5.3 SECONDARY CONTAINMENT SYSTEM

5.3.1 Safety Objective

The safety objective of the Secondary Containment System is to limit the release of radioactivity to the environs after an accident so that the resulting exposures are kept to a practical minimum and are within the guideline values given in published regulations (10 CFR 20 and 10 CFR 50.67 as applicable).

5.3.2 Safety Design Basis

The Secondary Containment System provides secondary containment when the primary containments are intact. In the event of release of radioactivity to the Reactor Building atmosphere, the Secondary Containment System contains the necessary reliable, redundant components and subsystems to isolate, to contain, and to assure controlled filtered elevated release of Secondary Containment Building atmosphere.

The Secondary Containment System can provide primary containment when any of the three Primary Containment Systems are open such as during refueling (MODE 5) and maintenance operations.

During normal operation and when isolated, the secondary containment is maintained at a negative pressure relative to the building exterior. When isolated, the secondary containment atmosphere is filtered by the Standby Gas Treatment System and released from the plant stack. Provision is made for removal of decay heat from activity deposited on filters.

The secondary containment inleakage rate is less than the SGTS capacity when the building is subjected to an internal negative pressure of 0.25 inch of water. Wind conditions are considered.

The Reactor Building superstructure siding is designed to withstand internal pressure in excess of 57.6 lb/ft^2 without structural failure. Pressures in excess of 50 lb/ft^2 will be relieved by blowoff panels in the siding. The above-grade exterior concrete walls are designed for pressures up to 250 lb/ft^2 without structural failure. The roof is designed for 50 lb/ft^2 live load and 25 lb/ft^2 dead load. The roof internal pressure design goal is 5-inches water gauge[1] (see page III-145 of Reference 1). The loads from fans, ducts, and tanks are carried directly to the building steel and do not load the deck.

The tornado design basis is a pressure decrease of 3 psi at a rate of 0.6 psi per second. (See Question 2.1 of Amendment 2 of the Browns Ferry Unit 3 Design and Analysis Report.)

The Reactor Building and the Standby Gas Treatment Building are Class I structures. The Standby Gas Treatment System (SGTS) and Secondary Containment System are designed as Class I systems except for the penetrations through the secondary containment membrane and SGTS drains. These penetrations are designed to limit the inleakage flow in order to maintain a negative pressure inside secondary containment following a Design Basis Earthquake. SGTS drains have been designed to meet Seismic Class II pressure retention requirements.

The operation of the Secondary Containment System is independent of offsite power and normal generation system capacity.

The individual components and subsystems which receive a signal to isolate secondary containment and for operation of standby gas treatment are testable during normal operation of the nuclear systems.

The Standby Gas Treatment System and associated ventilation system active components are designed to the single-failure criteria for engineered safeguards.

Air cooling units provide for the removal of heat from equipment and piping losses from RHR, Core Spray, and RCIC Systems.

5.3.3 Secondary Containment System Description

5.3.3.1 General

The Reactor Building exterior walls, roof, floor, penetrations, and qualified membrane extensions form the secondary containment membrane. The Raw Cooling Water discharge lines from each unit are seismically qualified pressure boundary extensions from the Reactor Building penetration out to the point underground where the steel discharge lines join clay pipe in the yard. During refueling/maintenance activities (ex., OB MSIV, FW check valve maintenance) when secondary containment is required, secondary containment membrane may be extended to analyzed boundaries.

The Primary Containment Systems and essentially all of the Emergency Core Cooling Systems for the three reactors are located inside the bounds of the Secondary Containment System. The Reactor Building substructure consists of poured-in-place reinforced concrete exterior walls that extend up to the refueling floor. The refueling room floor is also made of reinforced poured-in-place concrete. The superstructure of the Reactor Building above the refueling floor is a structural steel frame. This frame supports the roof decking and the overhead crane tracks, as well as the foamwall stepped fascia panels and the insulated metal siding panels. The built-up roof, the stepped fascia panels, and the metal siding form the secondary containment membrane above the refueling floor.

The reinforced concrete exterior walls and the structural steel for the superstructure will withstand the design basis tornado. (See paragraph 12.2.2 for tornado considerations and missile protection.) The superstructure siding is assumed to be removed in the design basis tornado. However, the superstructure design is adequate in the event the siding is not removed because (a) the blowout panels will prevent excessive pressure differentials, and (b) the structural steel frame is designed for the full-wind load with all of the siding in place.

For a major steam line rupture, the excess pressure would be relieved through blowout panels. Small ruptures would probably be contained in the Reactor Building without relieving the blowout panels. Large blowout panels are located in the main steam valve room of each unit. This prevents overpressurization of the Reactor Building for a main steam line rupture between the second isolation valve and the secondary containment wall. For steam line failures in the Reactor Building, but outside the drywell and outside the main steam valve room, the pressure would be relieved to the refueling room by the hatches and hatchways. The pressure within would then be relieved to the large blowout panels in the insulated metal siding.

Secondary containment is isolated and operation of the Standby Gas Treatment System (SGTS) initiated by low reactor water level, high drywell pressure, high radiation in a Reactor Building ventilation system, or a manual signal from the Main Control Room. Subsection 5.3.3.2 describes the sequence and logic for isolation of the secondary containment system. Subsection 7.3, "Primary Containment and Reactor Vessel Isolation Control System," describes the actuation signals for the secondary containment isolation and startup of standby gas treatment.

The Units 1, 2, and 3 air dilution ducts, the Units 2 and 3 air dilution duct cross connects to SGTS, the cubicle exhaust duct, the steam packing exhaust duct and the cubicle and steam packing exhaust bypasses are automatically isolated from the stack and SGTS by redundant, safety-related, backdraft dampers which shut on backdraft or no flow. The use of these dampers limit the amount of a ground-level radioactive release during Design Basis Accidents which use SGTS to mitigate the radiological consequences of these Design Basis Accidents. Subsection 14.6, 'Analysis of Design Basis Accidents', evaluates the radiological consequences of design basis accidents.

5.3.3.2 Zone Ventilation System

The Reactor Building is divided into four ventilation zones which may be isolated independently. The refueling room which is common to the three units forms the refueling zone. The individual units below the refueling floor form the three reactor zones. The four-zone ventilation control system provides increased capability for localizing the consequences of an accident or radioactive release such that the effect may be localized in one zone while maintaining the ability to isolate the entire Reactor Building if necessary. With one or more zones isolated, normal operations may be continued in the unaffected zones. If radiation is detected in an unisolated zone, that zone too would isolate and the entire Reactor Building would still meet the requirements of secondary containment by assuring filtered elevated release. The zone system is not an engineered safeguard, and the failure of the zone system would not in any way prevent isolation or reduce the capacity of the Secondary Containment System.

A reactor zone is isolated upon isolation of the primary containment in that particular zone, by high radiation level in the ventilation exhaust duct leaving that particular zone, or by manual alignment. The refueling zone is always isolated when any reactor zone is isolated. The refueling zone only is isolated by a manual signal or by a high radiation signal from any of the six radiation monitors that serve the refueling zone (see FSAR Section 7.12.5). Upon isolation, all of the ventilation systems serving the isolated zone or zones are shut down, the ducts are isolated, and the Standby Gas Treatment System is started and begins exhausting from the isolated zone or zones.

5.3.3.3 Reactor Building Description

The Reactor Building is built on bedrock. A description of the underlying rock formation is found in Subsection 2.5, "Geology and Seismology." The structural design basis of the reinforced concrete walls, the refueling floor, and the steel superstructure framing are discussed in Subsection 12.2, "Principal Structures and Foundations."

