9.4 AIR CONDITIONING, HEATING, COOLING, AND VENTILATING SYSTEMS

NOTE: Tables 9.4-2 through 9.4-12 are marked "Historical" to signify that they need not be updated.

9.4.1 Control Building and Normal Switchgear Building Heating, Ventilating, and Air Conditioning System

The systems provide heating, ventilating, and air conditioning (HVAC) and, as necessary, space pressurization and smoke removal for the following areas within the control building and adjoining structures:

1. Main control room.
2. Relay room.
3. Remote shutdown rooms.
4. Standby switchgear rooms.
5. Computer room.
6. Basement.
7. Battery rooms.
8. Record storage vault.
9. Stairwells.
10. Electrical tunnels.
11. Normal switchgear building.

9.4.1.1 Design Bases

The design bases for the system are:

1. Provide an environment that ensures habitability of the areas served, consistent with personnel comfort and optimum performance of equipment, within the temperature limits shown in Table 9.4-1.
2. Maintain a positive space pressure in the control room and relay room to inhibit infiltration into these areas.
3. Detect and limit the introduction of airborne radioactive contamination into the control room and relay room, and remove any airborne radioactive materials from the control room.

4. Provide alternate points of intake for outdoor makeup air.

5. Provide smoke removal capability for the main control room and other major areas of the control building.

6. Provide once-through ventilation for each battery room ensuring dilution of generated hydrogen below the explosive concentration limit of 4 percent by volume.

7. Maintain each battery room at a negative space pressure to inhibit exfiltration of generated hydrogen to surrounding areas.

8. Provide clean and conditioned air with safety-related and seismically-qualified system components for the main control room, relay room, remote shutdown rooms, standby switchgear rooms, control building basement, control building battery rooms, and the electrical tunnels.

9. Provide clean and conditioned air with system components designed and constructed to nonnuclear safety standards for the control building computer room, record storage vault, and the normal switchgear building.

9.4.1.2 System Description

The control building HVAC system is shown on Figures 9.4-1a through 9.4-1f. Design data of principal equipment utilized in the system are listed in Table 9.4-2 (Historical). The system is located in a Category I structure that is missile and tornado protected.

In general, the HVAC system maintains conditions within the building by tempering recirculated air from the conditioned spaces, supplemented with sufficient outdoor air to offset exfiltration resulting from pressurization of the conditioned spaces. The system equipment has enough surplus capacity to maintain the design and maximum conditions listed in Table 9.4-1 during normal and post-accident modes of operation, including operation with outdoor air diverted through a safety-related charcoal air filter train, as a result of a monitored smoke, high-radiation condition at the outdoor air intake, or LOCA signal.

Outdoor air is supplied to the control building through four 100-percent capacity, missile and tornado protected, air intakes. Two of the intakes are located on the west side of the building at different elevations. The other two are located on the east side of the building, also at different elevations. The two outdoor air intakes located at the higher elevation, one on the east side and one on the west, supply outdoor air for ventilation

of the main control room and relay room. Both air intakes are normally open, but either of the intakes is sized and balanced to provide sufficient outdoor air for pressurization of control and relay rooms. Ventilation air for the standby switchgear/battery rooms is deducted from the higher elevation west side outdoor air intake. The two lower elevation outdoor air intakes, one on the east side and one on the west, supply outdoor air for ventilation of the basement. Sufficient outdoor air is provided in the main control room for pressurization.

The control building, electrical tunnels, and the normal switchgear building HVAC system are described in the following sections.

9.4.1.2.1 Main Control Room Elevation HVAC

The system consists of two safety-related, 100-percent capacity air conditioning units. Each unit contains a filter assembly, cooling coil, fan, and dampers. Conditioned air is supplied through ductwork to the main control room, office area, training room, lunch room, corridor, air conditioning equipment room, and Division I, II, and III cable chase areas. Return air from each area is also ducted to the air conditioning units. The air conditioning units also provide makeup air for the work release room and toilet rooms exhaust systems. Exhaust air from the lunch room kitchen unit and toilet rooms is discharged to the atmosphere through a tornado- and missile-protected hood by separate exhaust fans. System supply air capacity exceeds the combined return air and exhaust capacity to provide a positive pressure in the main control room.

Heating for all areas, except the corridor and the air conditioning equipment room, is provided by duct-mounted electric heaters. Local heating in the corridor, lunch room, work release room, and training room is provided by electric baseboard heaters. Local heating in the air conditioning equipment rooms and Division II and III cable chase areas is provided by electric unit heaters.

Return air and outdoor makeup air are mixed before passing through the air conditioning unit filter assembly. Manual dampers within each filter assembly permit air to be diverted through a charcoal filter section for odor removal. The charcoal section is normally bypassed.

Chilled water to each air conditioning unit cooling coil is supplied from the control building chilled water system (Section 9.4.10).

A smoke removal system, common for the main control room elevation and the relay room elevation, utilizes a separate smoke removal supply air unit, connected to HVAC system ductwork through normally closed air-operated dampers. When the smoke removal fan is manually started, the air conditioning unit for

that elevation is manually shut down. Outdoor makeup air is drawn through a missile- and tornado-protected opening located on the roof of the control building. Smoke exhaust is discharged to the atmosphere through a similarly protected exhaust hood.

9.4.1.2.2 Outdoor Air Special Filter Trains

When supply air radiation levels are high or LOCA signal exists, the supply air is diverted automatically to the intake of a safety-related special filter train. Two 100-percent capacity special filter trains are provided. Each contains an electric heating element, a prefilter, a high-efficiency particulate air (HEPA) filter, an activated charcoal adsorber for removal of radioactive iodine and other contaminants, and a second HEPA filter.

Air leaving a special filter train enters a filter booster fan, which discharges to the common duct supplying air to the air conditioning units.

Nonsafety-related smoke detectors monitor outdoor makeup air during all modes of operation and annunciate an alarm in the main control room.

9.4.1.2.3 Relay Room Elevation HVAC

The system consists of two safety-related, 100-percent capacity air conditioning units. Each unit contains a filter assembly, cooling coil, and fan. Conditioned air is supplied through ductwork to the relay room, instrument shop, corridor, air conditioning equipment room, and Division I, II, and III cable chase areas. Return air from each area is also ducted to the air conditioning units. System supply air capacity exceeds return air capacity to provide a positive pressure in the relay room.

Heating for all areas, except the computer room, corridor, and the air conditioning equipment room, is provided by duct-mounted electric heaters. Local heating in the corridor is provided by electric baseboard heaters. Local heating in the air conditioning equipment rooms and Division II and III cable chase areas is provided by electric unit heaters.

Return air and outdoor makeup air are mixed before passing through the air conditioning unit.

Chilled water to each air conditioning unit cooling coil is supplied from the control building chilled water system (Section 9.4.10).

Refer to Section 9.4.1.2.1 for a description of the smoke removal system that is common to the control room elevation and the relay room elevation.

The computer room located on the relay room elevation has redundant, self-contained air conditioning units. The operating unit recirculates computer room air plus a portion of outdoor makeup air to ensure pressurization of the space. Chilled water to each air conditioning unit cooling coil is supplied from the control building chilled water system (Section 9.4.10).

9.4.1.2.4 Standby Switchgear/Battery Room HVAC

The system consists of two safety-related 100-percent capacity supply air trains, which supply tempered outdoor makeup air through ductwork to Division I, II, and III cable chase areas, Division I, II, and III standby switchgear rooms and their associated battery rooms, chiller equipment rooms, corridor, and the stairwell to the basement. Each supply air train contains a filter unit, electric heating coil, and fan. Outdoor makeup air to each supply air train is provided through a common duct originating at the higher elevation west side air intake.

Tempered outdoor makeup air supplied to the corridor provides a source of makeup air for ventilation systems in adjoining rooms and spaces.

Safety-related unit coolers provide circulation of cooled air in the Division I, II, and III standby switchgear rooms and also supply cooled makeup air to the associated battery rooms. Air supplied to the battery rooms is exhausted by one of the two battery room exhaust fans. Battery room exhaust is provided by one of two 100-percent capacity safety-related exhaust fans. Each battery room is maintained at a negative pressure with regard to the surrounding areas to inhibit exfiltration of generated hydrogen. Each standby switchgear room unit cooler contains a filter, a cooling coil, and a fan. Thermostats maintain space temperature by opening and closing service water valves to the unit cooler cooling coils. Service water for the cooling coils is described in Section 9.2.1.

The standby switchgear rooms and associated battery rooms are isolated from other areas in the building by fire doors, fire dampers, and fire-rated walls.

Smoke removal is provided by a common exhaust fan connected to the separate areas with individual ductwork. Each individual duct terminates within the protected area at a normally closed manual damper. When smoke exhaust is required for an area, the damper for that area is manually opened and the exhaust fan is manually started.

The remote shutdown rooms have two 100-percent capacity safety-related air conditioning units. Each unit contains an air filter, chilled water cooling coil, and fan. Chilled water to each cooling coil is supplied from the control building chilled water system (Section 9.4.10). The air conditioning units are

thermostatically controlled to maintain space design temperatures.

The Division I and II chiller equipment rooms are ventilated by an exhaust fan that is duct-connected to each equipment room and discharges to the atmosphere through a missile- and tornado-protected opening. Exhaust makeup air is drawn from the adjacent corridor. Safety-related unit coolers provide additional cooling in the chiller equipment rooms. The unit coolers are nonducted and recirculate cooled air in each room. Each unit cooler contains a filter, cooling coil, and fan. Water to each cooling coil is supplied from the SWP system. Each unit cooler is thermostatically controlled to maintain room design temperature.

9.4.1.2.5 Basement HVAC

The Division I and Division II areas of the basement each have safety-related unit coolers, discharging cooled air through ductwork to all areas in the basement. Ductwork from basement cable areas returns air directly to the intakes of the unit coolers for recirculation. In all other areas, except the basement battery rooms, air is returned via ductwork and an air-mixing ventilation chase. Return air entering the chase is mixed with outdoor makeup air and is supplied to the intake of the unit coolers for recirculation.

The basement battery rooms are exhausted by one of the two battery room exhaust fans. Each battery room is maintained at a negative pressure with regard to surrounding areas to inhibit exfiltration of generated hydrogen.

Outdoor makeup air for basement ventilation is provided from the lower elevation east side and west side air intakes.

Each unit cooler contains a filter, a cooling coil to which water is supplied from the SWP system (Section 9.2.1), and a fan.

Thermostats maintain space temperature by opening and closing service water valves to the unit cooler cooling coils.

Smoke removal is provided for the basement by two exhaust fans, one each for Division I and II areas. The discharge ducts from the exhaust fans are connected together and discharge to the atmosphere through a common missile- and tornado-protected exhaust opening.

Basement areas are isolated from each other and from other areas in the building by fire doors, fire dampers, and fire-rated walls.

The records storage vault located in Division I of the basement area has a self-contained air conditioning unit, which maintains temperature and humidity in the records storage vault. The

air-cooled condensing section of the air conditioning unit is also located in the basement and utilizes air from the Division I cable area for cooling.

9.4.1.2.6 Electrical Tunnels HVAC

Two safety-related HVAC systems provide tempered air for the Division I and II control building/reactor building electrical tunnels (Figure 9.4-2). Outdoor makeup air is supplied to the systems through a missile- and tornado-protected air intake.

Each system consists of a unit cooler, associated dampers, and ductwork, and utilizes a mixture of return air and outdoor makeup air in the tunnels. Each unit cooler contains a filter, a cooling coil to which water is supplied from the SWP system (Section 9.2.1), and a fan. Thermostats maintain space temperature by opening and closing service water valves to the unit cooler cooling coils.

Smoke removal for the electrical tunnels and the Division I and II ventilation equipment room is provided by two exhaust fans located in the Division I and Division II equipment room. Both fans exhaust through a common relief hood located on the roof of the auxiliary service building. During smoke removal, the unit coolers are shut down. Makeup air required during operation of the smoke removal exhaust fans is provided through the outdoor makeup air intake.

9.4.1.2.7 Normal Switchgear Building HVAC

The normal switchgear building HVAC system is shown on Figure 9.4-3a.

Fans provide supply air to the general building areas, the stairwells, and the battery rooms. The supply air system is capable of supplying 100-percent outdoor air, or a combination of outdoor air and recirculated air, and consists of three 50-percent capacity fans, a filter, and a cooling coil to whichwater is supplied from the plant chilled water system (Section 9.4.10). Exhaust is accomplished by three 50-percent capacity exhaust fans (two operating and one standby). Penthouse areas of the normal switchgear building have individual ventilation fans and exhaust louvers. The general building areas, low-frequency motor generator (LFMG) set penthouse, and ventilation equipment penthouse have electric unit heaters for winter heating.

Smoke removal from the building is accomplished by manually placing the supply air system in a 100-percent outdoor air/100-percent exhaust air mode. This ensures that the stairwells are pressurized with supply air, thereby remaining free of smoke, and displacing any smoke-laden air in the remainder of the general building areas.

Each battery room is maintained at a negative space pressure, below atmospheric. Battery room exhaust is provided by one of two 100-percent capacity exhaust fans. One fan is redundant and starts automatically upon loss of air flow through the normally operating fan.

Outdoor air is provided to the ventilation equipment penthouse by three 50-percent capacity roof-mounted propeller fans and is exhausted to atmosphere through louvers in the penthouse wall. The LFMG set penthouse has an independent ventilation system, consisting of two outdoor air fans and two exhaust air louvers. Temperature in both penthouses is maintained by cycling the fans.

9.4.1.3 Safety Evaluation

With the exception of the normal switchgear building HVAC system, computer room HVAC system, and the smoke removal equipment, HVAC systems serving the main control room, relay room, (safety-related) switchgear rooms, associated battery room exhaust, remote shutdown rooms, basement equipment rooms, chiller equipment rooms, and electrical tunnels are safety related, seismically qualified, and redundant to maintain functional integrity during a DBA. The systems receive electrical power from two offsite sources during normal operation and from redundant standby diesel generators if offsite power is lost.

Chilled water is supplied to air conditioning unit cooling coils from the control building chilled water subsystem (Section 9.4.10.1), which is also safety-related and seismically qualified.

Outdoor air intakes serving the control building are missile and tornado protected. The intakes are constructed in the form of a hood, changing the airflow direction at 90 deg to minimize water droplet carryover. The remote exhaust outlet is protected in a similar manner.

Abnormal HVAC system conditions are alarmed in the main control room. Radiation monitors are located in the main control room/relay room outdoor air stream. Area radiation monitors are also provided in the main control room. In the event of increasing radioactivity levels, outdoor supply air is automatically diverted through a special air filter train.

Originally, the consequences of control building ventilation and conditioning system active component failure were contained in the Unit 2 FMEA document, which is historical. FMEAs for plant systems are now performed and controlled by the design process.

9.4.1.4 Inspection and Testing Requirements

The system is designed to permit periodic inspection and maintenance of active components. Local display and indicating devices are provided for inspection of parameters such as airflow

readings, temperature readings, and other measurements required to verify continued satisfactory operation of the system.

Ducted air flows are balanced to satisfy design requirements in accordance with procedures of the Associated Air Balance Council (AABC). The system is preoperationally tested to ensure it meets design requirements.

9.4.1.5 Instrumentation Requirements

9.4.1.5.1 Control Building

Description

Safety-related instruments and controls are provided for automatic and manual control of the control building HVAC system. The controls and monitors described below are located in the main control room. The control logic is shown on Figure 9.4-4.

Operation

The control building outdoor air inlet isolation dampers are controlled manually.

The control building (standby) air conditioning booster fan starts automatically when all of the following conditions exist: operating booster fan discharge air flow is low, control building supply air radiation is high, or LOCA isolation signal is present, associated control building special filter train charcoal adsorber temperature is not high-high, and the standby booster fan has not tripped on low discharge air flow. A booster fan will automatically trip when the associated control building special filter train charcoal adsorber temperature is high-high or the fan discharge air flow is low. The booster fans can also be controlled manually.

The control building air conditioning booster fans guide vanes are controlled manually.

The control building special filter trains bypass valves are controlled manually. An interlock prevents opening, or automatically trips closed, a bypass valve when the control building supply air radiation is high-high or LOCA signal is present.

Control building special filter trains electric heaters are controlled automatically by the associated heater outlet air temperature. Interlocks prevent energizing, or automatically trip, a heater when the associated special filter train air flow is low or the associated booster fan is not running.

Monitoring

Indicators are provided for each control building special filter train to monitor the following:

1. Outlet temperature.
2. Heater inlet temperature.
3. Heater outlet temperature.

Recorders are provided for each control building special filter train overall differential pressure and air flow.

Alarms are provided for:

1. Control building special filter trains inoperable.
2. Control building special filter trains system trouble.
3. Control building ventilation system trouble.
4. Control building booster fans auto start and auto trip/fail to start.
5. Process airborne radiation monitor activated.
6. Control building area radiation monitor activated.

9.4.1.5.2 Main Control Room

Description

Safety-related instruments and controls are provided for automatic and manual control of the main control room HVAC system. The controls and monitors described below are located in the main control room. The control logic is shown on Figure 9.4-4.

Operation

The control room (standby) air conditioning unit starts automatically when the operating unit discharge air flow is low. Interlocks prevent starting, or automatically trip, a unit when the associated discharge damper is not open, the associated chilled water circulation pump auto trips, or the other unit is running. The unit can be controlled manually.

The control room air conditioning unit discharge dampers open or close automatically when the associated fan is started or stopped, respectively. The dampers can also be controlled manually.

The control room, office, lunch room, training room, and supervisor's office supply air duct electric heaters are controlled automatically by the associated space air temperature.

An interlock prevents energizing, or automatically trips, a heater when the associated supply air flow is low. The training room and supervisor's office supply air duct heaters may be manually de-energized when not required for area heating.

The control and relay rooms smoke removal fan is controlled manually. Interlocks prevent starting the fan when the fan discharge damper or the fan discharge backup damper is not open. Interlocks automatically trip the fan when the fan discharge or the fan discharge backup damper is not open, or the Halon system discharge is in progress.

