generator set rooms for Unit 3 only, and Units 1 and 2 mechanical equipment room are ventilated for the removal of heat and dangerous fumes by two exhaust systems, one serving Units 1 and 2 and the other serving Unit 3. Each system contains two 100-percent capacity exhaust fans located on the control bay roof. A third exhaust fan for each system is provided within the control bay structure. Fire dampers are present in all ventilation ducts which penetrate the perimeter of the auxiliary battery rooms for all 3 units.

Cooling for the Switchyard Relay Room is provided by two safety related air handling units. Normally, Relay Room Air Handling Unit A provides cooling for the Relay Room. This unit contains a prefilter, heating and cooling coils, a humidifier, controls and a motor operated damper. Ventilation is provided for the Relay Room from the Unit 1 board room normal or emergency supply fan through air handling Unit A. Relay Room Air Handling Unit B automatically starts on high relay room temperature, which is annunciated as a common A/C alarm in the Unit 1 Main Control Room, and will continue to operate until it is manually shut off. Relay Room Air Handling Unit B, located in the Relay Room, is a local room cooler which contains a prefilter, cooling coil, controls and a backdraft damper at its discharge. During emergencies, if offsite power is available, the operating air handling unit will continue to run. Upon loss of offsite power, either Relay Room Air Handling Unit can be started locally within three hours to assure sufficient cooling.

The non-safety-related Process Computer Room, Units 1/2 Computer Room, Communications Battery Board Room, and Communications Room are cooled by redundant 100-percent capacity non-safety-related air-conditioning units located in the Turbine Building. Damper configuration allows each room to be independently isolated and cooled.

The Unit 3 Computer Room is cooled by the safety-related air supply system which serves the Unit 3 Auxiliary Instrument Room.

10.12.5.4 Radwaste Building

The Radioactive Waste Building ventilating system consists of two 50-percent capacity supply fans which supply a total of 28,000 CFM of filtered air to central areas on the various floor levels. Two 50-percent capacity exhaust fans with a total rated capacity of 30,000 CFM exhaust air from individual spaces in the Radioactive Waste Building through roughing and HEPA filters. Exhaust air is routed through the Reactor Building by a separate exhaust duct before being discharged on the Reactor Building roof. The filters are arranged in two separate plenums, each of which can handle 50-percent of the capacity and each of which can be isolated for servicing. When one plenum is isolated, one supply fan and one exhaust fan are stopped and the system operates on 50-percent capacity. Vents from tanks, sumps, and hoods are routed to the exhaust ducts. All exhaust grilles are equipped with opposed blade dampers for balancing, and doors used for air intakes to spaces are equipped with backdraft dampers (see Figure 10.12-4).

Generally, the Radioactive Waste Building is heated by tempering the building air supply with hot water coils located in the fan room. Sufficient heat is furnished to preheat the supply air for equipment protection and reasonable personnel comfort. The power stores, Elevation 580.0, which have a separate ventilation system are heated by suspended electric heaters. Additional electric heat is furnished for personnel comfort in the following areas: clothes change, ventilating equipment, and fan rooms.

Comfort air-conditioning is provided for the radio-chemical laboratory and the radioactive waste control room. The system consists of an air-handling unit, water-cooled condenser, and electric duct heaters located in the Service Building. A 100-percent fresh air supply with no return is used to prevent possible buildup of contaminants. The air supplied is exhausted through the laboratory hoods each of which is connected to an exhaust fan and HEPA filters. The fans and filters are located in the fan room at Elevation 580.0 and discharge to the roof of the Radioactive Waste Building.

10.12.5.5 Diesel Generator Building

The Diesel Generator Building (DGB) Heating, Ventilation and Air Conditioning (HVAC) system is designed to maintain the required environmental conditions for safety related equipment located in the Units 1, 2, and 3 DGB.

The protective safety functions are accomplished through the various ventilation methods described below. Ventilation cooling and fume removal from each of the eight (8) (DG) rooms is provided by one of two redundant exhaust fans (A & B) with associated room inlet and outlet, and fan discharge motor operated dampers. These fans discharge into a common exhaust plenum, which is open to the atmosphere.

Although not classified as protective safety related equipment, each DG room contains a separate battery vent hood exhaust fan. This fan is normally operating to prevent hydrogen gas buildup during battery charging operation.

Each Unit 1 and 2 Diesel Auxiliary Board room (480-V A and B) have roof mounted exhaust fans and air intakes. Each exhaust fan and each air intake have motor operated dampers which close when fan is off.

The Unit 3 480-V Diesel Auxiliary Board rooms (3EA and 3EB) are ventilated similar to Unit 1 and 2 with additional exhaust duct connections from room 3EA to an adjacent toilet room, and additional ventilation exhaust ducting from the pipe and electrical tunnel to the 3EB fan.

Unit 1 and 2 DGB Emergency Transformer, located in the pipe and electrical tunnel area, is cooled by a separate roof mounted exhaust fan with motor operated damper.

The Unit 3 250-V Battery Room 3EB, is ventilated and maintained at a negative pressure with two redundant roof mounted exhaust fans, each with associated back-draft dampers.

The Central Diesel Information Center, which is located in Units 1 and 2 DGB, is cooled by a roof mounted exhaust fan with an associated motor operated damper.

The Electrical Access and Miscellaneous Equipment Room, which is located in Unit 3 DGB, is cooled by a roof mounted exhaust fan with an associated motor operated damper.

For the four 4160-V Shutdown Board Rooms of Unit 3 (3EA, 3EB, 3EC, and 3ED) and the Bus Tie Board Room air conditioning is provided. In addition, outdoor air is available for pressurization and exhaust.

10.12.6 Safety Evaluation

The air-conditioning and ventilation systems of the Control Building, Diesel Generator Building, and shutdown board rooms shown on Figures 10.12-2a, -2b, -2c, 10.12-5, and 10.12-6 of the FSAR, are provided to condition the environment so that safety-related controls and electrical equipment will remain operable at all times. Sufficient equipment redundancy and alternate power sources ensure that tolerable limits are maintained and, therefore, extreme environmental conditions are not part of the design bases. These systems are discussed in Subsection 10.12.5.3 of the FSAR. (The Unit 3 4-kV shutdown board room air conditioning systems do not have single failure proof power sources. If required, manual actions ensure area temperatures remain within limits.) In general, two water chiller units or air conditioning units are provided, whereas only one is required; and at least two blowers are provided with one being a standby. Alternate electrical boards feed power from the offsite or emergency supplies to the redundant units. The dampers are motor- or air-operated; however, they can be easily and quickly positioned manually in the event of a operator malfunction. Thus, no criteria or design analyses are needed to cope with extreme environmental conditions associated with a loss of all air-conditioning and ventilation systems servicing the control rooms and equipment rooms.

Environmental control of the control bay is maintained for personnel occupancy and for continuous operation of plant equipment during any type of accident and throughout the life of the plant. All cooling facilities have redundant or backup systems. All essential functions are provided by two or more separate and redundant systems or subsystems. Power supplies for essential equipment are taken from separate shutdown boards and routed through separate boards and trays. Cooling water for essential equipment is taken from the Emergency Equipment Cooling Water System.

10.12.7 Inspection and Testing

The control bay and shutdown board room air-conditioning and ventilating systems are in continuous operation and are accessible for periodic inspection. Essential electrical components, switchovers, and starting controls are tested initially and periodically.