The Reactor Building roof consists of a metal deck, insulation, and built-up composition roofing. The deck is made of 18-gauge 3-inch-deep galvanized steel deck. The deck is formed from U.S. Standard gauge structural quality steel that conforms to ASTM Specification A 245. The metal roof deck is covered with a 2-inch-thick layer of rigid insulation. Just prior to installing the insulation, the deck will receive a vapor barrier consisting of a vapor barrier felt and steep asphalt. The insulation is secured to the deck with hot asphalt. The insulation is covered with a single ply asphalt base felt which is in turn covered with a 4 ply felt, fiberglass roof insulation, 3 plys of fiberglass felt, and is topped with a modified bitumen roof membrane which has an aluminum roof coating on its top. Special attention is given to the joints where the built-up portion joins the parapet and penetrations to assure a permanent leak-tight installation.

The siding panels form the secondary containment wall membrane on the superstructure. The vertical panels are made up of 18-gauge galvanized steel, insulated panels 12-inches wide and 1-1/2-inches thick faced with aluminum V-beam sheets. The steel panels are joined on the edges with 1-1/2-inch deep interlocking male and female ribs. The female rib is factory-caulked with a resilient caulking compound. A finned vinyl weatherstrip gasket is secured to the male leg with double-sided, pressure-sensitive tape. The male-female joint is then drawn up tight in place and locked by button-punching on 4-foot centers. A full 1/4-inch resilient caulk bead is laid along the downturned sides of the female joints. This provides a triple seal. The ends of the vertical insulated panels are sealed with a double row of pressure-sensitive tape laid side by side with the fasteners passing between the two rows of tape. Each stainless steel fastener is individually sealed. The exposed joint edges are continuously caulked.

The stepped fascia and accent panels are made of foamwall panels. The foamwall panels are made from urethane foam sheets bonded between 0.04-inch thick aluminum sheathing. All joints at the end of the panels are sealed with metal batten strips. The battens are double-sealed to the aluminum sheath with pressure-sensitive tape. The inner batten is attached to the outer batten with sheet metal screws. The corner joints at the steps are either tongue-and-groove or flashed. The tongue-and-groove joints are formed on the ends of the foamwalled panels. The tongue-and-groove joints are triple-sealed. The inner joint and the tongue joint are sealed with pressure-sensitive tape. The outside joint is caulked. The flashed joints are sealed with double rows of pressure-sensitive tape with the fasteners placed between the rows of tape.

5.3.3.4 Relief Panels

Excessive pressure differentials due to steam line ruptures and tornadoes are prevented by venting to the atmosphere through relief panels. Two sets of relief panels and a flow limiter prevent the overpressurization of the Secondary Containment System. These consist of the main steam relief panels, the exterior siding panels and the HPCI flow limiter. Main steam ruptures would be vented to the Turbine Building through main steam relief panels. The exterior siding panels vent the refueling room to the atmosphere. The zonal relief panels were removed to form the combined zone secondary containment system. Steam line ruptures other than main steam ruptures, and excess air vents during a tornado depressurization vent to the refueling floor. The combined zone configuration allows free flow of each reactor zone atmosphere with the common refuel zone atmosphere.

The portion of each main steam vault inside the Secondary Containment System is separated from the main steam tunnel in the turbine bay by large blowout panels made of several sections. These panels have an unobstructed area of approximately 360 square feet and are designed to relieve at 90 lb/ft^2. For large ruptures in the main steam vault the panels would relieve the steam and the steam would flow to the Turbine Building through a second set of relief panels, around the turbine foundation openings into the Turbine Building, and then to the atmosphere. The relief panels are held in place with necked aluminum rupture bolts. The panel sections are made of 10-gauge sheet metal, and the panel edges are sealed to the building steel. The panels are chained on one side to assure that the panels cannot collect on obstructions downstream, thereby blocking the flow area. The steam vault is designed to withstand an internal pressure of 1440 lb/ft^2. The biological shield penetrations from the drywell are sealed to prevent high external pressure on the drywell. The remainder of the vault is not leaktight, and some steam would leak to the Reactor Building through the access door and through ventilation penetrations.

Steam releases into the tunnel are detected by temperature sensors. When these sensors detect a high temperature condition in the steam tunnel, they initiate main steam line isolation but not RCIC isolation. If the break is in the 40 feet of RCIC steam piping traversing this area, the RCIC high-flow sensors are the only automatic sensors providing protection for RCIC breaks in the tunnel. (There are no RCIC temperature sensors located in the tunnel.) A RCIC steam line break that discharges less than 3 times the RCIC rated flow does not actuate the RCIC isolation valves; therefore, the steam pressure increases in the tunnel unless the operator responds to the emergency and manually isolates the RCIC. Radiation detectors in the reactor zone ventilation exhaust will sense the leak and will isolate that unit's reactor zone and the refueling zone. Lack of operator action permits the pressure to increase until the steam is eventually relieved through the tunnel blowout panels into the Turbine Building. Continuation of the blowdown causes venting of steam from the Turbine Building; however, steam leaks without liquid release produce insignificant radiological doses.

A high radiation level will be detected by the turbine area radiation monitoring instrumentation and will annunciate in the control room; thus, the operator would be alerted to examine his information display. An indication of RCIC steam flow without a concurrent reactor low water level, but with high tunnel temperature and with main steam line isolation, would be indicative of a RCIC steam line break in the tunnel area. The operator could then isolate RCIC (a very important system but not designated as a Emergency Core Cooling System), or he could dispatch someone to the Turbine Building to perform a survey. The operator's examination could take as long as 10 minutes before he deduces that the RCIC steam line probably has ruptured and manually isolates the RCIC steam line. The offsite doses for an undetected 300 percent RCIC steam leak in the tunnel that continues for this long (10 minutes) are less than 1 percent of the TEDE 10 CFR 50.67

guideline values. (These dose calculations were made using the methods and assumptions discussed in Chapter 14 of the FSAR.)

Each HPCI turbine steam supply line contains a flow limiter which limits the flow to approximately three times the maximum required for the HPCI turbine. With this flow limiter, a rupture of the HPCI steam supply line or any other line relieving steam to the secondary containment would relieve to the zone containing the rupture.

All of the zones were connected to the refueling floor with relief panels that were designed to relieve at 36 lb/ft^2. The elevator shafts in the Reactor Building are not in any of the four zones. In the event of a tornado depressurization, the elevator shafts would relieve to the refueling floor through relief panels of 25-square feet each. Each new fuel vault is vented to the refueling zone through an 8-inch diameter vent pipe.

BFN now utilizes a combined zone secondary containment which opens the Units 1, 2, and 3 reactor zones to the refueling zone during operation. The combined zone is created by removing the refuel floor equipment hatch covers which are equipped with blowout panels at El. 664 on Units 2 and 3 and the Unit 1 secondary containment equipment access shaft removable panels at El. 565, 593, 621, and 639. This configuration allows the total secondary containment in-leakage limits to be distributed into any of the four secondary containment zones.

The exterior siding relief panels are located on the north and south walls of the refueling room floor. The total panel area is 3200 square feet. This is equally distributed on the north and south walls. These 1600 square feet on each wall are divided equally along the three units even though they join a common room. The joints in the blowout panel are similar to the other joints in the vertical insulated siding except they are not button punched. The panels are held in place with necked aluminum rupture bolts.