The control room smoke removal outlet damper is controlled manually. Interlocks prevent opening, or automatically trip closed, the damper when either control room air conditioning unit fan is running.

The control and relay rooms smoke removal fan discharge dampers and smoke removal makeup air damper are controlled manually. Interlocks prevent opening, or automatically trip closed, the dampers when the control room or the relay room smoke removal inlet damper is not fully open.

The control and relay rooms makeup air supply heating and ventilating unit fan starts or stops automatically when the control and relay rooms smoke removal fan is running or not running, respectively.

The control and relay rooms makeup air supply heating and ventilating unit heating coil is controlled automatically by the unit discharge air temperature. An interlock prevents energizing, or automatically trips, the heating coil when the makeup air supply heating and ventilating unit fan is not running, air flow low, or thermal switches cut out.

<u>Monitoring</u>

Indicators are provided for each:

1. Control room air conditioning return air temperature.
2. Control room intake gaseous radiation.

Recorders are provided for each control room intake gaseous radiation and control building special filter train flow.

Alarms are provided for:

1. Control room ventilation system inoperable.
2. Control room ventilation system trouble.
3. Control room air conditioning units auto start and auto trip/fail to start.

4. Fire damper closed.

9.4.1.5.3 Relay, Computer, and Remote Shutdown Rooms

Description

Safety-related instruments and controls are provided for automatic and manual control of the relay and remote shutdown rooms HVAC systems. Except where noted, the controls and monitors described below are located in the main control room. The control logic is shown on Figure 9.4-5. Nonsafety-related instruments and controls are provided for the computer room HVAC system.

Operation

The relay room (standby) air conditioning unit starts automatically when the operating unit discharge air flow is low. Interlocks prevent starting, or automatically trip, a unit when the associated discharge damper is not open, the associated chilled water circulation pump auto trips, or the other unit is running. The unit can be controlled manually.

The relay room air conditioning unit discharge dampers open and close automatically when the associated air conditioning fan is started and stopped, respectively. The dampers can also be controlled manually.

The relay room and relay room instrument shop supply air duct electric heaters are controlled automatically by the associated space temperature. An interlock prevents energizing, or automatically trips, a heater when the associated supply air flow is low.

The relay room smoke removal damper is controlled manually. Interlocks prevent opening, or automatically trip closed, the damper when either relay room air conditioning unit fan is running.

The computer room supply air fans are controlled manually and locally. Interlocks prevent starting (or automatically trip) a fan when the Halon system discharge is initiated, or both computer room air conditioning units are stopped. The computer room air conditioning units stop automatically when the Halon system discharge is initiated.

The computer room smoke removal dampers are controlled manually. Interlocks prevent opening, or automatically trip closed, the dampers when the Halon system discharge is initiated.

The remote shutdown room air conditioning units are controlled locally. Each unit is controlled automatically by the associated

remote shutdown room space temperature. The units can also be controlled manually.

<u>Monitoring</u>

Indicators are provided for each relay room air conditioning return air temperature.

Alarms are provided for:

1. Relay room ventilation system trouble.

2. Relay room ventilation system inoperable.

3. Relay room air conditioning units auto start and auto trip/fail to start.

4. Computer room ventilation system trouble.

5. Remote shutdown room ventilation system inoperable.

6. Remote shutdown room air conditioning units trouble.

9.4.1.5.4 Standby Switchgear and HPCS Switchgear Rooms

<u>Description</u>

Safety-related instruments and controls are provided for automatic and manual control of the standby switchgear and HPCS switchgear rooms HVAC systems. Except where noted, the controls and monitors described below are located in the main control room. The control logic is shown on Figure 9.4-7.

<u>Operation</u>

The standby switchgear and HPCS switchgear rooms unit coolers are controlled manually.

The standby switchgear air conditioning equipment room unit coolers are controlled automatically by the associated room space temperature. The unit coolers can also be controlled manually.

The standby switchgear supply air fan is controlled manually.

The standby switchgear room (standby) supply air fan starts automatically when the operating supply air fan discharge flow is low. Interlocks prevent starting, or automatically trip, a fan when the associated supply air fan suction damper is not open or the associated fan has tripped on low discharge air flow.

The standby switchgear room supply air fan suction dampers open or close automatically when the associated supply air fan is started or stopped, respectively. The dampers can also be controlled manually.

The standby switchgear room supply air heaters are controlled automatically by the associated corridor air temperature. An interlock prevents energizing or automatically trips a heater when the associated supply air flow is low.

The standby switchgear battery rooms (standby) exhaust fan starts automatically when the operating fan discharge air flow is low. An interlock prevents starting a fan when the fan has tripped on low discharge air flow. An interlock automatically trips a fan when the fan discharge air flow is low. The fans can also be controlled manually.

The standby switchgear and HPCS switchgear rooms smoke removal dampers are controlled manually. Interlocks prevent opening, or automatically trip closed, the dampers when the CO_2 system is discharged.

The standby switchgear rooms smoke removal fan is controlled manually. An interlock automatically trips the fan when the CO_2 system is discharged.

<u>Monitoring</u>

Indicators are provided for each standby switchgear room temperature.

Alarms are provided for:

1. Standby switchgear rooms ventilation system trouble.

2. Standby switchgear rooms ventilation system inoperable.

3. Standby switchgear room fans auto start.

9.4.1.5.5 Normal Switchgear Building

<u>Description</u>

Instruments and controls are provided for automatic and manual control of the normal switchgear room HVAC system. The controls described below are located locally. The monitors described below are located in the main control room. The control logic is shown on Figure 9.4-6.

<u>Operation</u>

The normal switchgear building (standby) ventilation supply fan starts automatically when either of the two operating fans is stopped. An interlock automatically trips a fan when the discharge air flow is low. An interlock prevents starting a fan when it has tripped on low discharge air flow. The fans can also be controlled manually.

The normal switchgear building (standby) ventilation exhaust fan starts automatically when either of the two operating fans is stopped. An interlock automatically trips a fan when the discharge air flow is low. An interlock prevents starting a fan when it has tripped on low discharge air flow. The fans can also be controlled manually.

The interlock between the supply and exhaust fans prevents running the supply fans without running the exhaust fans or vice versa.

The supply and exhaust fans will be tripped automatically upon CO_2 fire protection system actuation.

The normal switchgear building makeup air damper, exhaust air damper, and recirculation air damper are controlled automatically by the building return air temperature, provided a supply fan is running and the dampers' switches are set for normal mode of operations. The makeup air damper and exhaust air damper open and the recirculation air damper closes when the dampers' switches are set for smoke removal mode of operation and also upon CO_2 fire protection system actuation.

The normal switchgear building unit heaters and fans are controlled automatically by the associated space temperature. An interlock prevents a unit heater from energizing unless the associated fan is running. Each unit heater fan can also be started and stopped manually.

The normal switchgear building battery room standby exhaust fan is started automatically when the operating exhaust fan discharge flow is low. Interlocks prevent starting, or automatically trip, a fan when smoke is detected in the zone, or when the fan has tripped on low discharge flow. The fans can also be controlled manually.

The normal switchgear building battery room supply air heater is controlled automatically by battery room exhaust air temperature. An interlock prevents energizing, or automatically trips, the heater when the supply air flow is low.

The normal switchgear building ventilation penthouse supply fans are controlled automatically by the associated penthouse space temperature. The fans can also be controlled manually.

The normal switchgear building ventilation LFMG set penthouse supply fans are controlled automatically by the associated penthouse space temperature. An interlock prevents starting, or automatically trips, a fan when the associated LFMG set penthouse supply damper is less than 40-percent open. The fans can also be controlled manually.

The normal switchgear building ventilation LFMG set penthouse supply dampers open or close automatically when the associated

exhaust fan is started or stopped, respectively. The dampers are also controlled manually.

Monitoring

Alarms are provided for control building ventilation system trouble (normal switchgear building HVAC system alarm conditions).

9.4.1.5.6 Electrical Tunnels, Cable Area, Basement Cable Area, Cable Chase, Cable Shaft, Computer Battery Room, 24-V Battery Rooms, and Records Storage Vault

Description

Safety-related instruments and controls are provided for automatic and manual control of HVAC systems serving the electrical tunnels, cable area, basement cable area, cable chase, and cable shaft areas. Except where noted, the controls and monitors described below are located in the main control room. The control logic is shown on Figure 9.4-7.

Operation

The electrical tunnels and basement cable area unit coolers are controlled manually. Interlocks prevent starting a unit cooler when the associated discharge damper is not open or when the fan has tripped on low discharge flow. Interlocks automatically trip a unit cooler when the associated discharge damper is not open or the associated discharge flow is low.

The electrical tunnels and basement cable area unit coolers discharge dampers open or close automatically when the associated unit cooler is started or stopped, respectively. The dampers can also be controlled manually. An interlock prevents closing a damper when the associated fan is running.

The electrical tunnels smoke removal fans are controlled manually. Interlocks prevent starting, or automatically trip, a fan when the associated fan system damper is not fully open, the associated fan discharge damper is not fully open, or the associated unit cooler discharge damper is not fully closed.

The electrical tunnels smoke removal fans suction dampers are controlled manually. An interlock prevents opening, or automatically trips closed, a damper when the associated electrical tunnel unit cooler discharge damper is not fully closed.

The electrical tunnels smoke removal fans discharge dampers open or close automatically when the associated fan is started or stopped, respectively. The dampers can also be controlled manually. An interlock prevents manually closing a damper unless the associated fan is stopped.

The electrical tunnels makeup air dampers open or close automatically when the associated fan is started or stopped, respectively. The dampers can also be controlled manually.

The cable areas smoke removal fans are controlled manually. Interlocks prevent starting, or automatically trip, a fan when the associated cable area smoke removal section damper is not fully open or the associated cable area makeup air damper is not fully open.

The cable areas smoke removal suction dampers are controlled manually. An interlock prevents opening, or automatically trips closed, a damper when the associated basement cable spreading area unit cooler discharge damper is not closed.

The cable area smoke removal dampers for the various individual cable areas are controlled manually.

The cable areas makeup air dampers are controlled manually.

The cable chase smoke removal dampers are controlled manually.

The cable chase, cable shaft, and east entrance unit heaters and fans are controlled locally. The unit heaters and fans are controlled automatically by the associated space temperature. An interlock prevents a unit heater from energizing unless the associated fan is running. Each unit heater can also be controlled manually.

The 24-V battery rooms and computer battery room exhaust fans are controlled locally. The standby exhaust fan starts automatically when the operating fan discharge air flow is low. An interlock automatically trips an operating exhaust fan when its discharge air flow is low.

The records storage vault air conditioning unit is controlled locally, manually, and automatically by the vault air temperature.

Monitoring

Indicators are provided for each electrical tunnel unit cooler return air temperature.

Alarms are provided for:

1. North and south tunnels unit coolers trouble.

2. Cable area unit coolers trouble.

9.4.2 Reactor Building Heating, Ventilating, and Air Conditioning System

The reactor building HVAC system is shown schematically on Figure 9.4-8, a through h, j, k, l. Design data of principal equipment utilized in the system are listed in Table 9.4-3 (Historical). The HVAC system consists of the following subsystems:

1. Drywell cooling.

2. Primary containment purge.

3. All other reactor building areas, including spent fuel pool areas.

9.4.2.1 Design Bases

The design bases for the three subsystems are as follows.

9.4.2.1.1 Drywell Cooling

Power Generation Design Basis

Provide an environment that ensures optimum performance of equipment, within the temperature limits shown in Table 9.4-1.

Safety Design Basis

Provide seismically-qualified ductwork and accessories to protect adjacent safety-related equipment in the event of a design basis earthquake (DBE). The system is designed to nonnuclear safety standards and is not required for safe shutdown of the plant.

9.4.2.1.2 Primary Containment Purge (CPS)

Power Generation Design Basis

1. Provide sufficient purging capability for the primary containment to permit entry of personnel within 16 hr of a reactor cold shutdown.

2. Provide the piping interconnection between the nitrogen inerting system (GSN) and the drywell and suppression chamber to permit inerting of the primary containment, and to maintain the primary containment at positive pressure with nitrogen during normal operation so that any leakage can be monitored.

3. Provide a backup system to the redundant hydrogen recombiners for the dilution of hydrogen following a LOCA. The hydrogen recombiners are described in Section 6.2.5.

Safety Design Basis

Provide seismically-qualified piping and valves to protect adjacent safety-related equipment in the event of a DBE. The

containment isolation provisions for the purge system lines facilitate compliance with 10CFR50.67 for the radiological consequences of a LOCA occurring during CPS operation (Section 15.6.5). The system is designed to nonnuclear safety standards and is not required for safe shutdown of the plant.

Beyond Design Basis Hardened Containment Vent System (HCVS)

Provide a primary containment vent path to have the capacity to vent the steam equivalent of a decay heat rate of 1% of the rated thermal power at the Primary Containment Pressure Limit (and Design Pressure) of 45 psig to be used during a Beyond Design Basis Event (BDBE) resulting in an Extended Loss of AC Power (ELAP). The design of the system is guided by NRC Order EA-13-109 and NEI 13-02.

9.4.2.1.3 All Other Reactor Building Areas

Power Generation Design Basis

1. Provide an environment that ensures habitability of the areas served and optimum performance of equipment, within the temperature limits shown in Table 9.4-1.

2. For normal plant operation, provide a once-through ventilation system, utilizing outdoor air with controlled discharge of exhaust air to the atmosphere.

3. Exhaust more air from the reactor building than is being supplied, thereby maintaining the area at a negative pressure to inhibit the exfiltration of airborne contaminants.

4. Provide the capability to clean up the RPV head during the refueling operation with the help of the reactor head evacuation filter assembly.

Safety Design Basis

1. Provide means to monitor all effluent from the reactor building prior to release for radioactive contamination and to isolate all ventilation openings in the reactor building in the event that radiation levels exceed a predetermined value.

2. During accident conditions, divert recirculated air through a standby gas treatment system (SGTS) (Section 6.5.1) so that offsite radiation doses are maintained below allowable values.

3. Provide seismically-qualified ductwork and accessories to protect adjacent safety-related equipment in the event of a DBE.

9.4.2.2 System Description

9.4.2.2.1 Drywell Cooling

The drywell cooling system consists of 10 unit coolers containing fans, cooling coils, dampers, and controls, together with ductwork and ductwork accessories. Cooling water is piped to each cooling coil from the RBCLCW system (Section 9.2.2.1). The drywell cooling system is shown schematically on Figure 9.4-8j. The 10 unit coolers are arranged as follows:

1. Four unit coolers are located on el 240 ft and serve to cool the RPV CRD area, the RPV skirt, and the general drywell areas on el 240 ft and 261 ft. Return air to the unit coolers is ducted from the general drywell areas above el 316 ft.

2. Four unit coolers are located on el 278 ft 6 in and serve to cool the general drywell areas on the same elevation. Supply and return air is nonducted.

3. Two unit coolers are located on el 288 ft 3 in and discharge through a common supply air duct to cool the RPV top head area. Return air from the same area is transmitted through a common return air duct to both unit coolers.

9.4.2.2.2 Primary Containment Purge

The primary containment purge system is shown schematically on Figures 9.4-8k and l.

The system is comprised of purge and pressurization subsystems as follows:

<u>Purge Subsystem</u>

The purge subsystem consists of one 100-percent capacity centrifugal fan, piping, valves, controls, and accessories. Piping penetrations through the primary containment (penetrations Z-48, Z-49, Z-50, Z-51, and Z-96 as listed in Table 6.2-56) are each protected with redundant safety-related normally closed, fail closed isolation valves. The AOVs inside the primary containment are operated by nitrogen through penetration Z-96, while the AOVs outside are operated by air. To protect the isolation valves, the open end of each 12-in and 14-in purge subsystem line (supply and exhaust) within the primary containment is provided with a QA Category I debris screen.

The purge subsystem is utilized to inert the primary containment atmosphere with nitrogen prior to ascension to full power. Nitrogen is supplied from the GSN through manually-controlled valves to the drywell and suppression chamber utilizing,

respectively, 14-in and 12-in CPS supply lines. The GSN system is described in Sections 6.2.5.2.3 and 9.3.1.5.

The purge subsystem also is utilized to purge the primary containment of nitrogen prior to personnel reentry, beginning not more than 24 hr before descending to 15 percent of full power. During purging, makeup air is fan-supplied from the reactor building ventilation system and delivered to the drywell and suppression chamber through the 14-in and 12-in CPS supply lines. Purge exhaust is drawn by the SGTS (Section 6.5.1) from the drywell and suppression chamber, respectively, through 14-in and 12-in CPS exhaust lines for monitored release through the main stack. During ascension to full power or normal operation, the purge subsystem and SGTS can be operated to control primary containment pressure excursions that may occur or to vent the primary containment, as necessary, if nitrogen is added during normal operation to offset losses; or, to maintain the oxygen concentration limit (see the pressurization subsystem). All isolation valves are automatically initiated to close (and fail closed) on a LOCA signal.

A connection to the purge subsystem is included for attachment of a portable air compressor which is required for performance of the integrated leak rate test.

A connection to the purge subsystem is included for attachment of drywell/outage ventilation fans. These fans will exhaust to the reactor building exhaust plenum.

Pressurization Subsystem

The pressurization subsystem consists of 2-in piping, valves, controls, and accessories. Piping penetrations through the primary containment (penetrations Z-58 and Z-59 as listed in Table 6.2-56) are each protected with redundant safety-related normally closed, fail closed solenoid isolation valves. To protect the isolation valves, the open end of each 2-in pressurization subsystem line within the primary containment is provided with a QA Category I debris screen.

During normal operation, the pressurization subsystem is utilized manually to add nitrogen to the primary containment to either maintain primary containment pressure within the range of 0.5 to 1.0 psig or the oxygen concentration limit at less than or equal to 4 percent volume.