5.3.3.5 Locks and Penetration

All entrances and exits to and from the Reactor Building are through personnel and equipment locks. These locks are shown on Figures 1.6-2, 1.6-3 sheets 1 and 2, 1.6-5, 1.6-6, 1.6-11, 1.6-12, and 1.6-13. Two personnel locks in the north wall of the Reactor Building at EL. 565 lead to the Reactor Building from EL. 565 of the Turbine Building. One lock leads to either Unit 1 or Unit 2, the second personnel lock leads to either Unit 2 or Unit 3. These two personnel locks are the normal access to the Reactor Building. Two personnel locks at El. 565 extended through the south wall of the Reactor Building and to the outside by passing under the berm. They will be used when equipment or fuel is being passed through the large equipment lock. There are six personnel locks between the control bay and the Reactor Building at El. 621.25 and El. 593. These provide emergency exits from the control bay and emergency access from the Reactor Building to the shutdown board rooms. Small equipment locks serve Unit 2 and Unit 3 and lead to EL. 565 of the Turbine Building. Two personnel locks on the north side of the refueling floor (EL. 664) lead to the stairs for access to the Reactor Building roof and the control bay roof.

The personnel and small equipment lock doors have locking devices powered from the 120-V AC Plant Preferred Electrical System. When one door is open, the locking devices will be engaged, which prevents the other door from being opened. The doors are also interlocked with a Main Control Room alarm which annunciates in the highly unlikely event that both doors are opened simultaneously. The doors for the personnel locks and the two small equipment locks are weather stripped to reduce infiltration. The six emergency access locks require a magnetically coded card-key access control system, or on failure of the individual card readers, the door latches will be left open. Both failures will be annunciated in the Unit 1 Main Control Room and action initiated to secure the doors with a key-operated deadbolt.

For personnel access locks and the equipment access locks construction and loads information. (See FSAR Section 12.2.2.1.6.)

After initial installation, all doors will be tested for operation of hinges, latches, and keylocks. Doors and locking mechanisms are to be inspected periodically for free operation and interlock functions. These inspections include an examination of the frame sealant to determine if cracks are developing and only normal deterioration is taking place. Also included in the inspection program is the weather stripping which is evaluated for fit and deterioration.

New and spent fuel and other items enter and leave the Reactor Building through a large equipment lock located in the south wall of Unit 1 at EL. 565. The large motor-operated double doors at each end of the large equipment lock are fitted with inflatable pneumatic seals. The air to operate the inflatable seals is supplied from two independent air receivers, one for each set of door seals, that are supplied from the Control Air System. Two check valves in series on the receivers' control air supply lines prevent depressurizing the system upon loss of control air. The receiver capacity is adequate to inflate the seals twice and maintain the seal including system leakage for at least 30 days of operation without makeup from the Control Air System. The 30 day duration is based on minimizing secondary containment membrane leakage so that overall post-accident releases to the environment do not exceed those assumed for control room and offsite calculated 30 day doses. The air system is designed so that the system leakage rate may be determined with the seals inflated to assure that the receiver capacity is adequate to supply inflation air for a minimum of 30 days. Low pressure in the seals on both sets of doors can occur only when low pressure occurs in the system. Loss of seal pressure is annunciated in the Main Control

Room. The doors are interlocked to ensure secondary containment integrity. The doors and the air system are designed for the maximum earthquake loads.

A sub-door is installed in one leaf of each of the inner and outer equipment access doors. The sub-door is used to provide an alternate method of egress/ingress of equipment during construction and maintenance activities. The sub-doors are so designed that, when used, no additional loading of the large equipment access doors will occur. This is accomplished with a removable ramp design. A fork lift vehicle with a capacity of 15,000 lbs. is able to pass over the access lock door threshold without putting loads on the access door frame, hinges, or seal. The sub-doors and equipment access lock doors are mechanically interlocked such that no two doors may be opened at a given time. The mechanical interlocking system is designed utilizing four keyed alike, key retaining padlocks. One key will be available for use and administratively controlled. The key is retained within the lock until the door is closed and secure. The local control panel to each access lock door and both the inner and outer sub-doors will be interlocked using this method. Each sub-door is equipped with a (non-inflatable) mechanical seal. The design function of each sub-door is consistent with that of the access lock doors and will provide containment integrity functions. The sub-doors are an element of the access lock doors and when not in use become a functional component of the equipment access lock doors.

Significant Condition Report (SCR) BFNNEB 8601 Revision 1 documented a discrepancy between Section 5.3, Appendix F and the secondary containment piping penetration configurations installed in the plant. The discrepancy identified was a difference between the plant configuration and the FSAR. Section 5.3 and Appendix F identified the secondary containment piping penetrations as Seismic Class I while the actual configurations did not always appear to be Seismic Class I. To resolve this SCR, analysis of the existing secondary containment penetrations was performed by EQE Engineering, Inc. to determine the potential for a pipe break on both sides of the secondary containment boundary. Such a break would result in an increase in the air leakage rate into secondary containment. This evaluation[2], dated October 12, 1988, documents that although class I design requirements were not necessarily met, the secondary containment piping does meet Seismic Class II pressure retention requirements such that there is no credible likelihood of pipe breaks which would result in leakage area increases into the secondary containment volume for systems existing prior to this date.

Any piping systems which are installed after October 12, 1988, are required to satisfy the isolation requirements given in the following paragraphs.

Secondary containment piping penetrations can be divided into two groups. The first group covers penetrations for systems that are open in the secondary containment and open to the outside environment. These penetrations contain double isolation valves. The section of pipe or duct from the secondary containment through the second isolation valve is designed to withstand the maximum earthquake. The isolating valves in this group close automatically by zone upon secondary containment isolation, or they may be operated manually from the Main Control Room. The valves have position-indicating lights in the Main Control Room. The second group covers penetrations for systems that do not open into the secondary containment. These closed systems that are designed for the maximum earthquake throughout the secondary containment do not have isolation valves at the secondary containment membrane. All lines that are not analyzed for the maximum earthquake, except as noted below, have a means of sealing the line at the secondary containment membrane, and the section of pipe from the seal to the containment membrane is designed to withstand the maximum earthquake. Lines postulated to break by an earthquake without means of sealing the line at the secondary containment membrane have been analyzed to maintain the secondary containment inleakage rate less than the SGTS capacity when the building is subjected to an internal negative pressure of 0.25 inch of water. These seals are arranged to prevent inflow into the secondary containment through a ruptured line when the secondary containment is under negative pressure of 3-inches water gauge. For lines that only flow out of secondary containment, check valves, water seals or other qualified methods of ensuring containment integrity are used. Lines that have flow into secondary containment or in both directions are sealed by either remote manual valves operated from the Main Control Room, or water-seal legs or check valves that require in excess of 3-inches water gauge to open; or the lines have been analyzed to maintain the secondary containment inleakage rate less than the SGTS capacity when the building is subjected to an internal negative pressure of 0.25 inch of water. All piping or ducts serving a secondary containment pressure boundary function complies with Seismic Class I or Seismic Class II pressure retention criteria.

No credit is taken for the RCW discharge lines check valves' seats and disks to provide secondary containment isolation. The RCW discharge lines external to the reactor building penetrations and within the Seismic Class I service water tunnels are seismically qualified for pressure boundary retention out to the point underground where the carbon steel discharge lines join clay pipe. The clay pipe portion of the discharge lines tie into the respective unit's Condenser Circulating Water (CCW) conduit which discharges into the river. Either RCW discharge flow or river water level provide a water seal against secondary containment air inleakage under all plant operating modes and accidents. River water level is routinely monitored for low level to detect the potential for uncovering the RCW discharge flow path at the CCW conduit. During a design basis earthquake, the underground clay piping could fail, but the ends of the carbon steel RCW discharge lines would be sealed under the yard soil.

The supply and exhaust ventilating duct penetrations fall in the open system category. Low-leakage dampers are used for this service. The damper frame is a 6-inch extruded aluminum channel. The extruded aluminum airfoil-shaped damper blades seal on the edges with a resilient seat and on the ends with stainless steel pressure plates. The pneumatic damper operators close upon loss of air or control signal.

Typical piping penetration seals are shown in Figure 5.3-1. All electrical penetrations are sealed with sealant around the conductors. Figures 5.3-2 and 5.3-2a through 5.3-2d show typical penetrations for both conductors in cable trays and for conductors in conduit. Figure 5.3-5 shows a typical duct penetration and seal.

All functional through-wall penetrations of the concrete Reactor Building walls (i.e., penetrations through which electrical conductors or process fluid piping pass) enter the environs below grade level or into adjoining concrete structures which provide tornado and wind-driven missile protection. A single 4-inch mechanical sleeve (spare penetration) on the Unit 2 Reactor Building south wall, eight 4-inch conduit penetrations on the Unit 1 Reactor Building south wall, and several small penetrations (2-inches or less nominal diameter) that provide access to the atmosphere for equipment control penetrate above ground level and are exposed to the ambient environment. The spare penetration is sealed on both ends by blind flanges. The conduit penetrations are equipped with iron fittings that will withstand tornado and wind-driven missiles on both the interior and exterior sides of the penetration. The small penetrations contain piping which is connected to closed systems inside the Reactor Building. Thus, the integrity of secondary containment is preserved. Analysis has shown that the probability of these penetrations being breached by a tornado or wind-driven missile is so unlikely as to constitute an incredible event. Their exposure to the ambient environment is, therefore, acceptable. All Reactor Building penetrations are readily accessible and can be visually inspected. If the plant experiences a tornado that threatens the integrity of secondary containment, an inspection and test can be conducted.

Several ducts and conduit pass through the insulating siding panels. Where these penetrations are made in the siding, the siding is sealed directly to the duct or conduit similar to the joints where the siding is sealed to structural steel and concrete walls.

Zone penetrations are similar to the secondary containment penetrations except piping penetrations are designed for normal loads and do not necessarily contain isolation valves.

5.3.3.6 Reactor Building Heating and Ventilating System

The Reactor Building is heated, cooled, and ventilated during normal and shutdown operation by a circulating air system. The Reactor Building Heating and Ventilating System is shut down and isolated when that zone of secondary containment is isolated and connected to the SGTS. While the Reactor Building Heating and Ventilating System is not an engineered safeguard, certain components do perform engineered safeguards functions. The double isolation valves and the equipment area cooling units serve engineered safeguards systems and are designed to engineered safeguards standards and criteria. The double isolation valves are described in paragraph 5.3.3.5. The equipment area cooling units remove the heat from the basement rooms during operation of RHR and Core Spray Systems. These air-cooling units are described in paragraph 5.3.3.6.2.

Duct penetrations through fire area boundaries in the Reactor Building are evaluated for fire protection adequacy and, where necessary, are protected by fire dampers. The flow diagram for the Reactor Building Heating and Ventilating Systems and Standby Gas Treatment is shown in Figures 5.3-3a, 5.3-3b, 5.3-3c, and 5.3-3d.

5.3.3.6.1 Basic Ventilating System

The ventilation system provides 100 percent makeup air. Outside air is taken from grade level on the south side of the Reactor Building. The air is filtered, then passes across hot water coils for winter heating and through evaporative coolers for summer cooling, and, hence, to four supply fans per unit. Two 100-percent capacity supply fans per unit furnish air to the refueling zone. Two 100-percent capacity fans supply air to each of the unit reactor zones. The filters, coils, coolers, and supply fans are located outside the Reactor Building.

The ventilation system air flow values to the refueling room are shown on Figures 5.3-3a, 5.3-3c, and 5.3-3d (these values can be reduced by 1/2 during heating season). This provides a minimum of 2.7 changes of air per hour, except in the heating season when the flow may be reduced to a minimum of 1.35 changes of air per hour. The air is distributed to the south side only of the refueling room. The air flow in the room is directed across the clean areas to the less clean areas and finally collected around the periphery of the fuel storage pool (including the dryer and separator pool and refueling well when primary containment is open) and other areas of high potential for contamination.

The reactor zone ventilation system air flow values are shown on Figures 5.3-3a, 5.3-3c, and 5.3-3d (these values can be reduced by 1/2 during heating season). This provides 4.0 changes of air per hour, except during the heating season when the flow may be reduced to 2.0 changes per hour. This air is distributed to the clean areas of the four main floors (El. 565, El. 593, El. 621.25, and El. 639). A portion of this air is collected for exhaust after sweeping across the open rooms. The remainder of the air flows to areas with a higher potential for contamination, and then is collected for exhaust. Rooms below El. 565 are ventilated by supplying air down the open stairwells to each of the corner rooms, then into the pressure suppression chamber and the HPCI room where the air is collected for exhaust. The TIP room, the steam and feedwater valve room, and all rooms containing Reactor Water Cleanup System components are maintained at a negative pressure. Air flows from the main rooms into these rooms through backflow dampers. The exhaust from the CRD repair room is routed through HEPA filters directly into the reactor zone exhaust system upstream of the radiation monitors. The exhaust from these rooms is collected and routed to the Reactor Building roof.

The ventilation air from the Reactor Building is ducted to exhaust fans located on the Reactor Building roof. One-hundred percent standby exhaust-fan capacity is provided. The refueling zone fans exhaust through a fan stack with the top at El. 730.25. The reactor zone fans exhaust through a fan stack with the top at El. 733.25. The air from each zone is monitored before release. High activity will isolate the secondary containment ventilation zones with the high activity (see Subsection 5.3.3.2). Normal ventilation air exhaust is not filtered.

5.3.3.6.2 Equipment Area Cooling

The RHR pumps and the core spray pumps are located in the basement rooms of the Reactor Building. The heat loss from the motors, pumps, and piping is removed by air-cooling units. The air-cooling units are designed to maintain the air at 148 degrees F when the unit is supplied with 95 degrees F cooling water. There is one air-handling unit for each RHR pump. The cooled discharge from each air-handling unit is ducted to and directed across the RHR pump motor. One air-handling unit serves both core spray pumps in the same compartment. The cooled air-handling unit discharge flow is divided, with half directed to and across each spray pump motor. Each unit in the RHR rooms removes 405,000 Btu/hr under design conditions. The units in the core spray pump rooms remove either 508,000 or 405,000 Btu/hr. The larger units are installed in the core spray rooms that contain control rod drive pumps.

A reliable Class I source of cooling water for the Core Spray pump room cooling units and the RHR pump room equipment area cooling units is supplied from the Emergency Equipment Cooling Water System. The EECW system is described in Subsection 10.10, "Emergency Equipment Cooling Water System."

The electric power for the equipment area cooling units is taken from the 480-V Reactor MOV boards. The cooling units in each RHR pump room are fed from separate, independent boards of the same divisional power source as the pumps.

An equipment area air-cooling unit starts automatically when a RHR pump (or a core spray pump) in that compartment starts. The air-cooling units also start automatically when compartment temperatures approach 100 degrees F. The control system meets the single-failure criteria of IEEE-279.

The equipment area cooling units are factory-assembled self-contained package units. The package unit and the associated ducting are designed to withstand the maximum earthquake.

5.3.3.6.3 Primary Containment Purge

The Reactor Building ventilation system can supply 6000 cfm to each drywell or 6000 cfm to each pressure suppression chamber. This air is used for purge and ventilation of the Primary Containment System. The purge and ventilation exhaust from the primary containment is first processed by a filter train assembly and then channeled through the Reactor Building roof exhaust system. Such an installation allows either the drywell or the suppression chamber to be purged on each of the three plant units simultaneously.

The purge supply piping is configured such that it is possible to establish a large bypass path from the drywell to the pressure suppression chamber. If this path is established, then the pressure suppression function of the primary containment could be compromised. Administrative controls prevent the simultaneous purging or inerting of the drywell and the pressure suppression chamber except when the unit is at cold shutdown (MODE 4 or Mode 5). The primary containment purge and ventilation system is isolated from the primary containment by two isolation valves in series, during power operation. Furthermore, these valves cannot be reopened if high radiation exists in the Reactor Building ventilation ducts. These valves are part of the primary containment that is described in Subsection 5.2, "Primary Containment System."