Hardened Containment Vent System (HCVS)

The HCVS consists of a 16-in branch line off of the 20-in CPS header leading to 2GTS*AOV101. The 16-in line exits secondary containment and is routed up the side of the Reactor Building and terminates above the roof. 2CPS*AOV109, 2CPS*AOV111 (located off of penetration Z-51) and 2CPS-AOV134 (located on the new 16-in vent line) may be operated via a Nitrogen based motive gas system

located in the Reactor Building Track Bay, in the event instrument air is lost. The motive gas system can be operated from either the Control Room or locally in the Track Bay after initial valve lineups are made in the Track Bay.

Since venting during a severe accident will result in the potential of a combustible mixture in the pipe after venting, an Argon purge system, also located in the Track Bay is used to purge out the contents of the pipe and create an inert atmosphere. Similar to the motive gas system, the purge system can be operated from the Control Room or locally in the Track Bay after initial valve lineups are made in the Track Bay.

The HCVS is powered by a dedicated set of batteries located in the Track Bay that are designed to operate for 24 hours prior to needing to be recharged. The batteries power the solenoid operated valves of the motive gas and purge system as wellas instrumentation including vent line pressure, temperature and radiation indicators, valve position switches, a data recorder and indicating lights in the Control Room.

The vent line is prevented from becoming a bypass leakage pathway, by the use of a leak tight rupture disc located in the line downstream of 2CPS-AOV134 and an open vent 9in the purge line within secondary containment. In order to operate the HCVS, the purge system is used to pressurize the space between 2CPS-AOV134 and the rupture disc, bursting the disc and creating the vent path.

9.4.2.2.3 All Other Reactor Building Areas

The HVAC subsystem is shown schematically on Figures 9.4-8a through h.

The system has the following modes of operation:

1. Normal operation.

2. Emergency operation.

Normal Operation

The supply ventilation air handling unit assembly consists of an air intake, prefilter, filter, heating coil, cooling coil, dampers, controls, and supply fans. Three 50-percent capacity vaneaxial fans are provided; two operate normally while one is in standby.

The prefilter and filter are of the extended surface disposable type. The glycol heating coil preheats the supply air to the required discharge air temperature. Glycol is supplied to the heating coil from the plant glycol heating system (Section 9.4.11). The cooling coil maintains the required discharge air

temperature. Cooling water is supplied to the cooling coil from the SWP system (Section 9.2.1).

Supply air is distributed through a network of ductwork and ductwork accessories. Supply and exhaust air to various areas, including the spent fuel pool area, is maintained in such a way that the preferred direction of air flow is from areas with low contamination potential to areas of progressively greater contamination potential.

Electric unit heaters are provided to offset building transmission heat losses, supplementing the heating coil in supply air ductwork. Each electric unit heater includes an electric heating element, propeller fan, casing with fan guard, and discharge diffusion device. Each unit heater is controlled thermostatically so that, when required for air circulation, the unit heater fan will operate with the heating element de-energized. The two main supply air ducts for the refueling floor each have an electric duct heating coil to increase, as required, the supply air temperature.

All ventilation air is exhausted through an exhaust duct network to two exhaust air systems. One system exhausts air primarily from the refueling floor and the other from areas below the refueling floor. Each exhaust air system is equipped with two 100-percent capacity vaneaxial fans; one operates normally while the other is in standby. Exhaust ductwork is arranged to maintain the preferred direction of air flow.

A connection to the reactor building exhaust plenum is included for attachment of drywell outage ventilation fans. These fans will take a suction on the drywell through the containment purge supply line.

During normal shutdown prior to RPV head removal, air from the RPV head is diluted and exhausted to the reactor building exhaust assembly through the reactor head evacuation filter system consisting of ductwork, a filter assembly, accessories, and a centrifugal fan.

The filter assembly consists of the following components in series:

1. Demister (moisture separator).
2. Electric heating coil.
3. Prefilters.
4. HEPA filters (first bank).
5. Charcoal adsorber filters.
6. HEPA filters (second bank).

The exhaust air systems are monitored for radiation. Permanently installed monitors as well as connection taps for continuous airborne monitors are provided (Section 11.5).

If the radiation levels exceed a predetermined limit or a LOCA signal is received, the system automatically switches to the emergency operation mode.

Unit space coolers recirculate cooled air within the space they serve to maintain the required space temperature below a maximum setpoint. These coolers consist of fans, cooling coils, dampers, and controls, together with ductwork and ductwork accessories. Cooling water is piped to each cooling coil from the SWP system (Section 9.2.1).

The unit space coolers, emergency recirculation unit coolers, and isolation dampers are designed to Safety Class 3 and Category I requirements. Other ventilation equipment, such as fans, coils, filters, and electric unit heaters, is designed to nonnuclear safety standards and is not required to operate for safe plant shutdown. The support of system ductwork and accessories, piping, and ventilation equipment is in accordance with Category I criteria, to preclude damage to adjacent safety-related equipment in the event of a SSE.

<u>Emergency Operation</u>

If the radiation level exceeds a predetermined limit, or a LOCA signal is received, the normal operation supply air system is automatically shut down and the emergency operation recirculation air system is actuated as well as the unit space coolers. The SGTS (Section 6.5.1) is automatically actuated by the same high radiation or LOCA signal.

The emergency operation recirculation air system consists of two 100-percent capacity recirculation unit coolers, together with ductwork and ductwork accessories and controls, arranged to provide recirculation, mixing, and cooling for the reactor building.

The emergency recirculation unit cooler takes suction through a network of return air ductwork from each floor level below the refueling floor. Air is recirculated into the reactor building through a network of recirculated air ductwork and accessories above the refueling floor to provide a high degree of entrainment and mixture with the surrounding air. The air is then drawn through the hoist space and stairways into the return air system located at each floor level. The emergency recirculation system ensures mixing throughout the reactor building atmosphere, including the spent fuel pool area.

The intake duct connection for the SGTS (Section 6.5.1) is taken at the discharge side of the emergency recirculation unit cooler to maintain the reactor building at a negative pressure.

Unit space coolers with sufficient capacity to satisfy the cooling requirements of the emergency safeguard equipment provide cooling to handle the heat gain load of the respective safeguard equipment. Cooling for general areas is provided by unit space coolers.

HVAC equipment and components that operate following a LOCA are designed to Category I and Safety Class 2 and 3 criteria. Equipment motors and controls in the safety-related portion of the system are supplied from their respective independent emergency power sources and have sufficient redundancy to satisfy the single-failure criterion.

9.4.2.3 Safety Evaluation

The safety features of the reactor building HVAC system are as follows:

1. All safety-related components are designed to Safety Class 2 and 3 criteria and Category I requirements. Safety-related components are located so that failure of a portion of other nonessential systems does not prevent operation of any safety-related system.

2. Safety-related components have sufficient redundancy to meet the single active failure criteria. Originally, the FMEA of the reactor building HVAC system was contained in the Unit 2 FMEA document, which is historical. FMEAs for plant systems are now performed and controlled by the design process.

3. Redundant isolation valves in each line penetrating the primary containment are in accordance with ASME Section III. The piping between the isolation valves is Safety Class 2 and both the valves and piping are designed to Category I. All other system piping is seismically supported. The inboard end of each 12-in and 14-in CPS isolation valve located inside the primary containment is provided with a QA Category I debris screen to prevent entrainment of foreign matter in the valve seat.

4. All primary containment penetrations associated with the reactor building HVAC have redundant isolation valves. The valves are designed, manufactured, and "N" stamped Safety Class 2 in accordance with ASME Section III and are designed to operate in the event of a postulated SSE (Category I).

5. Radiation monitors located on the exhaust air ducts monitor air exhausted from the reactor building and transmit an isolation signal upon indication that the radiation level exceeds a preset level. Refer to Section 11.5 for a discussion of the process radiation monitoring system.

6. The reactor building is maintained at a negative pressure with respect to the atmosphere during normal plant operation by bypassing supply air from the discharge side of the supply fans back into the supply side of the supply ventilation air handling unit assembly. During emergency operation, the SGTS (Section 6.5.1) maintains the reactor building at a negative pressure with respect to the atmosphere.

7. The reactor building floor and equipment drain system sumps are vented through the reactor building ventilation exhaust system to minimize the release of radioactive material to the surrounding areas during normal plant operation (Section 9.3.3).

8. Temperatures in the drywell zones are computer monitored and annunciated in the main control room through a common alarm.

9. The safety-related equipment is supplied from the Class 1E power distribution system and, in case of LOOP, receives its power supply from redundant standby onsite power sources. The nonsafety-related components of the system are supplied from non-Class 1E power sources.

10. IAS and GSN relief valve discharge lines are directly connected to the reactor building ventilation exhaust system to preclude nitrogen being discharged into surrounding areas during normal operation of the plant.

9.4.2.4 Testing and Inspection Requirements

The system is preoperationally tested to ensure it meets design requirements.

Ducted air flows are balanced to satisfy design requirements in accordance with procedures of the AABC. The system is designed to permit periodic inspection and maintenance of active components.

9.4.2.5 Instrumentation Requirements

9.4.2.5.1 Drywell Cooling

Description

Instruments and controls are provided for manual control of the drywell unit coolers. The controls and monitors described below are located in the main control room. The control logic is shown on Figure 9.4-9.

Operation

The drywell unit coolers are controlled manually. Interlocks prevent starting, or trip automatically, the unit coolers when any of the associated RBCLCW containment isolation valves are closed. The isolation valves' closed interlock can be overridden by a LOCA keylock switch.

Monitoring

Recorders are provided for drywell unit coolers suction and discharge air temperatures.

Alarms are provided for:

1. Drywell unit cooling groups system trouble.

2. Drywell unit coolers vibration high.

3. Drywell unit cooling groups LOCA override.

9.4.2.5.2 Primary Containment Purge

Description

Safety-related instruments and controls are provided for automatic and manual control of primary containment ventilation and pressurization. The controls and monitors described below are located in the main control room. The control logic is shown on Figure 9.4-9.

Operation

The primary containment purge fan is controlled manually. The fan trips automatically when the drywell and suppression chamber purge ventilation air inlet flows are sustained low.

The primary containment drywell purge and suppression chamber purge inside and outside isolation valves are opened manually. Interlocks prevent opening the valves, or automatically trip closed the valves, when manual isolation is initiated, SGTS exhaust radiation high, or a LOCA signal is present. The valves can also be controlled manually.

The primary containment pressurization nitrogen inlet flow control valve is controlled automatically by hand indicating control stations, provided the primary containment pressure is not high. The control valve trips closed automatically when the

primary containment pressure is high. The primary containment pressure high trip interlock can be manually overridden.

The primary containment drywell purge discharge, drywell purge pressurization, suppression chamber purge discharge, and suppression chamber purge pressurization inside and outside isolation valves are opened manually. Interlocks prevent opening the valves, or automatically trip closed the valves, when manual isolation is initiated or a LOCA signal is present. The LOCA signal can be overridden by a keylock switch. The valves can also be closed manually.

<u>Monitoring</u>

Indicators are provided for:

1. Drywell purge ventilation air inlet flow.

2. Suppression chamber purge ventilation air inlet flow.

3. Primary containment pressurization inlet nitrogen flow.

4. Primary containment pressurization inlet pressure.

Alarms are provided for:

1. Primary containment isolation valves inoperable.

2. Primary containment purge ventilation air inlet flow low.

3. Primary containment leak rate high.

9.4.2.5.3 All Other Reactor Building Areas

<u>Description</u>

Safety-related and nonsafety-related instruments and controls are provided for automatic and manual control of the reactor building HVAC systems. In the following descriptions, the controls described are located in the main control room except as noted. The monitors are located in the main control room. The control logic is shown on Figure 9.4-9.

<u>Operation</u>

The reactor building supply air fans are controlled locally. A standby fan starts automatically when either of the other two operating fans stops running, provided the supply air isolation dampers are open and the associated supply air discharge damper is more than 40-percent open. A fan trips automatically when the discharge air flow is sustained low, either isolation damper is not open, the reactor building differential pressure is sustained

high, or the associated discharge damper is less than 40-percent open. The fans can also be controlled manually.

The supply air fan discharge dampers are controlled locally. The dampers open or close automatically when the associated fan is started or stopped, respectively. The dampers can also be controlled manually.

Exhaust air fans are controlled locally. The standby fan starts automatically when the operating fan stops running, provided the exhaust air isolation dampers, or the purge damper, are open and the associated exhaust air discharge damper is more than 40-percent open. A fan trips automatically when the exhaust air isolation damper and the purge damper are closed, the discharge air flow is sustained low, the reactor building differential pressure is sustained low, or the associated discharge damper is less than 40-percent open. The fans can also be controlled manually.

Exhaust air fan discharge dampers are controlled locally. The dampers open or close automatically when the associated fan is started or stopped, respectively. The dampers can also be controlled manually.

Refueling area exhaust air fans are controlled locally. A standby fan starts automatically when the operating fan stops running, provided the exhaust air isolation dampers or the purge damper are open and the associated exhaust air discharge damper is more than 40-percent open. A fan trips automatically when the exhaust air isolation damper and the purge damper are closed, the discharge air flow is sustained low, the reactor building differential pressure is sustained low, or the associated discharge damper is less than 40-percent open. The fans can also be controlled manually.

Refueling area exhaust air fan discharge dampers are controlled locally. The dampers open or close automatically when the associated fan is started or stopped, respectively. The dampers can also be controlled manually.

Reactor building unit heaters are controlled locally. The heaters are controlled automatically by the associated area temperature. An interlock prevents a unit heater heating element from energizing unless the unit heater fan is running. Each unit heater can be started or stopped manually.

The elevator shaft damper, fuel pool backwash tank damper, emergency recirculation damper, and phase separator tank damper are controlled manually from a local panel.

The auxiliary filter fan is controlled manually from a local panel. The fan trips automatically when the discharge air flow is sustained low.

The standby gas treatment building roof fan is controlled automatically by a HVAC equipment room space thermostat. Local manual control is provided.

The standby gas treatment building equipment room inlet damper opens or closes automatically when the standby gas treatment building roof fan is started or stopped, respectively. Local manual control is also provided.

The reactor building standby emergency ventilation recirculation unit cooler starts automatically when air flow above/below the refueling floor is low, the refueling area radiation is high-high, or a LOCA signal is present, and the operating unit cooler air flow is low. A unit cooler trips automatically when the associated discharge air flow is low. The unit coolers can also be controlled manually from a local panel or from the control room.

Supply air isolation dampers, exhaust air isolation dampers, and refueling area exhaust air isolation dampers are controlled manually from the control room. Interlocks prevent opening the dampers when the refueling area radiation is high-high, or a LOCA signal is present, or above/below refueling floor air flow is low, except when keylock test switches, which are provided for surveillance testing, are in the test position. Any one of the signals described above closes the emergency ventilation recirculation unit cooler suction test damper, except when keylock test switches, which are provided for surveillance testing, are in the test position. The refueling floors air flow low signal starts the SGTS filter train. The isolation damper trip closes automatically when the refueling area radiation is high-high, a LOCA signal is present, or air flow above/below the refueling floor air flow is low, except when keylock test switches, which are provided for surveillance testing, are in the test position. The refueling floor air flow low signal can be manually overridden. The test switches, which are provided for surveillance testing, illuminate an INOP light in the control room when in the test position.

The reactor building emergency ventilation air fan suction dampers open or close automatically when the associated emergency recirculation unit cooler starts or stops, respectively. The dampers can also be controlled manually from the control room.

The supply air fans' recirculation dampers are controlled automatically by reactor building differential pressure.

Area unit coolers are controlled automatically by the associated area space temperature as well as radiation levels exceeding a predetermined limit, or a LOCA signal being received. The unit coolers can also be controlled manually from the control room. Some unit coolers can also be controlled locally.

Emergency ventilation recirculation unit cooler suction test dampers open automatically when the associated unit cooler is started in the test mode. The dampers trip closed automatically when air flow above/below the refueling floor is low, the reactor building area radiation is high-high, a LOCA signal is present, or the emergency ventilation recirculation unit cooler is not running. When keylock test switches, which are provided for surveillance testing, are in the test position, the signals, reactor building area radiation high-high, LOCA, or air flow above/below the refueling floor-low will not close the damper. The test switches, when in the test position, illuminate an INOP light in the control room. The dampers can also be controlled manually from the control room.

The ventilation auxiliary filter damper is controlled manually from the control room.

Duct heaters are controlled automatically by the refueling floor area space temperature. The duct heaters are de-energized automatically when the associated duct heater air flow is low.

<u>Monitoring</u>

Indicators and recorders are provided for:

1. Above/below refueling floor gaseous radiation discharge level.

2. Above/below refueling floor particulate radiation discharge level.

3. Drywell personnel hatch radiation level.

Alarms are provided for:

1. HVAC systems trouble.

2. HVAC systems emergency recirculation air temperature high.

3. Unit coolers auto trip/fail to start, auto start, and air flow low.

4. Above/below refueling floor air flow low.

5. Test dampers open.

6. HVAC systems inoperable.

7. Area radiation monitor activated.

8. Reactor building head cavity evacuation filter trouble.

9. Unit coolers motor overload.

10. Reactor building exhaust/service water injection differential temperature alarm low and low-low.

9.4.3 Radwaste Building Heating, Ventilating, and Air Conditioning System

The radwaste building HVAC system is shown schematically on Figures 9.4-10a through 9.4-10e. Design data of principal equipment utilized in the system are listed in Table 9.4-4 (Historical). The HVAC system consists of the following subsystems:

1. Supply air.
2. Unit heaters.
3. General area exhaust.
4. Equipment exhaust.
5. Liner filling hood exhaust.
6. Smoke exhaust.

In addition to the aforementioned systems, radwaste decontamination areas and radwaste control room HVAC subsystems also are shown schematically on Figure 9.4-10. Design data of principal equipment utilized in the system are listed in Table 9.4-4 (Historical). The HVAC system consists of the following subsystems:

1. Radwaste decontamination general area air conditioning.
2. Radwaste decontamination clean area return/exhaust.
3. Radwaste control room air conditioning.
4. Radwaste control room return/exhaust.
5. Radwaste decontamination dirty area and chemistry laboratory return/exhaust.
6. Post-accident sampling equipment exhaust.
7. Chemistry laboratory air conditioning.