An operability analysis of the containment purge valves was performed to justify the design of the containment purge system. The analyses show that the purge valves are adequate for closure against DBA forces. Modifications (new solenoids) have been made on the purge line isolation valves on all units to reduce the valve closure times for the large purge valves from about 15 seconds to less than 5 seconds. The reduced stroke time brings the valve closure time into conformance with NRC Branch Technical Position CSB 6-4. This significantly reduces the analytical dose and also protects against pressurization of appurtenant duct work as discussed in TVA submittals (L. M. Mills to Thomas A. Ippolito) dated March 17, 1980 and June 2, 1981 and resolved in an NRC letter to TVA (D. B. Vassallo to H. G. Parris) dated July 1, 1985. In addition, six purge valves have been rotated to assure a uniform flow distribution on the valve disc. Debris screens on the purge lines have also been provided to ensure that isolation valve closure is not prevented by debris which might become entrained in the escaping steam and air. These provisions allow use of the main purge valves, as restricted by the technical specifications, during operation. The purge valves involved are shown schematically in Figure 5.3-10.

The purge and ventilation filter assembly contains the following components in sequence of flow: a high-efficiency particulate absolute filter, a carbon absorber, and a fan.

The first component of the filter assembly is a HEPA filter. This filter assembly has the capability of removing radioactive particulate 0.3 micron in size and larger with an efficiency of 99.95 percent. The bank consists of six 2-foot square standard high-efficiency particulate filter elements. Each filter has a waterproof, fire-retardant, glass fiber filter media in a frame.

The second component is an activated charcoal bed. The adsorber unit is a standard size unit tray type capable of removing 99.955 percent of radioactive iodine as elemental iodine and 85 percent of radioactive iodine as methyl iodine with an intake flow at 90 percent relative humidity. The holding capacity is 2.5 milligrams of radioactive iodine per gram of carbon with 95 percent elemental iodine and 5 percent methyl iodine. The minimum retention time of the air is 0.25 seconds.

The final component in the filter assembly is a centrifugal fan having a capacity of 6000 cfm at 8.5-inches water gauge. The fan is driven by a 15-hp, V-belt drive, electric motor.

5.3.3.7 Standby Gas Treatment System

The Standby Gas Treatment System provides a means for minimizing the release of radioactive material from the containment to the environs by filtering and exhausting the air from any or all zones of the Reactor Building and maintaining the building at a negative pressure (such that air leakage is into, not out of, the building) during containment isolation conditions. Elevated release is assured by exhausting to the plant stack.

The basic system consists of a suction duct system, three filter trains and blowers, and a discharge vent system. The suction duct system exhausts from the normal ventilation exhaust duct of each of the three reactor zones ahead of the isolation valves and from the refueling zone independent of the normal ventilation system. Each train contains seven major components. In the direction of flow, these components are: (1) moisture separator, (2) relative humidity heater, (3) prefilter, (4) upstream HEPA filter, (5) charcoal filter, (6) downstream HEPA filter, and (7) blower. The second through seventh components are, in order, approximately 1.5, 5, 10, 13, 20, and 34 feet, respectively, from the moisture separator.

The three filter trains and blowers are arranged in parallel and are located in two Standby Gas Treatment System buildings. (See Subsection 12.2, "Principal Structures and Foundations".) In the SGTS building containing two filter trains and blowers, each blower is normally aligned with its respective filter train, but either blower can be used with either filter train. Inside this building, the trains are separated by a 42-inch thick concrete-shield wall. The third train is located in the second building. All three trains share a common suction manifold. In this way, each of the three trains is connected to all three reactor zones and the refueling zone. Upon an accident signal, all three SGTS units will start.

Allowable surveillance inleakage occurs as a result of ongoing secondary containment maintenance and/or modifications, siding and roof leakage, HVAC damper leakage, airlock door leakage, penetration leakage, and other similar leakages. The limiting value for the allowable surveillance inleakage is specified by Technical Specification SR 3.6.4.1.4. The design basis margin is the flow required to compensate for the increase in leakage following a design basis event. The design basis margin is based on a calculated value of the increased leakage through the secondary containment boundary due to a design basis event. The minimum acceptable capacity is the sum of the allowable surveillance inleakage and the design basis margin. The minimum acceptable flow rate of two SGTS trains is equal to the flow rate defined by the minimum acceptable capacity.

The three Standby Gas Treatment blowers share a common discharge header which is connected to the 600-foot high plant stack through a dual underground piping network. Both Standby Gas Treatment buildings are located west of the Reactor Building under the berm. The diagram of the Standby Gas Treatment System is shown on Figures 5.3-3a, 5.3-3b, 5.3-3c, and 5.3-3d.

The ducts, filter trains, blowers, and associated valves are designed to withstand the maximum earthquake without impairing the ability of the system to operate at design capability. The design of the ducts and equipment, such as valves and operators, etc., prevents introduction of foreign materials such as lubricants into the air stream.

The radiolytic heating in the filter train is approximately 2650 watts. Any heat is removed by the flowing air when a train is in service. When it is required to remove heat from one train with the other trains in service, a small bypass stream is drawn through the train that requires heat removal.

When it is necessary to remove heat with all trains shut down, a stream of room air is supplied to the train that requires cooling, then exhausted up the stack by one or more of the blowers. All of the cooling functions are controlled manually from the main control center. All power-operated valves and dampers have position-indicating lights in the Main Control Room.

The Units 2 and 3 offgas air dilution ducts cross connect to SGTS, the cubicle exhaust duct, the steam packing exhaust duct, and the cubicle and steam packing exhaust bypasses are automatically isolated from the stack and SGTS by redundant, safety-related, backdraft dampers which shut on backdraft or no flow during periods of SGTS operation. Such isolation limits a ground-level release from SGTS in the event that the dilution fans are not operating. Because the dilution fans are not nuclear safety-related, their operation cannot be assured during or after a design basis accident. Chapter 14 includes the evaluation of the radiological consequences from Design Basis Accidents which require the use of these isolation dampers to mitigate the radiological consequences.

The standby gas treatment flow rate is measured downstream of the filter trains. The flow rate is indicated in the Main Control Room during SGTS operation.

The moisture separator is designed to remove 99.9 percent of moisture particles 2 microns or larger, and 30 percent of 1-micron sized particles. The design inlet conditions are 9000 cfm of 140 degree F air with 36 lb/min of entrained moisture. The separator consists of six 2-foot square woven mesh modules with the mesh mounted vertically. Separator pressure drop is less than 1.2-inches water gauge with the design flow conditions. The filter will withstand a pressure differential of 4-inches water gauge without structural damage.

The moisture separator drains by gravity to two standby gas treatment sumps. Sump pumps powered from the 480-V diesel auxiliary boards for trains A and B sump and 480-V SGT board for the train C sump, pump the drains from the sump to the Radwaste Building waste collector tank.

The second component of each filter train is an electric air heater capable of a total output of at least 40 kW. The purpose of the air heater is to reduce the relative humidity of the influent to less than 70 percent. The heater is energized automatically with startup of the Standby Gas Treatment System and remains energized throughout operation. The heater is interlocked to prevent heater burnout on high heater temperature.

A bulb and capillary type temperature sensor is used in conjunction with the relative humidity heater. The sensor is mounted near the heater module and is close to the heater elements, with an air space between. The sensor is set to trip the heater off at a sensor temperature of 180 degrees F and thus prevent overheating.

The heater is made of hairpin elements; each Incoloy-sheathed element is 0.5 inch in diameter. The pressure drop across the element is about 0.1-inch water gauge. The heaters are powered from the 480-V diesel auxiliary boards for trains A and B and from the 480-V SGT board for train C.

The third element of the filter train is a prefilter. The prefilter is used to remove large particulates and protect the high-efficiency particulate filter. The prefilter has an efficiency of at least 40 percent using the NBS dustspot method with atmospheric dust. The clean pressure drop is less than 0.2-inch water gauge. The filter will withstand a differential pressure of 1-inch water gauge without structural failure.

The fourth unit in the filter train is a high-efficiency particulate filter. This filter removes radioactive particulates 0.3 micron in size and larger with an efficiency of up to 99.97 percent. The bank consists of nine 2-foot square filter elements of the standard high-efficiency particulate filter element design. Each filter has a waterproof, fire-retardant, glass-fiber filter media built in an integral frame. The frame of each element is held against a gasket and a flat plate surface by four independent clamps. Periodic inplace testing assures that the filter efficiency is ≥ 99 percent using the standard DOP test. The clean pressure drop is less than 1-inch water gauge. The filter is capable of withstanding a moisture loading in the form of mist or fog that will produce a pressure of 10-inches water gauge for 15 minutes; the filter will not suffer permanent damage or a decrease in efficiency after the filter has dried out. The fifth element in the filter train is an activated charcoal bed. The charcoal adsorbers in each train of the Standby Gas Treatment System are mounted in dual tray module stainless steel drawers. A train has 27 of these drawers with each drawer having a nominal rating of 330 cfm. Each drawer contains approximately 44 lb. of charcoal--a total of 1200 lb. per train. The drawers are arranged in a single bank of nine horizontal rows, with each row being three drawers wide. The drawers are mounted in a rigid welded, leaktight, stainless steel case. The air flows vertically through each drawer containing a 2-inch thick layer of charcoal. This vertical air flow through the charcoal is equally distributed across all of the drawers. The drawers are sealed to the bulkhead frame with continuous gaskets. The drawers are held in place with individual clamps. The flow resistance of the clean charcoal bed is less than 1 inch of water gauge. The minimum residence time in the adsorbent is 0.25 second per 2-inch bed depth when processing Reactor Building effluent in a post-accident environment.

Charcoal decay heat removal air flows are established through the cross connection duct of any idle SGTS filter train provided the two remaining filter train fans are operating and the respective decay heat inlet damper (FCO-65-4,-26 or -52) is open. Also by running an individual filter train's fan and opening up either its decay heat inlet damper of its normal inlet damper (FCO-65-3, -25 or -51) charcoal decay heat can be removed.

Any one of the methods is adequate to prevent excessive charcoal temperatures or iodine desorption.

A humidity detector upstream of the charcoal initiates alarms in the Main Control Room when relative humidity exceeds 80 percent.

The impregnated charcoal has a minimum ignition temperature of 330 degrees C (625 degrees F). The maximum ash content is 6.5 weight percent maximum. The particle size is 8-14 Tyler mesh with a packed density of 0.39 to 0.45 grams per cc and a BET surface area of 1400 to 1500 square meters per gram.

The charcoal in all three trains is maintained above the maximum dewpoint temperature of the gas that could enter upon startup of the Standby Gas Treatment System by an electric heater installed in the inlet of each train capable of a total output of at least 40 kW. The purpose of the heater is to reduce the relative humidity of the influent. The heater is energized automatically with startup of the Standby Gas Treatment System and remains energized throughout operation, except during high heater temperature.

Operation of each SGT train with the heaters on (automatic heater cycling to maintain temperature) for $\geq$ 10 continuous hours every 31 days eliminates moisture on the adsorbers and HEPA filters.

Typically, the laboratory test for activated carbon shows its capability of removing at least 95 percent of iodine in the form of methyl iodide, CH_3I, and 95 percent of elemental iodine under entering conditions of 70 percent relative humidity.

The sixth unit in the filter train is a second high-efficiency particulate air filter. This filter is identical in characteristics to the first HEPA filter; however, the function is not the same. Since the first filter removes essentially all (99 percent) of the particulates from the Reactor Building atmosphere prior to it reaching the charcoal absorber, the function of the second HEPA filter is to preclude the passage of any remaining radioactive particulates, especially carbon from the charcoal absorber. This function is ensured by performance of DOP testing discussed 5.3.5.2.

Filter trains A and B are cross-connected downstream of the second high-efficiency particulate filter. The cross connection is isolated by a single electrically operated damper (FCO-65-22) which can be manually operated from the Main Control Room, this damper is normally closed. Two manual dampers (DMP-65-24 and -2) are in parallel to FCO-65-22, these dampers are locked in their required positions. Filter train C is cross-connected through a bypass heat decay line via manual valve DMP-65-66 which is left open.

The last element in the Standby Gas Treatment System filter train is a blower. The blower is a heavy-duty industrial fan that develops approximately 16 inches of water gauge pressure while delivering approximately 9500 cfm. Each fan is driven with a 30-hp electric motor through a V-belt drive. The blowers may be isolated from their trains by intake dampers. These dampers are electrically operated and controlled from the Main Control Room. Each blower is followed by a back draft damper. The blowers for trains A and B are powered from the independent 480-V diesel auxiliary boards and the blower for train C is powered from the independent 480-V SGT board.

Control logic for the Standby Gas Treatment System automatically and concurrently starts all three filter trains upon receipt of an accident signal. All three trains will continue to run for the duration of the accident. Should one train fail, the two remaining trains will continue to provide the minimum flow requirements. Any two SGTS trains must maintain the minimum acceptable capacity at 1/4-inch of water negative pressure for all four zones of secondary containment. Local and remote manual control of dampers and blowers is provided, including instrumentation and controls in the reactor control rooms. A temperature sensor is interlocked with the humidity control heater controls to prevent burnout due to high heater temperature.

The blowers of trains A, B, and C discharge to a common header. This header discharges to the stack through dual underground pipeline. The two parallel pipelines are 30-inch outside diameter, 3/8-inch thick welded steel pipe. The activity released by the Standby Gas Treatment System is monitored by the Main Stack Radiation Monitoring System described in Subsection 7.12, "Process Radiation Monitoring."

The isolation and control dampers in Standby Gas Treatment System trains A and B are electrically operated with the power supplied for each train (from the Units 1 and 2 independent 480-V diesel auxiliary boards). The isolation and control dampers for train C are electrically operated with the power supplied from the independent 480-V SGT board.

5.3.4 Safety Evaluation

5.3.4.1 Secondary Containment Isolation

The secondary containment isolation is initiated from any of three signals: low reactor water level, high drywell pressure or high activity in a ventilation exhaust duct, or by manual alignment and operation from the Main Control Room. Each signal simultaneously isolates the secondary containment zone or zones, shuts down normal ventilation equipment, opens dampers to and from the Standby Gas Treatment System and starts the Standby Gas Treatment System blower. The isolation condition is removed and the Standby Gas Treatment System shut down only by manual reset. Subsection 5.3.3.2 describes the sequence and logic for isolation of the secondary containment system. The control system is described and evaluated in Subsection 7.3, "Primary Containment and Reactor Vessel Isolation Control System."

Upon secondary containment isolation, the SGTS is required to maintain a negative pressure inside secondary containment. The SGTS is required to maintain a 1/4-inch of water negative pressure with a flow equal to the minimum acceptable capacity as discussed in Section 5.3.3.7. This inleakage considers the total infiltration including locks, roof, siding, and isolation dampers in addition to requirements for seismic and thermal expansion effects.

The relief panels for the main steam tunnel are designed to relieve at 90 lb/ft^2. The relief panels in the vertical siding are designed to relieve at 50 lb/ft^2. All relief panels are held in place with necked aluminum rupture bolts.