9.4.3.1 Design Bases

The design bases for the system are:

1. Provide an environment that ensures habitability of the areas served, consistent with personnel comfort and

optimum performance of equipment, within the temperature limits shown in Table 9.4-1.

2. Provide the means for movement of air from clean areas to areas of progressively greater potential contamination prior to final exhaust. This serves to prevent the migration of airborne contaminants from potentially contaminated areas into clean areas.

3. Exhaust more air from the building than is being supplied, thereby maintaining the building at a negative pressure to inhibit the exfiltration of airborne contaminants.

4. Provide a smoke exhaust system for the asphalt storage tank cubicle, and for all solid waste areas of the building, to be used only in the event of fire and testing.

5. Provide high-efficiency filtration of all exhaust air, except smoke exhaust, prior to discharge to atmosphere through the reactor/radwaste building vent.

6. Monitor all exhaust air, except smoke exhaust, for radioactive contaminants (Section 11.5) prior to discharge to atmosphere through the reactor/reactor building vent.

7. Supply more air to the radwaste control room than is being returned, thereby maintaining the control room at a positive pressure to inhibit the infiltration of airborne contaminants.

9.4.3.2 System Description

9.4.3.2.1 Supply Air Subsystem

The radwaste building HVAC supply air subsystem consists of one air handling unit, distribution ductwork, accessories, and controls. The air handling unit components include an air intake, prefilter, filter, heating coil, cooling coil, two 100-percent capacity vaneaxial fans, and control dampers. One fan serves as a standby. The prefilter and filter are of the disposable bag type and function to remove dust particles from the outdoor air. The glycol heating coil and chilled water cooling coil maintain the required air temperature. Glycol is supplied to the heating coil from the plant glycol heating system (Section 9.4.11). Chilled water is supplied to the cooling coil from the plant chilled water system (Section 9.4.10).

During normal plant operation the supply air subsystem operates continuously, providing heated or cooled air. The subsystem is balanced to supply slightly less air than is exhausted, thereby

maintaining a negative pressure and inhibiting the exfiltration of air from the building.

9.4.3.2.2 Unit Heaters Subsystem

Electric unit heaters are provided to offset building transmission heat losses, supplementing the heating coil in the supply air subsystem unit.

Each electric unit heater includes an electric heating element, propeller fan, casing with fan guard, and a discharge diffusion device. Each unit heater is controlled thermostatically so that, when required for air circulation, the unit heater fan will operate with the heating element de-energized.

9.4.3.2.3 General Area Exhaust Subsystem

The general area exhaust subsystem operates continuously during normal plant operation. Exhaust air from general areas is discharged by a 100-percent capacity vaneaxial exhaust fan through an exhaust filter train to the reactor/radwaste building vent. A standby exhaust fan and filter train permit operation on a rotating basis.

Exhaust ductwork is arranged to maintain the preferred direction of air flow, which is to draw air from areas of low potential radioactive contamination into and through areas of higher potential radioactive contamination before filtering and exhausting it from the building.

The general area exhaust fans are used for smoke removal in the event of fire in the building. This is accomplished by means of a normally closed bypass duct around each filter train. The bypass duct damper will be opened by a manual switch, when necessary.

Each filter train consists of the following components:

1. Medium-efficiency filters to remove coarse particulates from the air stream. The filters are designed for 35-percent efficiency based on the ASHRAE Std. 52-76 test method.

2. HEPA filters for essentially complete removal of fine airborne particulates. The filters are of water-repellent and fire-resistant construction and are designed for a minimum efficiency of 99.97 percent, on a 0.3-micron DOP (dioctylpthalate) test. The HEPA filters are fabricated in accordance with MIL-F-51068 and MIL-STD-282 and carry an Underwriters' Laboratories (UL) label.

9.4.3.2.4 Equipment Exhaust Subsystem

The equipment exhaust subsystem operates continuously during normal plant operation. Exhaust air from tanks and potentially contaminated equipment is ducted to a separate 100-percent capacity centrifugal fan and is then discharged through an exhaust filter train to atmosphere through the reactor/radwaste building vent. A standby exhaust fan and filter train permit operation on a rotating basis.

Effluent from the equipment exhaust subsystem is continuously monitored for noble gas activity by the off-line monitoring system. Iodine and particulate activity is determined by laboratory analysis of filters in the combined reactor/radwaste building vent effluent monitoring system (Section 11.5).

Each filter train consists of medium-efficiency and HEPA filters as previously described in Section 9.4.3.2.3.

9.4.3.2.5 Liner Filling Hood Exhaust Subsystem

The liner filling hood exhaust subsystem is started before the extruder-evaporator is started. Exhaust air from the hood is discharged by a separate 100-percent capacity centrifugal fan, through medium-efficiency and HEPA filters, to the radwaste building main exhaust duct.

9.4.3.2.6 Smoke Exhaust Subsystem

The smoke exhaust subsystem is placed in operation manually as the result of a smoke alarm or fire alarm in the asphalt storage tank cubicle. The exhaust air is discharged directly to the atmosphere through louvers by an axial-centrifugal exhaust fan. When the smoke exhaust subsystem is operating, the general area exhaust passage to the asphalt storage tank cubicle is manually closed. This action prevents smoke migration from the cubicle.

9.4.3.2.7 Radwaste Decontamination General Area Air Conditioning Units

The radwaste decontamination and general areas' HVAC air conditioning unit consists of two 100-percent air conditioning units, distribution ductwork, electric duct heaters, accessories, and controls.

The air conditioning unit components include a mixing section with outside air/return air duct connections, filter, mixing box, chilled water cooling coil, electric heating coil, centrifugal fan, and dampers. One air conditioning unit serves as a standby. The filter is a disposable bag-type. The electric heating coil and chilled water cooling coil maintain the required air temperature. Chilled water is supplied to the cooling coils from the plant chilled water system (Section 9.4.10).

During normal plant operation, the air conditioning unit operates continuously, providing heated or cooled air. This system is

balanced to supply slightly less air than is exhausted, thereby maintaining a negative pressure to inhibit exfiltration.

Ventilation air for the switchgear room is balanced to supply slightly more air than is exhausted, thereby maintaining positive pressure in this room.

9.4.3.2.8 Radwaste Decontamination Clean Areas Return Air/Exhaust Fans

The electrical equipment room and the HVAC equipment room return/exhaust subsystem operates continuously during normal plant operation. The return/exhaust consists of two 100-percent capacity vaneaxial fans, ductwork, dampers, and accessories. The air from these areas is either returned to the air conditioning unit or exhausted to the outside environment.

9.4.3.2.9 Radwaste Control Room Air Conditioning Units

The radwaste control room HVAC supply air conditioning unit consists of two 100-percent air conditioning units, distribution ductwork, accessories, and controls. Each air conditioning unit consists of a mixing box with outside air/return air duct connections, filter, direct expansion cooling coil (served by two 50-percent capacity roof-mounted air-cooled condensing units), electric heating coil, centrifugal fan, and dampers. One air conditioning unit serves as a standby. The filter is a disposable bag-type. The electric heating coil and direct expansion cooling coil maintain the required air temperature and dehumidification.

During normal plant operation, the supply air subsystem operates continuously, providing heated or cooled air. The subsystem is balanced to supply slightly more air than is returned or exhausted, thereby maintaining a positive pressure to inhibit infiltration.

Electric steam humidifiers and associated controls maintain the minimum relative humidity by introducing steam into the common supply air duct. The water source for the humidifier is from the domestic water system (Section 9.2.4).

9.4.3.2.10 Radwaste Control Room Return Air/Exhaust Fans

The radwaste control room return/exhaust operates continuously during normal plant operation. The return/exhaust subsystem consists of two 100-percent capacity vaneaxial fans, ductwork, dampers, and accessories. The air from these areas is returned to the air handling unit.

9.4.3.2.11 Radwaste Decontamination Dirty Area and Chemistry Laboratory Return/Exhaust System

The radwaste decontamination dirty area and chemistry laboratory return/exhaust system operates continuously during normal plant operation. Exhaust air from these areas is discharged by a 100-percent capacity vaneaxial fan through exhaust filters to the reactor/radwaste building vent. A standby fan and filter permit operation on a rotating basis. The chemistry laboratory fume hood exhaust fans also discharge into the exhaust system ductwork.

Exhaust ductwork is arranged to maintain the preferred direction of air flow, which is to draw air from areas of low potential radioactive contamination into and through areas of higher potential radioactive contamination before filtering and exhausting it from the building.

The radwaste decontamination dirty areas exhaust fans are used for smoke removal in the event of a fire in the building. This is accomplished by means of a normally closed bypass duct around each filter. The bypass duct damper will be opened by a manual switch, when necessary.

9.4.3.2.12 Post-accident Sampling Equipment Exhaust

The post-accident sampling equipment exhaust operates only after an accident; however, it has the capability to operate continuously during normal plant operation. Exhaust air from post-accident sampling equipment is discharged by a 100-percent capacity exhaust fan through filters before it is released to the atmosphere through the reactor/radwaste building vent.

Removal of radioiodines from the post-accident sampling equipment exhaust is accomplished through the use of charcoal/HEPA combination filters located within the HVAC equipment room.

9.4.3.2.13 Chemistry Laboratory Air Conditioning Unit

The chemistry laboratory air conditioning unit consists of a single 100-percent packaged air conditioning unit. During normal operation, the air conditioning unit operates continuously, as a supplement to the radwaste decontamination dirty area return/exhaust ventilation system, to maintain desired temperature and humidity conditions in the chemistry laboratory.

9.4.3.2.14 Chemistry Laboratory Annex Air Conditioning Unit

The chemistry lab annex air conditioning unit consists of a single 100-percent packaged air conditioning unit. During normal operation, the air conditioning unit operats continuously, as a supplement to the radwaste building general area air conditioning system, to maintain desired temperature conditions in the chemistry lab annex.

9.4.3.3 Safety Evaluation

The radwaste building HVAC system has no safety-related function. Failure or malfunction of the system will not compromise any safety-related system or component or prevent safe reactor shutdown. The following features are incorporated in the design of the system to ensure system reliability and to minimize the release of airborne radioactivity:

1. One-hundred percent standby capacity of the main exhaust fans and filter trains ensures full system capacity with any unit inoperative due to equipment failure of maintenance outage.

2. All exhaust air is passed through a high-efficiency filter train before discharge, thus minimizing the release of radioactive contaminants.

3. All exhaust air from the building is monitored at the reactor building/radwaste building vent by an off-line monitor for gaseous activity. Iodine and particulate sample cartridges are analyzed isotopically at the end of the sample acquisition period.

In addition to the above, the radwaste decontamination area, radwaste control room HVAC systems, and post-accident sampling equipment exhaust system have no safety-related function. Failure or malfunction of the systems will not compromise any safety-related systems or component or prevent safe reactor shutdown.

9.4.3.4 Testing and Inspection Requirements

The system is designed to permit periodic inspection and maintenance of active components. Local display and indicating devices are provided for periodic inspection of parameters such as filter pressure drops, air flow readings, temperature readings, and other measurements required to verify continued satisfactory operation of the systems.

Duct air flows are balanced to satisfy design requirements in accordance with procedures of the AABC.

The system is preoperationally tested to ensure it meets design requirements (Chapter 14).

9.4.3.5 Instrumentation Requirements

<u>Description</u>

Instruments and controls are provided for automatic and manual control of the radwaste building HVAC system. Except where noted, the controls and monitors are located on local panels in the radwaste building. The control logic is shown on Figure 9.4-11.

<u>Operation</u>

The fans, dampers, heaters, and air conditioning units are controlled automatically and manually from local panels in the radwaste building.

<u>Monitoring</u>

Alarms are provided for:

1. Radwaste building ventilation system trouble (main control room).

2. Radwaste building area radiation monitor activated (main control room).

9.4.4 Turbine Building Heating, Ventilating, and Air Conditioning System

The turbine building HVAC system is shown schematically on Figures 9.4-12a through 9.4-12d. Design data of principal equipment utilized in the system are listed in Table 9.4-5 (Historical). The HVAC system consists of the following subsystems:

1. Supply air.

2. Exhaust air.

3. Unit coolers.

4. Unit heaters.

5. Sample room air conditioning.

6. Charcoal decay-bed room air conditioning.

7. Elevator machine rooms ventilation.

8. Smoke removal.

9.4.4.1 Design Bases

The design bases for the system are:

1. Provide an environment that ensures habitability of the areas served, consistent with personnel comfort and optimum performance of equipment, within the temperature limits shown in Table 9.4-1.

2. Provide the means for the movement of air from clean areas to areas of progressively greater potential contamination prior to final exhaust. This serves to

prevent the migration of airborne contaminants from potentially contaminated areas into clean areas.

3. Exhaust more air from the building than is being supplied, thereby maintaining the building at a subatmospheric pressure to inhibit the exfiltration of airborne contaminants.

4. Monitor all exhaust air for radioactive contaminants (Section 11.5), prior to discharge from the building to atmosphere through the main stack.

5. Provide the sample room with conditioned air for personnel comfort and to satisfy equipment and exhaust hood requirements.

6. Provide the charcoal decay-bed room with conditioned air required for maintenance of the decay beds.

9.4.4.2 System Description

9.4.4.2.1 Supply Air Subsystem

The turbine building HVAC supply air subsystem consists of one air handling unit, distribution ductwork, accessories, and controls. The air handling unit components include an air intake, prefilter, filter, heating coil, cooling coil, three fans, and control dampers for automatic control of recirculation and outdoor air.

HVAC unit fans are of the vaneaxial type with heavy-duty, manually-adjustable pitch blades. One fan normally serves as a standby; however, under certain conditions only one fan may be in operation for turbine building pressure control purposes, in which case there are no fans in standby. All three fans are connected to a common supply air duct distribution system that delivers air to various locations within the building. The prefilter and filter are of the extended surface disposable type. The glycol heating coil and chilled water cooling coil maintain the required air temperature. Glycol is supplied to the heating coil from the plant glycol heating system (Section 9.4.11).

Chilled water is supplied to the cooling coil from the plant chilled water system (Section 9.4.10).

During normal plant operation, the supply subsystem operates continuously, providing heated or cooled air. Generally, air is discharged to open areas and is exhausted through cubicles and confined areas. An air flow pattern is thereby established from clean areas to potentially contaminated areas.

The subsystem is balanced to supply slightly less air than is exhausted, thereby maintaining a subatmospheric pressure and inhibiting the exfiltration of air from the building. The

subatmospheric pressure is maintained even during periods of operation when the turbine building roof vents are opened to provide additional cooling of the turbine building and main steam tunnel.

9.4.4.2.2 Exhaust Air Subsystem

The turbine building exhaust air subsystem consists of three 50-percent capacity fans (two operating, with the third on standby) and exhausts air from specific areas within the building.

In exception to the above paragraph, Modification N2-95-011 has been installed to allow concurrent operation of all three exhaust fans. The autostart feature of the third fan, when placed in standby, is not affected.

Exhaust fans and ductwork are arranged to maintain the preferred direction of air flow, which is to draw air from areas of low potential radioactive contamination into and through areas of higher potential radioactive contamination before capturing and exhausting it from the building.

Unfiltered exhaust air is discharged to the atmosphere through the elevated main stack and is monitored prior to discharge by off-line gaseous effluent monitors (Section 11.5).

9.4.4.2.3 Unit Coolers Subsystem

The supply air subsystem is supplemented by fan coil recirculation-type unit coolers, thereby minimizing the extent of distribution ductwork within the building and providing spot cooling in certain compartments and areas of high heat release. Supply and return air ductwork is provided for unit coolers where necessary to satisfy air distribution requirements.

Each unit cooler consists of a fan plenum section and a cooling coil section. Cooling water is supplied from the SWP system (Section 9.2.1).

9.4.4.2.4 Unit Heaters Subsystem

Electric unit heaters are provided to offset building transmission heat losses, supplementing the heating coil in the supply air subsystem unit.

Each unit heater includes an electric heating element, propeller fan, casing with fan guard, and a discharge diffusion device. Each unit heater is controlled thermostatically. When required for air circulation, the unit heater fan will operate with the heating element de-energized.

9.4.4.2.5 Sample Room Air Conditioning Subsystem

The sample room is provided with sample exhaust hoods and a self-contained air conditioning unit. The air conditioning unit consists of a direct-expansion cooling coil, water-cooled condensing unit, a fan, disposable filters, and distribution ductwork. It supplies outdoor air for makeup and provides recirculation of air through the cooling coil for personnel comfort. Air is exhausted through the sample room hoods and is discharged to the turbine building exhaust air subsystem. The water-cooled condensing unit is supplied with cooling water from the TBCLCW system (Section 9.2.7).

9.4.4.2.6 Charcoal Decay-Bed Room Air Conditioning Subsystem

The charcoal decay bed room is provided with a self-contained air conditioning unit. The air conditioning unit consists of a direct-expansion cooling coil, a water-cooled condensing unit, a fan, disposable filters, and distribution ductwork.

Charcoal decay-bed room air is circulated through the air conditioning unit to maintain the required temperature. The water-cooled condensing unit is supplied with cooling water from the TBCLCW system (Section 9.2.7).

9.4.4.2.7 Elevator Machine Rooms Ventilation

The elevator machine rooms in the building are provided with fans and inlet and outlet dampers. During normal operation the fans and dampers provide ventilation in the machine rooms. They are controlled automatically by area temperature, but also can be controlled manually. In case of fire they can be used for removing smoke.

9.4.4.2.8 Smoke Removal

The turbine building is provided with roof-mounted vents for the purpose of removing smoke. The vents have fusible links and open automatically in case of fire.

9.4.4.2.9 Additional Building Cooling

To preclude inadvertent or spurious MSIV isolation and to provide additional general turbine building cooling in response to high outside air temperatures, the roof vents may be opened intermittently to lower temperatures in the main steam tunnel and turbine building.

9.4.4.3 Safety Evaluation

The turbine building HVAC system has no safety-related function. Failure or malfunction of the system will not compromise any safety-related system or component or prevent safe reactor shutdown. The following features are incorporated in the design of the system to ensure system reliability and to minimize the release of airborne radioactivity.

1. Standby supply and exhaust fans are provided to ensure full-system capacity in the event of a single fan failure. When one supply fan configuration is in operation, there are no supply fans in standby.

2. Supply fans are provided with bypass and modulating dampers arranged to maintain the building under a slight subatmospheric pressure to prevent leakage of any unmonitored, potentially contaminated air to the environment. When the turbine building roof vents are opened during operation, the turbine building differential pressure is monitored and trended to ensure the vents are not open without supplemental monitoring if the pressure reaches or exceeds atmospheric.

3. Supply air and exhaust air subsystems are provided with recirculation capability to minimize the heating load on the auxiliary electric boilers if the reactor and turbine are shut down during the winter, and to provide controls necessary to maintain subatmospheric pressure in the turbine building and adequate flow in the main stack.

4. Operating and standby supply and exhaust fans can be sequenced periodically to ensure uniform wear.

5. Exhaust air is drawn from areas of low potential contamination into and through areas of higher potential radioactive contamination.

9.4.4.4 Testing and Inspection Requirements

The system is designed to permit periodic inspection and maintenance of active components. Local display and indicating devices are provided for periodic inspection of parameters such as filter pressure drops, air flow readings, temperature readings, and other measurements required to verify continued satisfactory operation.

Ducted air flows are balanced to satisfy design requirements in accordance with procedures of the AABC.

The system is preoperationally tested to ensure it meets design requirements (Chapter 14).

9.4.4.5 Instrumentation Requirements

9.4.4.5.1 Description

Instruments and controls are provided for manual and automatic control of the turbine building HVAC system. The controls are

mounted on local panels. The monitors are located in the main control room. The control logic is shown on Figure 9.4-13.

9.4.4.5.2 Operation

For two supply fan configuration, a turbine building ventilation supply air fan starts automatically when one of the other supply fans is stopped, provided that its discharge damper is more than 40-percent open. For one supply fan configuration, there are no supply fans in standby. A fan trips automatically when there is a sustained high turbine building positive differential pressure or a sustained low discharge air flow. The associated discharge damper opens or closes automatically with the starting or stopping of the fan. The discharge damper can also be controlled manually. Interlocks prevent closing the damper while the fan is running.

The turbine building unit coolers are controlled automatically by the turbine building area temperature. The unit coolers can also be controlled manually.

The turbine building ventilation normal supply and exhaust damper and recirculation supply and exhaust dampers are manually controlled.

The turbine building ventilation supply air bypass air dampers are controlled automatically by the turbine building inside/outside differential pressure.

The turbine building unit heaters and fans are controlled automatically by the turbine building area temperature. An interlock prevents the unit heater from energizing unless the unit heater fan is running. The fan can be started manually. The unit heater and fan can be stopped by a common manual switch.

The turbine building elevator machine room ventilation fans are controlled automatically by the area temperature. The fans can also be controlled manually. The associated inlet and outlet dampers open or close automatically when the associated fan is running or not running, respectively. The dampers can also be controlled manually.

9.4.4.5.3 Monitoring

Indication is provided for:

1. Turbine building inside/outside differential pressure.

2. Turbine building ventilation supply air temperature.

3. Main stack gaseous radiation.

CRT indication is provided for:

1. Main stack gaseous radiation high.
2. Main stack radiation monitor activated.
3. Main stack loss of Allen-Bradley communication.
4. Main stack noble gas count high.
5. Main stack loss of MCA communication.
6. Main stack noble gas count low.
7. Main stack loss of power to DEC computer.
8. Main stack Allen-Bradley PLC not in run-program mode.
9. Main stack system not in remote.
10. Main stack loss of effluent flow.
11. Main stack loss of sample flow.

Alarms are provided for:

1. Turbine building ventilation system trouble.
2. Turbine building ventilation elevator machine rooms smoke detected.
3. Turbine building ventilation supply air smoke detected.
4. Turbine building area radiation monitor activated.
5. Process airborne radiation monitor activated.
6. Main stack radiation monitor activated.
7. Main stack effluent monitor trouble.

9.4.5 Service Building Heating and Ventilating System

The service building heating and ventilating system, shown schematically on Figure 9.4-2, serves the following areas:

1. Foam room and entrance corridor
2. Access passageway
3. Service water valve pit
4. I&C Shop (el 261')

Design data of principal equipment utilized in the system are listed in Table 9.4-6 (Historical).

9.4.5.1 Design Bases

The design bases for the system are:

1. To provide an environment that ensures habitability of the areas served, consistent with personnel comfort and optimum performance of equipment, within the temperature limits shown in Table 9.4-1.

2. The system is designed to nonnuclear safety standards and is not required for safe shutdown of the plant.

3. To provide filtered and tempered outdoor air for the I&C Shop.

9.4.5.2 System Description

The foam room of the service building is ventilated by one roof-mounted, 100-percent capacity exhaust roof ventilator and one outdoor air supply hood. The system is a basic once-through design. Outdoor air is induced through the intake supply hood and exhausted by the roof ventilator to maintain the space temperature. An individual space thermostat starts the fan if the temperature exceeds the thermostat setpoint.

The access passageway area is ventilated by one 100-percent capacity supply roof ventilator and one 100-percent capacity exhaust roof ventilator. The supply roof ventilator draws air from outdoors and discharges through ductwork to the ventilated area. Air from this area is exhausted, via ductwork, by the exhaust roof ventilator.

The system serving the I&C Shop (el 261') consists of a rooftop air conditioning unit with distribution ductwork and associated controls. The packaged rooftop air conditioning unit utilizes a direct-expansion cooling coil with an air-cooled condensing section. The unit contains an outdoor air/recirculation air mixing section with mixing dampers, an air filter, electric preheat coil, and one 100-percent capacity centrifugal fan.

Electric baseboard heaters are provided to offset building transmission heat losses, supplementing the preheat coil in the packaged rooftop air conditioning unit.

Thermostatically-controlled electric unit heaters maintain the foam room, entrance corridor, access passageway and the service water valve pit above the minimum design temperature during the winter. An electric duct heater in the access passageway supply air ductwork preheats the supply air to maintain a preset minimum temperature.

9.4.5.3 Safety Evaluation

The service building heating and ventilating system has no safety-related function. Failure or malfunction of the system will not compromise any safety-related system or component or prevent safe reactor shutdown.

9.4.5.4 Testing and Inspection Requirements

The system is designed to permit periodic inspection and maintenance of active components. Ducted air flows are balanced to satisfy design requirements in accordance with procedures of the AABC. The system is preoperationally tested to ensure it meets design requirements.

9.4.5.5 Instrumentation Requirements

Description

Instruments and controls are provided for automatic and manual control of the service building heating and ventilating, and air conditioning system. The controls and monitors are located locally. The control logic is shown on Figure 9.4-14.

Operation

The foam room exhaust roof ventilator is controlled automatically by an area thermostat. The ventilator can also be controlled manually.

The foam room outdoor air intake damper has been abandoned in place (closed). Intake of air is provided by roof-mounted ventilator and a backdraft damper.

The access passageway supply roof ventilator is controlled automatically by the access passageway area thermostat. The supply ventilator can also be controlled manually.

The access passageway duct heater is controlled automatically by space temperature, but can be energized only when the supply ventilator is running, the associated duct air flow is normal, and thermal cutout switches are reset.

The access passageway exhaust roof ventilator starts automatically when the supply ventilator is running and stops automatically when the supply ventilator is not running. The exhaust ventilator also can be controlled manually.

The I&C shop air conditioning system runs continuously, providing heated or cooled air, and is controlled automatically by a space heating and cooling thermostat. The outdoor air/recirculation mixing dampers modulate in response to a mixed air thermostat self contained in the unit to achieve maximum benefit of outdoor air cooling. Electric baseboard heaters are individually controlled by self-contained adjustable thermostats.

Unit heaters in the foam room, entrance corridor, access passageway and the service water valve pit are controlled automatically by area thermostats. An interlock prevents a unit heater electric heating coil from energizing unless the integral unit heater fan is running. The fan also can be started and stopped manually.

9.4.6 Diesel Generator Building Heating, Ventilating, and Air Conditioning System

The diesel generator building HVAC system is shown schematically on Figure 9.4-15a.

9.4.6.1 Design Bases

The design bases for the system are:

1. Provide an environment that ensures habitability of the areas served, consistent with personnel comfort, the diesel generators' operating mode, and optimum performance of equipment, within the temperature limits shown in Table 9.4-1.

2. Provide a normal-duty outdoor air ventilation system for removal of combustible fumes.

3. Provide a safety-related and seismically-qualified cooling system for each of the three diesel generator control rooms.

4. Provide a safety-related and seismically-qualified emergency-duty outdoor air ventilation system for each diesel generator room general area, operating when the respective diesel generator is started.

9.4.6.2 System Description

The diesel generator building HVAC system is divided into four subsystems, as follows:

1. Normal-duty heating.

2. Normal-duty ventilation.

3. Control room cooling.

4. General area emergency-duty ventilation.

Design data of principal equipment utilized in the system are listed in Table 9.4-7 (Historical).

9.4.6.2.1 Normal-Duty Heating

The diesel generator rooms are heated by thermostatically-controlled electric unit heaters, sized to maintain the rooms above the minimum design temperature (Table 9.4-1) during the winter.

9.4.6.2.2 Normal-Duty Ventilation

Each of the three diesel generator rooms has a 100-percent capacity fan that exhausts room air to the atmosphere through motor-operated dampers and associated ductwork. Makeup air is induced into each room from an adjacent corridor through fire damper-protected openings. The corridor is provided with a supply air unit consisting of a 100-percent capacity fan, filter section, electric heating coil, motor-operated damper, and associated ductwork. All openings to the atmosphere are protected by tornado dampers and are missile-proof.

9.4.6.2.3 Diesel Generator Control Room Cooling

The separate control room serving each diesel generator room is equipped with a safety-related and seismically-qualified unit cooler, and associated ductwork, to maintain the room below the maximum design temperature (Table 9.4-1). Cooling water for the unit coolers is provided from the SWP system (Section 9.2.1).

9.4.6.2.4 General Area Emergency Ventilation

Each diesel generator room has an emergency ventilation system, designed to maintain the space below the maximum design temperature (Table 9.4-1) for efficient equipment operation. Outdoor air is induced into each room through air-operated dampers and associated ductwork. Two 50-percent capacity vaneaxial fans with associated motor-operated dampers and ductwork discharge air to the atmosphere and/or recirculate it back into the room, depending on the space temperature. All openings to the atmosphere are missile and tornado protected.

9.4.6.3 Safety Evaluation

The normal-duty heating and normal-duty ventilation subsystems are not safety related or seismically qualified. Failure or malfunction of these subsystems will not compromise any safety-related system or component or prevent safe reactor shutdown.

The control room cooling and general area emergency-duty ventilation subsystems are safety related and seismically qualified and are necessary to achieve and maintain a safe shutdown condition.

Originally, the FMEA of the diesel generator building HVAC system was contained in the Unit 2 FMEA document, which is historical. FMEAs for plant systems are now performed and controlled by the design process.

9.4.6.4 Testing and Inspection Requirements

The system is designed to permit periodic inspection and maintenance of active components.

Ducted air flows are balanced to satisfy design requirements in accordance with procedures of the AABC.

The system is preoperationally tested to ensure it meets design requirements.

9.4.6.5 Instrumentation Requirements

Description

Safety-related instruments and controls are provided for automatic and manual control of the HVAC system. Except as noted, the controls and monitors are located in the main control room. The control logic is shown on Figure 9.4-16.

Operation

Each diesel generator room emergency ventilation exhaust fan starts automatically when the associated diesel generator start signal is activated. The exhaust fans are de-energized automatically upon a loss of inlet air flow. Each exhaust fan can be controlled manually. The exhaust fans for Divisions I and II also can be started manually from the local panel.

Each diesel generator room inlet air damper is interlocked with the associated exhaust fan, to open when the exhaust fan is started and to close when the exhaust fan is stopped. Each inlet air damper can be controlled manually.

Each pair of diesel generator room exhaust air and recirculation air dampers is controlled automatically by the associated room thermostat when the exhaust fan is running. The recirculation air damper opens and the exhaust air damper closes when the exhaust fan is stopped.

Each diesel generator control room unit cooler is controlled automatically by the associated control room thermostat. Each unit cooler also can be controlled manually.

Local controls are provided for the makeup air fan, makeup air heating coil, and makeup air damper; and each unit heater, normal-duty exhaust fan, and normal-duty exhaust damper.

Monitoring

Local thermostats are provided for temperature indication and adjustment. Indicators are provided in the main control room for each standby diesel generator room temperature.

Alarms are provided for:

1. Standby diesel generator room normal ventilation system trouble.

2. Standby diesel generator room divisional ventilation system inoperable.

3. Standby diesel generator room divisional ventilation system trouble.

9.4.7 Miscellaneous Buildings' Heating, Ventilating, and Air Conditioning Systems

The miscellaneous buildings' heating and ventilating or HVAC systems are shown schematically on Figure 9.4-2 and serve the following buildings and areas:

1. Screenwell building.

2. Service water pump bays.

3. Fire pump rooms.

4. Demineralizer water storage tank building.

5. CST building.

6. Electrical bay.

7. Screenhouse.

8. Chiller building.

9. CWS chemical injection and analysis facility.

Design data of principal equipment utilized in the various heating and ventilating and HVAC systems are listed in Table 9.4-8 (Historical).

9.4.7.1 Design Bases

The design bases for the systems are:

1. Provide environments that ensure habitability of the buildings and areas served, consistent with personnel comfort and optimum performance of equipment, within the temperature limits shown in Table 9.4-1.

2. Provide filtered and tempered outdoor air for ventilation, together with heating capability for the screenwell building.

3. Provide safety-related and seismically-qualified cooling system for the service water pump bays.

4. Provide a heating system and smoke removal system for the service water pump bays.

5. Provide cooling for the electric fire pump room and outdoor air for ventilation and combustion air, together with heating capability for the diesel fire pump room.

6. Provide outdoor air for ventilation, together with heating capability for the demineralized water storage tank building, CST building, and electrical bay.

9.4.7.2 System Description

9.4.7.2.1 Screenwell Building Heating and Ventilating System

The supply air portion of the screenwell building heating and ventilating system consists of three 50-percent capacity supply fans, filters, ductwork, dampers, controls, and accessories. The system is capable of supplying 100-percent outdoor air or a combination of outdoor air and recirculated room air.

Exhaust to the atmosphere is accomplished by one of two redundant roof-mounted exhaust fans and two relief vents. One relief vent is connected by ductwork to two 100-percent capacity exhaust booster fans. The exhaust booster fans draw air over the motors of the circulating water pumps and discharge the air either to the atmosphere through ductwork to the relief vent or to the supply air duct where it is used to temper makeup air from outdoors. The second relief vent is provided as a backup in the event of a failure of the exhaust booster fans.

The screen backwash pump area is ventilated with air induced from the screenwell building general area by a supply fan.

Thermostatically-controlled electric unit heaters maintain the building above the minimum design temperature (Table 9.4-1) during the winter.

9.4.7.2.2 Service Water Pump Bays' HVAC System

Each of the two service water pump bays is provided with two safety-related unit coolers to maintain the space below the maximum design temperature (Table 9.4-1). Water from the SWP system is circulated through the cooling coil of each unit cooler to provide the required cooling.

A smoke removal system consisting of an exhaust fan, isolation dampers, ductwork, controls, and accessories is provided for the service water pump bays. The smoke removal fan is connected to each bay by separate ductwork passing through missile- and

tornado-protected penetrations and has an air-operated damper for isolation.

Thermostatically-controlled electric unit heaters maintain the bays above the minimum design temperature (Table 9.4-1) during the winter.

9.4.7.2.3 Fire Pump Rooms' HVAC System

The electric fire pump room is cooled by a thermostatically-controlled 100-percent capacity unit cooler utilizing fire pump water as the source of cooling. Since the room is entirely enclosed within the screenwell building, there is negligible heat loss from the room; therefore, heating capability is not provided.

Outdoor air is supplied to the diesel fire pump room for combustion and natural cooling by a 100-percent capacity fan. Two modulating air-operated dampers are capable of supplying 100-percent outdoor air or a combination of outdoor air and recirculated room air. The room is relief-exhausted to the atmosphere through a roof-mounted relief vent. The diesel engine draws combustion air from the room.

A roof-mounted exhaust fan draws air from the screenwell area through a fire damper or exhausts a portion of the supply air to the atmosphere, depending on the mode of operation of the system, to remove possible combustible fuel fumes from the vicinity of the diesel fuel oil tank.

A thermostatically-controlled electric unit heater maintains the diesel fire pump room above the minimum design temperature (Table 9.4-1) during the winter.

9.4.7.2.4 Demineralizer Water Storage Tank Building Heating and Ventilating System

Ventilation is accomplished by a 100-percent capacity, thermostatically-controlled, roof-mounted exhaust fan. Outdoor makeup air is drawn through a louver containing an air-operated damper. Additionally, an exhaust fan, dampers and ductwork are provided to exhaust the building. Makeup air is drawn through wall openings (dampers) from the screenwell building.

Thermostatically-controlled electric unit heaters maintain the building above the minimum design temperature (Table 9.4-1) during the winter.

9.4.7.2.5 Condensate Storage Tank Building Heating and Ventilating System

Two 100-percent capacity, thermostatically-controlled, roof-mounted exhaust fans provide ventilation by inducing outdoor air through two 100-percent capacity louvers containing

air-operated dampers. Two additional 100-percent capacity exhaust fans provide exhaust venting of various tanks located in the building. Ducted air from these tanks is discharged through the main stack to the atmosphere.

Thermostatically-controlled electric unit heaters maintain the building above the minimum design temperature (Table 9.4-1) during the winter.

9.4.7.2.6 Electrical Bay Heating and Ventilating System

The heat gain in this area requires two separate outdoor air ventilating systems. During the summer, the area is ventilated with outdoor air induced through air-operated dampers by two 50-percent capacity, roof-mounted exhaust fans. During the winter, ventilation is provided by a 100-percent capacity fan drawing outdoor air, or a combination of outdoor and recirculated air, through air-operated dampers. This air is relief-exhausted to the atmosphere through a roof-mounted relief vent.