Sample bolts have been laboratory-tested to failure. These bolts failed within plus or minus 10 percent of the design value.

The SGTS power supply and damper arrangement meet single-failure criteria. The power supply for trains A and B is taken from the 480-V diesel auxiliary boards with each train supplied from a separate board and the damper in the crosstie supplied from both boards. Train C is powered by the 480-V SGT board. A power failure to any train will result in a fail-safe condition in that train. The damper downstream of each blower is a gravity-type backflow damper and will prevent backflow through the blower. The damper upstream of the filter bank and the damper that supplies cooling air from the room will fail closed, thereby assuring that any suction is from secondary containment. The bypass cooling stream valves fail closed; however, it is powered from the same source as the blower in a companion train. Thus, a cooling mode is always assured with any two blowers powered, and in some arrangements with one blower powered. All other dampers will fail open. By manual positioning of dampers in the train A and train B crosstie, and in the powered train, either filter bank A or filter bank B can be used with blower A or blower B assuring a maximum utilization of components.

Two out of three Standby Gas Treatment System blowers are adequate to keep all three Reactor Building zones and the refueling zone at a pressure of 1/4-inch water gauge below atmospheric. Reduction in flow due to filter loading will be sufficiently offset by the reduction in the required flow capacity due to the diminishing nature of the thermal expansion effect.

In the Chapter 14 radiological dose analyses, no credit is taken for secondary containment during the Control Rod Drop Accident, Refueling Accident, or Main Steam Line Break Accident.

5.3.4.2 Standby Gas Treatment Instrumentation and Control

The objective of the SGTS is to maintain the secondary containment at a negative pressure so the release mode is through the SGTS and to process all effluent from the Reactor Building when required, thereby limiting the discharge of radioactive material to the environs. The system accomplishes its objective by maintaining the Reactor Building at a slightly negative pressure relative to the atmosphere and filtering all the exhaust. The SGTS control and instrumentation provide the logic and signals to allow the equipment or redundant components to become functional as required to cope with any radioactivity releases. Thus, the controls and instrumentation assure that the performance of the SGTS is such that the radioactivity released to the environs is kept to a practical minimum and well within the guideline values of 10 CFR 20 and 10 CFR 50.67.

The design bases for the SGTS controls and instrumentation to protect the health and safety of the public are as follows:

1. All three SGTS trains automatically start in the event of a secondary containment isolation signal.

2. Low system flow will be indicated and annunciated in the Main Control Room.

3. The trains may be controlled manually from the Main Control Room with provision for complete remote manual operation of filter bank A with either blower A or B, filter bank B with either blower A or B, or filter bank C with blower C.

4. Manual alignment will provide for decay heat removal from fission products deposited on any filter bank using one of several flow paths.

5. Gas temperatures will be indicated, heater temperatures which are high will be annunciated, and overall filter bank pressure differential will be indicated and high values annunciated in the Main Control Room.

6. Misalignment of the control switches and instrumentation which places any train in the standby mode under normal operating conditions will be annunciated in the Main Control Room.

7. Misalignment of dampers or blowers in the trains will be annunciated in the Main Control Room.

The above design bases were incorporated in a controls and instrumentation scheme that is reflected in the control diagram shown in Figure 5.3-9. Separate controls and instrumentation are associated with the three independent SGTS trains of filter banks, blowers, dampers, and ducts. The logic initially places all trains in the auto mode and allows for trains to be placed in the standby mode.

Accident signals will initiate action in all three SGTS filter trains. This action consists of alignment of the dampers, starting the blowers, and energizing the relative humidity heaters when sufficient flow is established in the ducts.

The total time required to switch from the normal containment ventilation system to the Standby Gas Treatment System upon detection of high radiation is relatively small. The radiation monitor response time is 1 second, and the refuel zone exhaust dampers will close in approximately 15 seconds. Startup of the Standby Gas Treatment System blower motors is within 5 seconds from the time of the signal. The proper dampers (electric-motor-driven) in the SGTS trains are opened on Secondary Containment accident signal to allow flow of effluent to the SGTS trains. All Standby Gas Treatment System trains will be producing adequate flow when required to mitigate the consequences of an accident. In the event of concurrent loss of offsite power, the diesel start time of 10 seconds must be added to the total times to switch over from normal containment ventilation system to the Standby Gas Treatment System.

The SGTS is designed to maintain this negative pressure under accident conditions with the response time mentioned above. Thermal expansion due to loss of cooling decreases with time and provides extra margin for the SGTS to maintain the negative pressure. Thus, the secondary containment is maintained at some slight negative pressure, unfiltered release is prevented, and the health and safety of the general public is protected.

The time required to bring the secondary containment to the design negative pressure is not crucial to the safety of the plant but is used to ensure secondary containment boundary integrity and verify SGTS operability. The normal ventilation system maintains the Reactor Building at approximately 1/4 inch of water negative pressure relative to the outside environment. At the outset of the accident, the normal ventilation is isolated and the Standby Gas Treatment System is initiated. As discussed above, the Standby Gas Treatment System must wait for the diesels to start if offsite power is lost. As discussed in Chapter 14, the Reactor Building becomes pressurized relative to the outside environment for a short period of time during the initial phase of an accident. This is due to the isolation of the normal ventilation, the time required to start the Standby Gas Treatment System and thermal expansion of the air inside the Reactor Building due to the heat loads inside the building. However, negative pressure would be re-established in secondary containment prior to fission product release times specified by RG 1.183.

All dampers except the blower discharge backdraft dampers have position-indicating switches that operate position-indicating lights in the Main Control Room. Limit switches on the dampers, contacts in the blower control switch, and contacts in the train selector switches indicate misalignment for automatic train operation.

During a LOCA, there is no delay in initiating action in any train. However, during a LOCA and a Loss of Offsite Power (LOP), there is a 40-second delay in initiating action on Trains A and B. There is no delay in initiating action on Train C for a LOP/LOCA.

Gas temperatures of the relative humidity heater and the charcoal bed are measured and indicated both locally and in the Main Control Room as shown in Figure 5.3-9. High temperature in the charcoal bed and in the relative humidity heater are annunciated in the Main Control Room. The overall filter train pressure differential is measured and indicated in the Main Control Room. High pressure differential is annunciated. Each train, with its associated controls and instruments, is supplied with emergency power. This power is taken from separate emergency power supplies to guarantee that two trains are always available in case of loss of offsite power. The system is also arranged so that power failures that interrupt flow in an operating train may only momentarily reduce the rate at which the system processes effluent.

Separations criteria require that the power supplies be completely separate. However, the single crosstie damper which is normally supplied by train A power will be supplied by train B power upon loss of train A power and will automatically revert back to train A power if that source is restored. Each 120-V circuit leading to the switch is fused so that short-circuits will cause isolation of either or both circuits as required. Fuses are also provided to protect the connecting leads of the low-voltage annunciator circuit from short-circuits in the train selector switches.

The Main Control Room has annunciators to alert the operators of malfunctions in the system such as low flow, containment isolation signals with any train in the standby mode, power failures that interrupt flow in a train, and dampers improperly aligned. In the event of malfunction of both trains A and B, these trains can be manually aligned and controlled to use either filter bank with either blower. This operation is completely manual and will be used to circumvent some, but not all, combinations of multiple failures. This type of operation requires power along with the pertinent controls and instrumentation to some parts of both trains and is therefore not available for the complete loss of power to either train.

The design of the controls and instrumentation makes it possible for removal of decay heat from fission products deposited on the filter bank of any train. If one bank is in operation with flow from the secondary containment, there are sufficient dampers and valves in the system to remove decay heat from a shutdown bank. Crosstie valves are positioned to provide a small cooling flow through the shutdown filter bank, through the decay heat removal crosstie line and then through the blower of the operating train. In the event the train from which decay heat is being removed has suffered a complete loss of power, the decay heat cooling flow can be bled into the train from the building through a damper powered from the same source as the adjacent operating train. Thus, the controls and instrumentation assure that the removal of decay heat from the shutdown filter bank is accomplished while maintaining the safety objective of filtering the major fraction of the containment atmosphere through the operating train.

In time, it may be desirable to discontinue the secondary containment function, but removal of decay heat from the filter banks is still required. Provisions are incorporated in the controls and instrumentation such that cooling can be provided by bleeding building air into the system upstream of the filters. A blower is always available to produce flow through the train from which the decay heat is to be removed. All of these alignments to remove the decay heat are manual.

In the Chapter 14 radiological dose analyses, no credit is taken for SGTS operation during the Control Rod Drop Accident, Refueling Accident, or Main Steam Line Break Accident. In the Chapter 14 radiological dose analyses, no credit is taken for the SGTS charcoal adsorber during the Loss of Coolant Accident.

5.3.5 Inspection and Testing

5.3.5.1 Secondary Containment

The secondary containment siding has been laboratory tested by the siding vendor. The laboratory test consisted of both leakage tests and strength and deflection tests. The tests were conducted in the manner described in Section 9 of ASTM 372-61.

The infiltration rate is determined from the flow measured at the Standby Gas Treatment System filter train. During normal operating conditions, the total inleakage for the four zones must be less than the allowable surveillance inleakage value given in Section 5.3.3.7.

Permanent test connections are located in the section of duct between and adjacent to low-leakage dampers used to isolate the ventilation supply and exhaust ducts. These test connections are arranged and sized so that the composite leakage across both dampers can be determined. All ventilation ducts contain sealed manholes which may be used to visually inspect the damper blades, resilient seals, and operating mechanisms.

Necked rupture bolts identical to those used to secure the relief panels in place are factory tested to confirm the relieving load and to determine the relieving time for the relief panels. The relief panels are visually inspected periodically to assure that the panels have not partially relieved and thereby opened cracks in the siding.

5.3.5.2 Standby Gas Treatment System

The Standby Gas Treatment System filtration trains and blowers are arranged such that one redundant train and its associated blower may be serviced or tested while the other two trains are ready to operate. In the event of a signal to isolate secondary containment and start the Standby Gas Treatment System, the test signal will be overridden.

The Standby Gas Treatment System filtration trains are equipped for complete testing of the HEPA filters and the charcoal adsorbers. The filter housing and related ducting is designed to assure mixing for uniform distribution of DOP and Freon.

The charcoal adsorber bypass flow will be determined using an inplace Freon leak test. The Freon will be injected into the flowing gas stream well upstream of the adsorber. The mixed stream will be sampled upstream and downstream of the adsorber and the ratio of concentrations will be used to calculate the bypass flow. Standard testing procedures and apparatus will be used; these are described in Section 7.5.1 of ORNL-NSIC-65, "Design Construction and Testing of High Efficiency Air Filtration Systems for Nuclear Applications." DOP injection and detection connections are located upstream and downstream of both banks of the HEPA filters. Freon injection and detection connections are located upstream and downstream of the charcoal adsorbers. These connections and portable test equipment provide all essentials for the HEPA filters and the charcoal adsorbers.

The filtration efficiency and charcoal effectiveness are determined periodically.

Inspections of each filter will be performed at intervals specified in the Ventilation Filter Testing Program. Whenever a HEPA or charcoal filter is replaced, inplace DOP and Freon tests will be performed.

The effect of DOP retention and poison in charcoal was investigated by Wendell Anderson of the Naval Research Laboratory. Tests show that activated charcoal can adsorb up to approximately 0.25 gram of organic material per gram of charcoal. At lesser values, the charcoal will continue its intended function. Consequently, the adsorption of small amounts of DOP, due to testing, would have a negligible effect on adsorption qualities of the charcoal. It should be noted that DOP has a negligible vapor pressure and, therefore, it is not likely to be stripped from either the HEPA filters or the charcoal filters once a particle has impacted on either material. In making these tests, NRL utilized three particle sizes: (1) less than 0.1 micron, (2) 0.15 micron, and (3) larger than 5 microns. Only the first and a small portion of the second sizes would pass through the HEPA filters to any extent. Only these small parts and vapors may be considered adsorbed by the charcoal. However, the quantities involved in any reasonable estimate of testing over the lifetime of charcoal filters is insufficient to lower their efficiency by any detectable amount.

The ignition and combustion properties of activated carbon containing adsorbed hydrocarbons were studied by F. J. Woods and J. E. Johnson of the Naval Research Laboratory (NRL-6090, 1964). They classified ignitions into induced ignition and spontaneous ignition and concluded that for induced ignition, a carbon saturated with hydrocarbon generally had a flash point about the same as the liquid hydrocarbon, but not lower. If the carbon was not quite saturated with hydrocarbon, a flash point somewhat higher than that of the liquid was obtained. For spontaneous ignition, it was found that the flash point increases with decreasing hydrocarbon concentration and is generally above 500 degrees F for both coal-based carbon and coconut carbon when the hydrocarbon concentration is less than 10 wt. percent.

It is therefore concluded that the ignition temperature of the charcoal does not change appreciably due to the presence of the small amount of DOP.

Permanently mounted differential pressure gauges are mounted across the moisture separator, the prefilter, the HEPA filters, and the charcoal adsorber. The pressure differential across these elements and the system flow is analyzed during periodic testing to determine the extent of dust loading and plugging of the filters and adsorber.

The effectiveness of the standby gas treatment filters is monitored by preoperational tests, periodic inplace standard DOP and Freon tests, and scheduled laboratory tests to demonstrate charcoal adsorptivity.

The DOP aerosol is generated from liquid dioctyl-phthalate using dry air or by heating to produce a stable aerosol with proper particle size distribution in accordance with ANSI N510-1975.

The aerosol generator is capable of supplying sufficient DOP to test for leaks using the 9,000-cfm design flow of one train of the Standby Gas Treatment System.

The DOP particulate detection instrumentation is capable of detecting small changes in concentration of the aerosol. The instrumentation has a threshold sensitivity and range adequate to satisfy the recommendations of ANSI N510-1975, Testing of Nuclear Air-Cleaning Systems, as required by the Ventilation Filter Testing Program.

Halogenated hydrocarbon (Freon) tests of the charcoal bed absorbtion efficiency and integrity are also conducted in accordance with the recommendations of ANSI N510-1975 as required by the Ventilation Filter Testing Program.

The frequent leak tests, preoperational and periodic inplace Freon and DOP tests, and scheduled laboratory tests of charcoal adsorptivity assure that the HEPA and charcoal filter system will perform its intended function. Therefore, iodine monitoring is not necessary.

The heater used to maintain the charcoal bed above the dewpoint temperature, the temperature-indicating and alarm instrumentation, the differential pressure gauges, and the flow instruments are periodically tested and calibrated.

Testing and inspections of the controls and instrumentation will be made periodically. The dampers will be tested by operation of manual switches in the Main Control Room and observation of the position-indicating lights in the Main Control Room. The auto start signals and alarm functions will be functionally tested by applying test signals, simulating malfunction by switch operation/fuse removal, and observing results.

5.3.5.3 Equipment Area Cooling Units

The equipment area cooling units in the basement of the Reactor Building are tested during initial operation of the RHR pumps and the core spray pumps, and with each subsequent test of these systems. The cooling water supply to the cooling units was initially tested with EECW (Subsection 10.10, "Emergency Equipment Cooling Water") and is tested periodically in the same manner.