Thermostatically-controlled electric unit heaters maintain the area above the minimum design temperature (Table 9.4-1) during plant shutdown.

9.4.7.2.7 Screenhouse

Thermostatically-controlled electric unit heaters maintain the building above the minimum design temperature (see Table 9.4-1) during the winter.

9.4.7.2.8 Chiller Building

Two thermostatically-controlled, roof-mounted exhaust fans provide ventilation by inducing outdoor air through a wall-mounted louver containing an air-operated damper and a roof-mounted air supply hood.

Thermostatically-controlled electric unit heaters maintain the building above the minimum design temperature (see Table 9.4-1) during the winter.

9.4.7.2.9 CWS Chemical Injection and Analysis Facility

Heating and air conditioning of the laboratory area is provided by an air handling unit consisting of a supply fan, direct-expansion cooling coil, filters, electric heating coil, and a remote air-cooled condensing unit. Supply air is heated/cooled, filtered, and humidified as required in order to maintain the desired space temperature and relative humidity. Controls are electric.

Heating and ventilation for the chemical injection/storage area is provided by two 50-percent capacity exhaust fans and two 50-percent capacity supply fans with electric heating coils,

providing tempered air for the heating season and mechanical ventilation, as required, throughout the remainder of the year.

9.4.7.3 Safety Evaluation

The only part of the miscellaneous buildings' HVAC systems that is safety related is the cooling portion of the service water pump bays' HVAC system. Failure of this system to maintain the space temperature below the design temperature could result in the loss of operability of the service water pumps in the affected bay. This potential problem is mitigated by the provision of redundant pumps. If one pump bay is lost due to a failure of its cooling system, the redundant pump bay will replace it. The spare unit cooler in each pump bay provides an additional margin of safety.

Originally, the FMEA of the service water pump bays' HVAC system was contained in the Unit 2 FMEA document, which is historical. FMEAs for plant systems are now performed and controlled by the design process.

The other miscellaneous buildings' systems have no safety-related function and failure or malfunction of the systems will not compromise any safety-related system or component or prevent safe reactor shutdown.

9.4.7.4 Testing and Inspection Requirements

The systems are designed to permit periodic inspection and maintenance of active components. Local display and indicating devices are provided for periodic inspection of parameters such as airflow readings, temperature readings, and other measurements required to verify continued satisfactory operation of the systems.

Ducted airflows are balanced to satisfy design requirements in accordance with procedures of the AABC. The system is preoperationally tested to ensure it meets design requirements.

9.4.7.5 Instrumentation Requirements

Description

Instruments and controls are provided for automatic and manual operation of the HVAC system. The controls for the service water pump bay unit coolers described in the following paragraphs are located in the main control room. All other controls are local. The control logic is shown on Figure 9.4-17.

Operation

The screenwell building supply fan starts automatically if either of the other fans is not running and is de-energized

automatically upon a loss of discharge airflow. The fans also can be controlled manually.

In the normal mode, modulation of the screenwell building outdoor air dampers and recirculation air dampers is controlled automatically by the screenwell building space temperature, provided a supply fan is running. When no supply fan is running, the outdoor air dampers open and the recirculation air dampers close automatically.

The screenwell building roof fan starts and stops automatically when the outdoor air damper is at a predetermined open position. The fans also can be controlled manually.

The circulating water pumps' exhaust booster fans (located in screenwell building) start automatically when any pump is running and there is a low discharge air flow in the normally operating fan. The exhaust booster fans stop automatically when no circulating water pump is running or upon a loss of booster fan discharge air flow. The fans also can be controlled manually.

The service water pump bays' smoke removal fan (located in screenwell building) is started and stopped manually. An interlock prevents operation of the fan unless one of the smoke removal dampers is open. The service water pump bay smoke removal dampers are controlled manually. An override switch is provided in the main control room for smoke removal dampers.

The service water pump bays' unit coolers (located in screenwell building) are controlled automatically by the associated bay space temperature. The unit coolers also can be controlled manually from the control room.

The electrical bay supply fan is controlled manually. The electrical bay recirculation and outdoor dampers are controlled automatically by the space temperature, provided the supply fan is running. The recirculation damper closes and the outdoor air damper opens when the supply fan is not running.

The diesel fire pump room normal ventilation air fan is controlled manually.

The diesel fire pump room ventilation air fan starts automatically when the diesel engine-driven fire pump is started, and is stopped manually. The fan also can be controlled manually.

The diesel fire pump room ventilation air fan dampers are controlled automatically by the room space temperature when the diesel fire pump room ventilation fan is running. The dampers assume their respective failed positions (outdoor air damper open, recirculation air damper closed) when there is a loss of control power, or a loss of control air, or the fan is stopped.

The CST building, electrical bay, chiller building, and demineralizer water storage tank building roof fans are controlled automatically by the associated building area thermostats. Each roof fan can also be controlled manually.

The demineralizer water storage tank building exhaust fan normally operates continuously.

The CST building, electrical bay, and demineralizer water storage tank building ventilation air inlet dampers open or close automatically, provided its associated roof fan is running or not running, respectively. The dampers also can be controlled manually.

The chiller building ventilation system consists of two roof fans; one has an associated inlet damper while the inlet damper for the other has been abandoned in place (closed) and replaced with a roof-mounted ventilator for intake of outside air. The active inlet damper opens or closes automatically, provided its associated roof fan is running or not running, respectively. The damper can also be controlled manually.

The screenwell building, screenhouse electrical bay, CWS chemical injection and analysis facility, diesel fire pump room, CST building, and the chiller building unit heaters and fans are controlled automatically by the associated space temperature. An interlock prevents a unit heater coil from energizing unless the unit heater fan is running. Each unit heater and fan can be stopped by a common manual switch.

The demineralized water storage tank building unit heaters and fans are controlled automatically by the associated space temperature. The unit heaters also can be controlled manually.

The electric motor fire pump room unit cooler is controlled automatically by the room space temperature. The unit cooler also can be controlled manually.

The screen backwash pump area air circulation fan is controlled manually.

The CST building ventilation fan starts automatically if the other fan is not running and is de-energized automatically upon loss of its discharge airflow. The fans also can be controlled manually.

<u>Monitoring</u>

Alarms are provided in the control room for:

1. Screenwell building ventilation system trouble.

2. Electrical bay area ventilation system trouble.

3. CST building ventilation system trouble.

4. Service water pump bay unit cooler motor overload.

5. Service water pump bay ventilation system inoperable.

6. Screenwell building, smoke detected.

7. Chiller building roof ventilation fan motor overload.

9.4.8 Auxiliary Boiler Building Heating and Ventilating System

The auxiliary boiler building heating and ventilating system is shown on Figure 9.4-2c (Misc. HVAC Systems). Design data of principal equipment utilized in the system are listed in Table 9.4-9 (Historical).

The heating and ventilating system consists of the following subsystems:

1. Supply air.

2. Exhaust air.

3. Unit heaters.

9.4.8.1 Design Bases

The design bases for the system are:

1. To provide an environment that ensures habitability of the areas served, consistent with personnel comfort and optimum performance of the equipment, within the temperature limits shown in Table 9.4-1.

2. The system is designed to nonnuclear safety standards and is not required for safe shutdown of the plant.

9.4.8.2 System Description

9.4.8.2.1 Supply Air Subsystem

The auxiliary boiler building heating and ventilating supply air subsystem consists of two redundant, 100-percent capacity, roof-mounted air handling units, distribution ductwork, accessories, and controls. The supply air subsystem has been taken out of service by placing the air handling unit control switches in the pull-to-lock position. However, supply air can be induced to the room space through ductwork that is common to both air handling units by manually opening associated dampers as necessary. By taking the air handling units out of service and closing the recirculation damper, potential unmonitored release of radioactive air to the atmosphere through the air handling unit inlet is precluded. The air handling unit supply fans may

be operated manually to supply air to the room as necessary, provided the recirculation damper is closed and the pressure inside the room is subatmospheric.

9.4.8.2.2 Exhaust Air Subsystem

The subsystem consists of two redundant, 100-percent capacity fans, ductwork, accessories, and controls.

The fans are served by common ductwork, both inlet and discharge. Fan discharge is ducted to the reactor building vent, where the air is monitored for radioactive airborne contamination (Section 11.5) prior to discharge to atmosphere.

9.4.8.2.3 Unit Heaters Subsystem

Electric unit heaters are provided to offset building transmission heat losses.

Each unit heater includes an electric heating element, propeller fan, casing with fan guard, and a discharge air diffuser. Each unit heater is controlled thermostatically so that, when required for air circulation, the unit heater fan can be operated with the heating element de-energized.

9.4.8.3 Safety Evaluation

The auxiliary boiler building heating and ventilating system has no safety-related function. Failure or malfunction of the system will not compromise any safety-related system or component or prevent safe reactor shutdown. The following features are incorporated in the design of the system to maximize system reliability and efficiency:

1. The redundant exhaust fan is provided to ensure full system capacity with any unit inoperative due to equipment failure or maintenance outage.

2. Operating and standby equipment can be sequenced periodically to ensure uniform wear.

9.4.8.4 Testing and Inspection Requirements

The system is designed to permit periodic inspection and maintenance of active components. Local display and indicating devices are provided for periodic inspection of parameters such as air flow readings, temperature readings, and other measurements required to verify continued satisfactory operation.

The system is preoperationally tested to ensure that it meets design requirements.

9.4.8.5 Instrumentation Requirements

Description

Instruments and controls are provided for manual control of the auxiliary boiler building ventilating system, and automatic/manual control of the unit heaters subsystem. The controls described below are mounted on a local panel. The monitors described below are located in the main control room. Control logic is shown on Figure 9.4-18.

Operation

Each auxiliary boiler building ventilation air exhaust fan is controlled manually with the recirculation damper closed and the exhaust damper open.

The auxiliary boiler room air handling unit discharge air dampers are tripped closed automatically since neither fan is running. Each air damper can also be controlled manually as necessary to allow induced air into the room.

The air handling unit supply fans may be operated manually to supply air to the room as necessary, provided the recirculation damper is closed and the pressure inside the room is subatmospheric.

Unit heaters are controlled automatically by area thermostats. An interlock prevents a unit heater electric heating coil from being energized unless the integral unit heater fan is running. The fan also can be started and stopped manually.

Monitoring

Alarms are provided in the control room for auxiliary boiler room ventilation system trouble.

9.4.9 Auxiliary Service Building Heating, Ventilating, and Air Conditioning System

The auxiliary service building HVAC system is shown schematically on Figures 9.4-2d and 9.4-2e. Design data of principal equipment utilized in the system are listed in Table 9.4-10 (Historical).

9.4.9.1 Design Bases

The design bases for the system are:

1. Provide an environment that ensures habitability of the areas served, consistent with personnel comfort and optimum performance of equipment, within the temperature limits shown in Table 9.4-1.

2. Provide filtered and tempered outdoor air for all air conditioned areas.

3. The system is designed to nonnuclear safety standards and is not required for safe shutdown of the plant.

9.4.9.2 System Description

9.4.9.2.1 Auxiliary Service Building and Clean Access Area

The system consists of a rooftop air conditioning unit with distribution ductwork and associated controls. The unit serves the clean access area and all areas of the auxiliary service building except the CO_2 tank room. The exhaust system consists of two fans. One removes ducted exhaust air from the potentially contaminated areas of the auxiliary service building and discharges into the turbine building on el 277', which eventually exits to the atmosphere through the main stack via turbine building exhaust fans. The other fan removes ducted exhaust air from the decontamination rooms of the auxiliary service building and discharges to the atmosphere through the reactor building vent.

The packaged rooftop air conditioning unit utilizes a direct-expansion cooling coil with an air-cooled condensing section. The unit contains an outdoor air/recirculation air mixing section with mixing dampers, an air filter, electric preheat coil, and one 100-percent capacity centrifugal fan. The preheat coil is thermostatically controlled to maintain the required leaving air temperature.

Electric unit heaters are provided to offset building transmission heat losses, supplementing the preheat coil in the packaged rooftop air conditioning unit.

Each unit heater includes an electric heating element, propeller fan, casing with fan guard, and a discharge air diffuser. Each unit heater is controlled by an area thermostat. Unit heater fans can be operated with the heating element de-energized.

9.4.9.2.2 CO_2 Tank Room

The CO_2 tank room heating and ventilating system consists of one roof-mounted exhaust fan, a roof-mounted outdoor air intake hood with ductwork, and an air-operated damper through which makeup air is drawn.

Thermostatically-controlled electric unit heaters maintain the room above the minimum design temperature during the winter.

9.4.9.3 Safety Evaluation

This HVAC system (including CO_2 tank room) has no safety-related function. Failure or malfunction of the system will not compromise any safety-related system or component or prevent safe reactor shutdown.

9.4.9.4 Testing and Inspection Requirements

The system is designed to permit periodic inspection and maintenance of active components. Ducted air flows are balanced to satisfy design requirements in accordance with the procedures of the AABC. The system is preoperationally tested to ensure it meets design requirements.

9.4.9.5 Instrumentation Requirements

Description

Instruments and controls are provided for automatic and manual control of the system. The controls described below are mounted locally. The control logic is shown on Figure 9.4-19.

Operation

The auxiliary service building air conditioning unit is controlled manually.

Associated exhaust fans are interlocked to start or stop automatically when the air conditioning unit is started or stopped. The exhaust fans also can be controlled manually.

Duct heaters are energized and modulated automatically by space temperature, provided the duct air flow is not low and thermal cutout switches are reset.

Each CO_2 tank room unit heater is controlled automatically by a space thermostat. An interlock prevents a unit heater coil from energizing unless its associated fan is running. Each unit heater fan can be started manually. Each unit heater coil and fan can be stopped manually by a common switch.

The CO_2 tank room exhaust fan is controlled automatically by a space thermostat. The exhaust fan also can be controlled manually.

The CO_2 tank room exhaust fan is interlocked to start automatically when the CO_2 tank room air intake damper is open. The exhaust fan stops automatically when the air intake damper closes.

Monitoring

An alarm located in the main control room annunciates HVAC system trouble.

9.4.10 Plant Chilled Water System

The plant chilled water system provides the medium for removal of heat from designated areas. The plant chilled water system consists of two independent subsystems:

1. The control building chilled water subsystem (Section 9.4.10.1) is located in the control building and provides cooling for personnel and equipment in the control room, relay room, remote shutdown room, and computer room. With the exception of the computer room, the subsystem is safety related and seismically qualified.

2. The ventilation chilled water subsystem (Section 9.4.10.2) is located in the chiller building adjacent to the turbine building and provides cooling for personnel and equipment in the turbine building, the normal switchgear building, and the radwaste building. The system has no safety-related function. Failure or malfunction of the system will not compromise any safety-related system or component or prevent safe reactor shutdown.

9.4.10.1 Control Building Chilled Water Subsystem

9.4.10.1.1 Design Bases

The control building chilled water subsystem is designed in accordance with the following criteria:

1. Piping, coils, pumps, and chillers are "N" stamped according to ASME Section III, Subsection ND, Safety Class 3.

2. Coil support sections are built in accordance with ASME Section III, Subsection NF, Safety Class 3.

3. The computer room air conditioning units are nonsafety related and can be isolated from their respective safety-related chilled water trains with safety-related isolation valves.

The control building chilled water subsystem is shown schematically on Figure 9.4-1a. Design data of principal equipment utilized in the subsystem are listed in Table 9.4-11 (Historical).

9.4.10.1.2 System Description

The control building chilled water subsystem supplies chilled water during normal operation, plant shutdown, and DBA conditions to air conditioning units serving the control room, relay room, remote shutdown room, and computer room.

The subsystem is closed loop, and consists of two redundant chilled water trains, A and B. Each train is capable of meeting total chilled water demand, utilizing one hermetic centrifugal

water chiller, one chilled water circulating pump, one expansion tank, controls, and piping.

With one redundant (divisional) chilled water train operating, only one remote shutdown room air conditioning unit is running. The remote shutdown rooms are separated by a fire-rated wall such that the rooms are isolated. Thus, the air conditioning unit in one remote shutdown room does not provide cooling air to the other remote shutdown room. With this present system design, an auto start of a remote shutdown air conditioning unit in the same division as the redundant standby chiller initiates a start of that chiller. The chillers are sized such that the remote shutdown air conditioning unit that auto starts, based on the room temperature, does not present an adequate load for the train and places the water chiller in jeopardy of a trip. Therefore, both redundant chilled water trains are operated, with one major load (i.e., control room or relay room) assigned to each running train.

Water is provided to each chiller from the SWP system (Section 9.2.1). Each chilled water train, A and B, has separate condenser water connections to the corresponding A and B loops of the SWP system. The SWP system is capable of supplying water to the chiller condensers during all modes of plant operation.

Makeup water for the control building chilled water subsystem is normally derived from the plant makeup water system (Section 9.2.3). During accident conditions makeup water can be manually diverted from the SWP system.

9.4.10.1.3 Safety Evaluation

The control building chilled water subsystem is designed to perform during normal operation, plant shutdown, or accident conditions without loss of function. Each chilled water train is capable of meeting the total chilled water demand on the subsystem. The subsystem is designed to Category I criteria and conforms to the single-failure criterion. The subsystem receives electrical power from two offsite sources during normal operation and from redundant standby diesel generators if offsite power is lost. Equipment is located in the control building which is a tornado-proof, Category I structure. Each chiller and its associated equipment is located in a separate equipment room. The two chilled water trains are physically separated and protected with a barrier (Section 3.5.3). The walls, floor, and ceiling of each chiller equipment room are of 3-hr fire-rated construction. Doors are Class A fire doors in compliance with NFPA 80. Smoke and fire detectors are located in each equipment room and are annunciated in the main control room. Fire protection is described in Section 9.5.1. The equipment rooms are provided with ventilation and heating (Section 9.4.1).

The SWP system is a safety-related, seismically-qualified, fully redundant system, and is designed to assure an uninterruptible

supply of water to the chillers. In the unlikely event both chilled water trains fail, service water can be utilized for emergency cooling. Switchover from the chilled water system to the SWP system (standby mode) is manual.

The refrigeration system of each chiller utilizes a nonflammable refrigerant, R-11 (trichlorofluoromethane), which is classified in Group 1, the least hazardous, in the safety code for mechanical refrigeration (ANSI B9.1). To prevent a refrigerant barrier failure due to loss of coolant, condenser cooling water temperature is monitored. An increase in the condenser cooling water temperature above a preset level initiates an alarm in the main control room. If corrective action is not taken, the refrigerant system high-pressure cutout stops the chiller and another alarm is initiated in the main control room.

The refrigeration system of each chiller has a rupture disc designed to relieve excess pressure. Rupture disc discharge is piped outside the building.

Originally, the FMEA of the control building chilled water systems was contained in the Unit 2 FMEA document, which is historical. FMEAs for plant systems are now performed and controlled by the design process.

9.4.10.1.4 Testing and Inspection Requirements

The subsystem is designed to permit periodic inspection and maintenance of active components. Instruments and controls are provided for testing of the subsystem during normal Station operation or scheduled shutdown. Water flow rates are balanced and set to achieve design flow conditions. Flow elements for flow measurement are provided.

9.4.10.1.5 Instrumentation Requirements

Safety-related instrumentation and controls are provided for automatic and manual control of chilled water to the air conditioning units for the control, relay, remote shutdown, and computer rooms.

The controls and monitors described herein are located in the main control room. The control logic is shown on Figure 9.4-20.

<u>Operation</u>

The chilled water circulating pumps start automatically when the associated control room, relay room, remote shutdown, or computer room air conditioning fan is running. The pumps stop automatically when no fan is running or the associated chilled water flow is low. The pumps also can be controlled manually.

The chiller compressors start automatically when the associated control room, relay room, remote shutdown, or computer room air

conditioning fan is running. The compressors stop automatically when no fan is running. Interlocks prevent the compressors from starting (or trip them off if running) when the associated compressor auxiliary oil pump is not running or when the chilled water flow through the evaporator is low. The chiller compressors also can be controlled manually.

The chiller compressor auxiliary oil pumps start automatically when the associated control room, relay room, remote shutdown, or computer room air conditioning fan is running. The oil pumps stop automatically when no fan is running.

The computer room air conditioning chilled water inlet valves are controlled manually. Interlocks prevent the inlet valves from opening (or trip them closed if open) when the chilled water expansion tank level is low.

The control building chilled water temperature control valves are controlled automatically by the control room temperature. The valves control chilled water flow to the associated air conditioning units. The valves open fully when the control building return air temperature is sensed at high-high.

Monitoring

Alarms are provided for:

1. Chilled water circulating pump, auto trip/fail to start, and flow low.

2. Service water to chiller no flow.

3. Chiller compressor refrigerant pressure low, refrigerant pressure high, oil pressure low, auto start, auto trip/fail to start, oil temperature high, discharge temperature high, and purge high.

4. Chilled water expansion tank water level high/low-low.

5. Chilled water system inoperable.

6. Computer room air conditioning inlet valve closed.

9.4.10.2 Ventilation Chilled Water Subsystem

9.4.10.2.1 Design Bases

The ventilation chilled water subsystem is designed in accordance with the following criteria:

1. Piping and valves are in accordance with the power piping code, ANSI B31.1.

2. Equipment conforms to the codes and standards of IEEE and NEMA MG1.

The ventilation chilled water subsystem is shown schematically on Figure 9.4-3. Design data of principal equipment utilized in the subsystem are listed in Table 9.4-11 (Historical).

9.4.10.2.2 System Description

The ventilation chilled water subsystem supplies chilled water during normal operation to cool outdoor air used for ventilation in the turbine building, normal switchgear building, radwaste building and radwaste decontamination general area.

The subsystem consists of three 50-percent capacity hot water absorption liquid chillers, two 100-percent capacity service water pumps, two 100-percent capacity chilled water circulating pumps, one expansion tank, controls, and piping.

Water is provided to each chiller from the SWP system (Section 9.2.1). Hot water is provided to the generator shell of each chiller from the plant hot water heating system (Section 9.4.12).

9.4.10.2.3 Safety Evaluation

A redundant chiller, condenser water pump, and chilled water circulating pump are provided; however, the subsystem has no safety-related function. Failure or malfunction of the system will not compromise any safety-related system or component or prevent safe reactor shutdown.

9.4.10.2.4 Testing and Inspection Requirements

The subsystem is designed to permit periodic inspection and maintenance of active components. The system is preoperationally tested to ensure it meets design requirements. Instruments and controls are provided for testing of the subsystem during normal operation or scheduled shutdown. Water flow rates are balanced and set to achieve design flow conditions. A separate flow switch functions to shut down each chiller upon loss of chilled water flow or condenser water flow.

9.4.10.2.5 Instrumentation Requirements

Description

Instruments and controls are provided for automatic and manual control of the ventilation chilled water system. The controls described below are located locally. The monitors described below are located locally and in the main control room. The control logic is shown on Figure 9.4-21.

Operation

The standby chilled water pump starts automatically when the operating pump stops and the chiller run required signal is present. Interlocks are provided to stop the pump when pump discharge pressure is sustained low, or prevent starting when the pump suction pressure is low. The pumps can also be controlled manually.

The normal switchgear building, turbine building, and radwaste building chilled water temperature control valves are automatically controlled by the associated supply air fan discharge temperature to maintain the air temperature at the setpoint.

Monitoring

Local alarms are provided for AUTO-TRIP/FAIL TO START, SUCTION AND DISCHARGE PRESSURE LOW, and MOTOR ELECTRICAL FAULT. A common alarm for ventilation chilled water trouble is located in the main control room.

9.4.11 Plant Glycol Heating System

The plant glycol heating system functions with the plant hot water heating system (Section 9.4.12) to heat outdoor makeup air used for ventilation.

Hot water from the plant hot water heating system is used to heat the ethylene glycol solution to its required design temperature. The heated glycol solution is then circulated through outdoor makeup air preheating coils, thereby preventing freezeup of the coils when the outdoor temperature is below freezing, while heating the outdoor air to the design temperature.

9.4.11.1 Design Bases

The design bases for the system are:

1. Provide the medium needed to heat outdoor makeup air used for ventilation in the turbine building, reactor building, and radwaste building in accordance with the design temperatures listed in Table 9.4-1 while preventing freezeup of the preheating coils when the outdoor temperature is below freezing.

2. Provide piping and valves designed in accordance with ANSI B31.1 and miscellaneous equipment conforming to ASME Section VIII.

3. The system has no safety-related function. Failure or malfunction of the system will not compromise any safety-related system or component or prevent safe reactor shutdown.

9.4.11.2 System Description

The plant glycol heating system and the associated plant hot water heating system are shown on Figure 9.4-22. Design data of principal system components are listed in Table 9.4-12 (Historical).

The plant glycol heating system consists of three subsystems. One subsystem, located in the turbine building, serves the turbine building HVAC system (Section 9.4.4). The second subsystem, located in the standby gas treatment building, serves the reactor building HVAC system (Section 9.4.2). The third subsystem, located in the radwaste building, serves the radwaste building HVAC system (Section 9.4.3). The subsystems are not interconnected.

Each glycol subsystem contains one 100-percent capacity glycol heat exchanger, two 100-percent capacity glycol circulating pumps, one expansion tank, glycol addition tank, glycol drainage tank, air separator, one outdoor air preheating coil assembly, piping, valves, instrumentation, and controls.

Each glycol heat exchanger is connected to a separate hot water heating loop (Section 9.4.12). The three glycol heat exchanger loops are not interconnected.

A glycol addition tank is provided for the makeup of glycol to the system to maintain a 50/50 mixture. Makeup of glycol solution water to each glycol heat exchanger loop is from the demineralized water system (Section 9.2.3) controlled by a self-contained pressure-reducing valve.

9.4.11.3 Safety Evaluation

In each subsystem, a redundant glycol circulation pump is provided to ensure full subsystem capacity in the event of a single pump failure.

The ethylene glycol-water solution is used to prevent freezeup of outside air heating coils.

The system has no safety-related function. Failure or malfunction of the system will not compromise any safety-related system or component or prevent safe reactor shutdown.

9.4.11.4 Testing and Inspection Requirements

The plant glycol heating system is designed to permit periodic inspection and maintenance of active components. Local display and indicating devices are provided for periodic inspection of parameters such as glycol flow readings, temperature readings, strainer pressure drops, and other measurements required to verify continued satisfactory operation of the system.

The system is preoperationally tested to ensure it meets design requirements.

9.4.11.5 Instrumentation Requirements

Description

Instruments and controls are provided for manual and automatic control of the plant glycol heating system. The controls are mounted on local panels. The monitors described below are located in the main control room. The control logic is shown on Figure 9.4-23.

Operation

The turbine building, reactor building, and radwaste building glycol heating pumps are controlled automatically by the associated building outdoor air temperature. The redundant pump starts automatically if the operating pump fails, provided the redundant pump suction pressure is normal. Interlocks automatically trip a pump when the discharge pressure is low or the suction pressure is low. The pumps also can be controlled manually.

Monitoring

Alarms are provided for:

1. Turbine building vent/glycol system trouble.

2. Reactor building vent/glycol system trouble.

3. Radwaste building vent/glycol system trouble.

9 4.12 Plant Hot Water Heating System

The plant hot water heating system functions with the plant glycol heating system (Section 9.4.11) to heat outdoor makeup air used for ventilation.

Hot water is generated from steam and is circulated through hot water to glycol heat exchangers. The heated glycol solution is then circulated through outdoor makeup air preheating coils, thereby preventing freezeup of the coils when the outdoor temperature is below freezing, while heating the outdoor air to the required temperature.

The plant hot water heating system is equipped with piping connections to allow this system to be connected to a temporary hot water heating plant. This will only be used if the plant hot water heating system is not available and glycol heating in the reactor building is needed.

9.4.12.1 Design Bases

The design bases for the system are:

1. Provide the source of heat required to maintain the glycol solution at its design temperature.

2. Provide an intermediate step of separation between the contaminated steam, used as the heat source, and the glycol heating system.

3. Provide piping and valves designed in accordance with ANSI B31.1 and miscellaneous equipment conforming to ASME Section VIII.

4. The system is designed to nonnuclear safety standards and is not required for safe shutdown of the plant.

9.4.12.2 System Description

The plant hot water heating system and the associated plant glycol heating system are shown on Figures 9.4-22a through 9.4-22e.

The plant hot water heating system consists of two 100-percent capacity hot water recirculation pumps, two 70-percent capacity intermediate heat exchangers, two 70-percent capacity auxiliary heat exchangers, one expansion tank, nitrogen bottles, two 100-percent capacity makeup water pumps, one air separator, piping, valves, instrumentation, and controls.

The system is designed to provide hot water when:

1. The reactor is shut down.

2. The reactor is on-line but operating below approximately 61-percent power.

3. The reactor is on-line and operating above approximately 61-percent power.

During each of the above plant conditions a different source of steam is used to heat the hot water:

1. Reactor shutdown Electric boiler steam is used in conjunction with the building heating auxiliary heat exchangers to heat the 300 psig hot water.

2. Reactor operating at >5 percent and <61 percent (approximately) Reactor steam from the auxiliary steam system is supplied in the building heating intermediate heat exchangers to heat the 300 psig hot water.

3. Reactor operating at >61 percent (approximately) Extraction steam from the supply to the fifth-point

extraction heater is supplied to the building heating intermediate heat exchanger to heat the 300 psig hot water.

Steam is supplied to the shell side of both the building heating auxiliary heat exchangers and the intermediate heat exchangers. The intermediate heat exchangers drain to the main steam condenser and the auxiliary heat exchangers drain to the auxiliary boiler deaerator.

The hot water recirculating pump circulates water through the building heating intermediate heat exchangers or the building heating auxiliary heat exchangers. The heated water then passes through one of three sets of water-to-glycol heat exchangers: reactor building glycol heat exchangers, turbine building glycol heat exchangers, or radwaste building glycol heat exchangers.

Sampling valves are installed in the hot water supply main, downstream from the intermediate heat exchangers, for radioactive sampling. The plant hot water heating system is pressurized to maintain minimum pressure of the system above the vapor pressure of the fluid in the system based on maximum fluid temperature. Additionally, hot water pressure on the tube side of the steam-to-hot-water heat exchangers is maintained higher than the pressure of the radioactive steam on the shell side to preclude in-leakage of the radioactive steam. Nitrogen is used for system pressurization to minimize oxidation of the piping system. Initial filling and normal makeup of the system will be with demineralized water from the demineralized water system or alternative water sources (Section 9.2.3).

9.4.12.3 Safety Evaluation

A redundant hot water heating pump and redundant makeup water pump are provided to ensure full system capacity in the event of a single pump failure.

The system has no safety-related function. Failure or malfunction of the system will not compromise any safety-related system or component or prevent safe reactor shutdown.

9.4.12.4 Testing and Inspection Requirements

The plant hot water heating system is designed to permit periodic inspection and maintenance of active components. Local display and indicating devices are provided for periodic inspection of parameters such as water flow readings, temperature readings, strainer pressure drops, and other measurements required to verify continued satisfactory operation of the system.

The system is preoperationally tested to ensure it meets design requirements.

9.4.12.5 Instrumentation Requirements

Description

Instruments and controls are provided for manual and automatic control of the plant hot water heating system. The controls are mounted on local panels.

Operation

The steam-to-hot-water intermediate heat exchangers temperature control valves are controlled automatically by the associated hot water discharge temperature. A temperature control valve automatically trips closed when its associated hot water discharge shutoff valve is closed or when both hot water heating pumps are stopped. Hot water discharge shutoff valves are controlled manually.

The auxiliary heat exchangers shutoff valve is controlled manually. Interlocks prevent opening the valve on high water level in either of the heat exchangers, and automatically close the valve on high water level.

The hot water heating pumps are started and stopped manually. Interlocks prevent starting a pump on low suction pressure, and automatically trip a pump when the discharge pressure is low or when both glycol pumps are not running.

Reactor building, turbine building, and radwaste building hot water to glycol temperature control valves are controlled automatically by the respective supply air discharge temperature.The makeup water pumps are controlled automatically by hot water expansion tank level. An interlock starts the redundant hot water booster pump if the operating pump stops. The booster pump also stops or is prevented from starting on sustained discharge pressure low. The booster pump discharge valves are controlled automatically by the pump. The pumps and valves also can be operated manually.

The hot water heating hot water booster pumps are controlled automatically. An interlock starts the redundant pump automatically when the operating pump stops running. The pumps also can be controlled manually.

Monitoring

An alarm is provided for plant hot water heating system trouble.

TABLE 9.4-1

ENVIRONMENTAL AND SYSTEM DESIGN PARAMETERS FOR HVAC SYSTEMS

Normal Operation - Indoor Conditions

Building/Area	Temperature Range (°F)	Relative Humidity Range (%)	Pressure (in. W.G.)
Control building			
El 306'			
Control room[1][11]	70-85[1]	20-65	+0.125[8]
Remaining areas	65-104	20-65	+0.125[8]
El 288'-6"			
Relay room[3][11]	60-85[3]	20-65	+0.125[8]
Computer room	60-80	20-65	+0.125[8]
Remaining areas	65-104	20-65	+0.125[8]
El 261'			
Remote shutdown room[4]	65-85[4]	20-65	Atmospheric
Cable chases and corridors	65-110	20-90	Atmospheric
Remaining areas	65-104	20-90	Atmospheric
El 244' and 237'			
Record storage vault	65-85	20-65	Atmospheric
Remaining areas	50-108[9]	20-90	Atmospheric
El 214'			
All areas	50-104[9]	20-90	Atmospheric
Normal switchgear building	65-104	20-90	Atmospheric
Electrical tunnels	50-104[5]	20-90	Atmospheric
Turbine building			
Overhead operating floor	50-120	20-90	Subatmospheric
Above operating floor	65-104	20-65	Subatmospheric
Below operating floor			
Equipment area			
Electrical	65-104	20-90	Subatmospheric
Non-electrical	65-110	20-65	Subatmospheric
Charcoal decay room	65-85	20-65	Subatmospheric
Sample room	65-85	20-65	Subatmospheric
Steam tunnel	65-130	20-90	Subatmospheric
Radwaste building			
Control room	70-85	20-70	Atmospheric
Equipment area			
Electrical	65-104	20-90	Atmospheric
Non-electrical	65-110	20-90	Subatmospheric

TABLE 9.4-1 (Cont'd.)

Building/Area	Temperature Range (°F)	Relative Humidity Range (%)	Pressure (in. W.G.)
Reactor building**			
General areas	70-104	20-65	Subatmospheric
Pump, heat exchanger and tank rooms	70-120*	20-65	Subatmospheric
Auxiliary bays pump and heat exchanger rooms	65-120*	20-65	Subatmospheric
Auxiliary bays electrical equipment rooms	65-104(10)	20-65	Atmospheric
Pipe cases	65-120	20-65	Subatmospheric
Drywell			
General areas	70-150	20-100	+13.84 to 27.68
Upper dome area	70-150	20-100	+13.84 to 27.68
Area beneath RPV	70-150	20-100	+13.84 to 27.68
RPV support skirt area	70-150	20-100	+13.84 to 27.68
Screenwell building			
General areas	65-104	20-90	Atmospheric
Circulating water pump area	65-104	20-90	Atmospheric
Screen backwash pump area	65-104	20-90	Atmospheric
Service water pump bays	65-104	20-90	Atmospheric
Fire pump rooms	65-104	20-90	Atmospheric
Demineralized water storage tank building	65-104	20-90	Atmospheric
Condensate storage tank building	65-104	20-90	Atmospheric
Electrical bay	65-104	20-90	Atmospheric
Service building	65-104	20-90	Atmospheric
Access passageway	65-104	20-90	Atmospheric
Auxiliary boiler building	65-104	20-90	Atmospheric/Subatmospheric
Diesel generator building			
Control rooms	65-104	20-90	Atmospheric
Remaining areas	65-125*	20-90	Atmospheric
Auxiliary service building	65-104(5)	20-65	Atmospheric
Standby gas treatment building			
HVAC equipment rooms	65-104	20-90	Atmospheric
SGTS filter rooms	65-104	20-65	Atmospheric

TABLE 9.4-1 (Cont'd.)

Building/Area	Temperature Range (°F)	Relative Humidity Range (%)	Pressure (in. W.G.)
Screenhouse	65-104	20-90	Atmospheric
Main stack structure	65-104	20-90	Atmospheric
Chiller building	65-104	20-90	Atmospheric
CWS chemical injection and analysis facility Chemical injection/storage area	65-104	20-90	Atmospheric

* When equipment is operating. Maximum design temperature for RHR valve room (SC240140) is 134.5°F.

** Reactor building post-LOCA temperature range is 135-140°F except for the MCC and the RCIC rooms.

(1) All safety-related equipment located in the control room is qualified to an ambient temperature of 120°F within the panel. The maximum ambient temperature in the control room is limited to 90°F, which provides a margin to account for internal temperature rise within the safety-related control room panels.

(2) Design maximum indoor temperatures for safety-related equipment are based on safety-related cooling system performance utilizing the design maximum service water temperature of 84°F and the summer outdoor design maximum temperature of 100°F dry-bulb and 73°F wet-bulb. All safety-related equipment is qualified to the specified conditions.

(3) All safety-related equipment located in the relay room is qualified to an ambient temperature of 120°F within the panel. The maximum ambient temperature in the relay room is limited to 90°F, which provides a margin to account for internal temperature rise within safety-related relay room panels.

(4) All safety-related equipment located in the remote shutdown panel is qualified to an ambient temperature of 120°F within the panel and a maximum ambient of 104°F external to the panel.

(5) Unit coolers 2HVC*UC104 and 105 may be taken out of service without a LCO per Safety Evaluation 93-021. Temperatures for the following areas exceed the maximum design temperatures when the above unit coolers are out of service and a LOCA occurs:

Area	Temperature °F
Electrical tunnels	137[6]
Auxiliary services building	135[7]

(6) With the exception of redundant UPS units 2VBA*UPS2C and 2VBA*UPS2D, equipment located in these areas is either designed to operate following a LOCA for a minimum of 100 days, or if equipment fails, it will fail safe and will not interfere with other safety functions. The UPS equipment is qualified for operation at up to 122°F. Direction regarding maintaining the operability of this equipment with unit coolers out of service is provided in the associated operating procedure.

(7) Areas containing safety-related equipment on el 261' have a maximum design temperature of 104°F.

(8) +0.125 in W.G. pressure during and after a radiological accident. Slightly positive pressure during normal plant operation.

TABLE 9.4-1 (Cont'd.)

(9) Unit coolers 2HVC*UC106 and 107 may be taken out of service without a LCO per Safety Evaluation 93-021 when redundant UPS units 2VBA*UPS2C and 2D (and associated equipment) are de-energized. Temperatures for the following areas exceed the maximum design temperatures when the above unit coolers are out of service and a LOCA occurs:

Area	Temperature, °F
El 244' and 237'	
Remaining Areas	133°F
El 214'	
All Areas	117°F

With the exception of redundant UPS units 2VBA*UPS2C and 2D, equipment located in these areas is either designed to operate following a LOCA for a minimum of 100 days, or if equipment fails, it will fail safe and will not interfere with other safety functions. The redundant UPS units are qualified for operation at up to 122°F. Direction regarding maintaining operability of the UPS units with unit coolers out of service is provided in the associated operating procedure.

(10) Room temperatures in the reactor building auxiliary bays electrical equipment room may drop as low as 55°F in the winter months, since the room heaters are kept de-energized to satisfy the secondary containment drawdown requirements. The safety-related electrical equipment in these rooms can operate as low as 32°F ambient conditions with no detrimental effects as documented in the environmental qualification reports.

(11) The relative humidity range for the control room and relay room are nominal values.

NOTES:
a. Summer outdoor design conditions are 93°F dry-bulb (see Note 2 for the safety-related areas) and 73°F wet-bulb.
b. Winter outdoor design conditions are -10°F dry-bulb (for computing transmission loss) and -20°F dry-bulb (for sizing outdoor makeup air heating coils).
c. The summer and winter outdoor design conditions for computing transmission loss, as referenced in Notes a and b, respectively, are based on data for Oswego, New York, derived from the Carrier System Design Manual, Part 1 (Load Estimating), 9th Printing, 1972. The use of -20°F for sizing heating coils is additional conservatism applied over and above the Carrier literature.

TABLE 9.4-2 (Historical)

DESIGN DATA OF PRINCIPAL EQUIPMENT -
CONTROL BUILDING AND NORMAL SWITCHGEAR BUILDING HVAC SYSTEMS

<u>El 306' and Main Control Room Air Conditioning Units</u>	
Equipment Mark No.	2HVC*ACU1A, 1B
Quantity	2 (100% capacity each)
Type	Central station, draw-through
Each system includes the following components:	
1. Supply Fan:	
Type	Centrifugal
Capacity, cfm	23,280
Total pressure, in W.G.	4.94
Motor, hp	40
2. Filters:	
Equipment Mark No.	2HVC*FLT1A, 1B
Type	Disposable, dual flow
Media, normal flow	Fiberglass
Media, bypass flow	Fiberglass/charcoal/ Fiberglass
Efficiency, NBS dustspot, %	
Normal flow	50
Bypass flow	99
3. Cooling Coil:	
Type	Finned, tubular
Cooling medium	Chilled water
Cooling capacity, mbh	708.0
4. Duct Heaters:	
a. Equipment Mark No.	2HVC*CH11A, 11B
Quantity	2
Type	Electric
Capacity, each, kW	60
b. Equipment Mark No.	2HVC-CH1
Quantity	1
Type	Electric
Capacity, kW	6
c. Equipment Mark No.	2HVC-CH2
Quantity	1
Type	Electric
Capacity, kW	40

TABLE 9.4-2 (Historical)
(Cont'd.)

d. Equipment Mark No.	2HVC-CH8, CH9
Quantity	2
Type	Electric
Capacity, each, kW	4.4
5. Baseboard Heaters:	
a. Equipment Mark No.	2HVC-H1K
Quantity	1
Type	Electric
Capacity, kW	1.25
b. Equipment Mark No.	2HVC-H3A, 3H, 1L
Quantity	3
Type	Electric
Capacity, each, kW	1.5
c. Equipment Mark No.	2HVC-H1A, 1B
Quantity	2
Type	Electric
Capacity, each, kW	2
d. Equipment Mark No.	2HVC-H1C, 1D, 1E, 1F, 1G, 1H, 1J, 1M, 1N, 1P, 1Q, 1R, 1S
Quantity	13
Type	Electric
Capacity, each, kW	2.5
El 288' and Relay Room Air Conditioning Units	
Equipment Mark No.	2HVC*ACU2A, 2B
Quantity	2 (100% capacity each)
Type	Central station, draw-through
Each system includes the following components:	
1. Supply Fan:	
Type	Centrifugal
Capacity, cfm	26,185
Total pressure, in W.G.	5.0
Motor, hp	40
2. Filter:	
Type	Disposable
Media	Fiberglass
Efficiency, NBS dustspot, %	50

TABLE 9.4-2 (Historical)
(Cont'd.)

3. Cooling Coil:	
Type	Finned, tubular
Cooling medium	Chilled water
Cooling capacity, mbh	778
4. Duct Heaters:	
a. Equipment Mark No.	2HVC*CH12A, 12B
Quantity	2
Type	Electric
Capacity, each, kW	40
b. Equipment Mark No.	2HVC-CH4
Quantity	1
Type	Electric
Capacity, kW	26
c. Equipment Mark No.	2HVC-CH3
Quantity	1
Type	Electric
Capacity, kW	6
5. Baseboard Heaters:	
Equipment Mark No.	2HVC-H2A, 2B, 2C, 2D, 2E, 2F, 2G, 2H
Quantity	8
Type	Electric
Capacity, each, kW	2.5
<u>Computer Room Air Conditioning Units</u>	
Equipment Mark No.	2HVC-ACU4A, 4B
Quantity	2 (100% capacity each)
Type	Package
Number of fans per each unit	2
Supply fan capacity, each, cfm	5,000
Total pressure, each, in W.G.[(1)]	1.68
Supply fan motor, each, hp	7.5
Cooling medium	Chilled water
Cooling capacity, each, mbh	350.3
Heating medium	Electric
Heating capacity, each, kW	30
Humidifier type	Infrared
Humidifier capacity, each, water, lb/hr	22.1

The units are provided with the following outdoor air booster fans connected in series:

TABLE 9.4-2 (Historical)
(Cont'd.)

Equipment Mark No.	2HVC-FN17, 18
Quantity	2 (50% s.p. each)
Type	Vaneaxial
Capacity, each, cfm	120
Total pressure, each, in W.G.(2)	0.50
Motor, each, hp	1/12
<u>Remote Shutdown Room Air Conditioning Units</u>	
Equipment Mark No.	2HVC*ACU3A, 3B
Quantity	2 (100% capacity each)
Type	Central station, draw-through
Supply fan capacity, each, cfm	1,500
Total pressure, each, in W.G.	2.36
Supply fan motor, each, hp	2
Cooling medium	Chilled water
Cooling capacity, each, mbh	36.5
<u>Record Storage Vault Air Conditioning Unit</u>	
Equipment Mark No.	2HVC-ACU5/2HVC-CND1
Type	Split system
Supply fan capacity, cfm	1,800
Total pressure, in W.G.(1)	0.84
Supply fan motor, hp	1
Cooling medium	Refrigerant R-22
Cooling capacity, mbh	48.0
Heating medium	Electric
Heating capacity, kW	14.7
Humidifier type	Infrared
Humidifier capacity, water, lb/hr	11.0
<u>Unit Coolers</u>	
1. Standby Switchgear Rooms - Division I and II	
Equipment Mark No.	
Division I	2HVC*UC101A, 108A
Division II	2HVC*UC101B, 108B
Quantity	
Division I	2
Division II	2
Units 2HVC*UC101A and 101B include the following components:	

TABLE 9.4-2 (Historical)
(Cont'd.)

a. Fan:

Type	Vaneaxial
Capacity, each, cfm	10,000
Total pressure, each, in W.G.	2.5
Motor, each, hp	7.5

b. Cooling coil:

Type	Finned, tubular
Cooling medium	Service water
Cooling capacity, each, mbh	185

c. Filter:

Type	Disposable
Media	Fiberglass
Efficiency, NBS dustspot, %	50

Units 2HVC*UC108A and 108B include the following components:

a. Fan:

Type	Vaneaxial
Capacity, each, cfm	14,000
Total pressure, each, in W.G.	2.8
Motor, each, hp	10

b. Cooling Coil:

Type	Finned, tubular
Cooling medium	Service water
Cooling capacity, each, mbh	265.0

c. Filter:

Type	Disposable
Media	Fiberglass
Efficiency, NBS dustspot, %	50

2. Standby Switchgear Room - Division III

Equipment Mark No.	2HVC*UC102

The unit cooler includes the following components:

TABLE 9.4-2 (Historical)
(Cont'd.)

a. Fan:	
Type	Vaneaxial
Capacity, cfm	5,000
Total pressure, in W.G.	2.6
Motor, hp	5
b. Cooling Coil:	
Type	Finned, tubular
Cooling medium	Service water
Cooling capacity, mbh	95.0*
c. Filter:	
Type	Disposable
Media	Fiberglass
Efficiency, NBS dustspot, %	50
3. Chiller Equipment Rooms	
Equipment Mark No.	2HVC*UC103A, 103B
Quantity	2 (one/room)
Each unit cooler includes the following components:	
a. Fan:	
Type	Propeller
Capacity, cfm	3,000
Total pressure, in W.G.	0.75
Motor, hp	1
b. Cooling Coil:	
Type	Finned, tubular
Cooling medium	Service water
Cooling capacity, mbh	55
c. Filter:	
Type	Disposable
Media	Fiberglass
Efficiency, NBS, dustspot, %	18
4. Electrical Tunnel - Division I	
Equipment Mark No.	2HVC*UC104

* The specified value represents the capacity of the cooler at original plant design conditions. Changes in capacity due to variations in plant conditions are addressed in the associated system design calculations.

TABLE 9.4-2 (Historical)
(Cont'd.)

The unit cooler includes the following components:

a. Fan:

Type	Vaneaxial
Capacity, cfm	10,000
Total pressure, in W.G.	4.5
Motor, hp	15

b. Cooling Coil:

Type	Finned, tubular
Cooling medium	Service water
Cooling capacity, mbh	185

c. Filter:

Type	Disposable
Media	Fiberglass
Efficiency, NBS dustspot, %	55

5. Electrical Tunnel - Division II

Equipment Mark No.	2HVC*UC105

The unit cooler includes the following components:

a. Fan:

Type	Vaneaxial
Capacity, cfm	3,600
Total pressure, in W.G.	3.9
Motor, hp	5

b. Cooling Coil:

Type	Finned, tubular
Cooling medium	Service water
Cooling capacity, mbh	65

c. Filter:

Type	Disposable
Media	Fiberglass
Efficiency, NBS dustspot, %	55

6. Cable Area - Divisions I and II

Equipment Mark No.	2HVC*UC106, 107
Quantity	2 (one/area)

Each unit cooler includes the following components:

TABLE 9.4-2 (Historical)
(Cont'd.)

a. Fan:	
Type	Vaneaxial
Capacity, cfm	11,100
Total pressure, in W.G.	5.0/4.50
Motor, hp	15
b. Cooling Coil:	
Type	Finned, tubular
Cooling medium	Service water
Cooling capacity, mbh	205.0
c. Filter:	
Type	Disposable
Media	Fiberglass
Efficiency, NBS dustspot, %	55
Control Room Emergency Filtration System	
Equipment Mark No.	2HVC*FLT2A, 2B
Quantity	2 (100% capacity each)
The system includes the following components:	
1. Booster Fans:	
Equipment Mark No.	2HVC*FN2A, 2B
Quantity	2 (100% capacity each)
Type	Centrifugal
Capacity, each, cfm	2,250
Total pressure, each, in W.G.[(2)]	12.0
Motor, each, hp	10
2. Heating Coil:	
Equipment Mark No.	2HVC*CH7A, 7B
Quantity	2 (one/filter train)
Type	Electric
Capacity, each, kW	10
3. Transformer:	
Equipment Mark No.	2HVC*XD1A, 1B
Quantity	2
Rating, each, kVA	15
High voltage/low voltage, each, V	550/480

TABLE 9.4-2 (Historical)
(Cont'd.)

4. Prefilter:	
Quantity	2 (one/filter train)
Quantity	Disposable
Media	Fiberglass
Efficiency, NBS dustspot, %	80-85
5. Charcoal Adsorber:	
Quantity	2 (one/filter train)
Type	Gasketless
Media	Charcoal (4.0 in min thickness)
Retention, %	99
6. High-Efficiency HEPA Filter:	
Quantity	4 (two/filter train)
Type	HEPA
Media	Fiberglass
Efficiency, NBS dustspot, %	99.97
Smoke Removal Makeup Air Unit	
Equipment Mark No.	2HVC-HVU1
The unit includes the following components:	
1. Fan:	
Type	Centrifugal
Capacity, cfm	16,500
Total pressure, in W.G.	2.2
Motor, hp	15
2. Heating Coil:	
Type	Electric
Capacity, kW	265
3. Filter:	
Type	Disposable
Media	Fiberglass
Efficiency, NBS dustspot, %	50
Elevation 261' Supply Air Units	
Quantity	2 (100% capacity each)
The units include the following components:	

TABLE 9.4-2 (Historical)
(Cont'd.)

1. Fans:	
Equipment Mark No.	2HVC*FN11A, 11B
Quantity	2 (one/unit)
Type	Vaneaxial
Capacity, each, cfm	4,350
Total pressure, each, in W.G.	3.20
Motor, each, hp	7.5
2. Heating Coils:	
Equipment Mark No.	2HVC-CH6A, 6B
Quantity	2 (one/unit)
Type	Electric
Capacity, each, kW	140
3. Filters:	
Equipment Mark No.	2HVC*FLT3A, 3B
Quantity	2 (one/unit)
Type	Disposable
Media	Fiberglass
Efficiency, NBS dustspot, %	50
<u>Divisionalized Battery Room Exhaust Fans</u>	
Equipment Mark No.	2HVC*FN4A, 4B
Quantity	2 (100% capacity each)
Type	Vaneaxial
Capacity, each, cfm	1,275
Total pressure, each, in W.G.	1.31
Motor, each, hp	3
<u>Nondivisionalized Battery Room Exhaust Fans</u>	
Equipment Mark No.	2HVC-FN21A, 21B
Quantity	2 (100% capacity each)
Type	Vaneaxial
Capacity, each, cfm	1,450
Total pressure, each, in W.G.	1.67
Motor, each, hp	3
<u>Control Room and Relay Room Elevation Smoke Removal Fan</u>	
Equipment Mark No.	2HVC-FN3
Type	Centrifugal
Capacity, cfm	15,500
Total pressure, in W.G.[(2)]	2.00
Motor, hp	20

TABLE 9.4-2 (Historical)
(Cont'd.)

Elevation 261' Smoke Removal Fan	
Equipment Mark No.	2HVC-FN6
Type	Centrifugal
Capacity, cfm	2,700
Total pressure, in W.G.[(2)]	1.28
Motor, hp	1
Divisions I and II Cable Area Smoke Removal Fans	
Equipment Mark No.	2HVC-FN12, 14
Quantity	2 (one/division)
Type	Centrifugal
Capacity, each, cfm	10,000
Total pressure, each, in W.G.[(2)]	7.00
Motor, each, hp	20
Toilet Exhaust Fan	
Equipment Mark No.	2HVC-FN1
Type	Vaneaxial
Capacity, cfm	400
Total pressure, in W.G.[(2)]	0.77
Motor, hp	1/12
Lunch Room Kitchen Unit Exhaust Fan	
Equipment Mark No.	2HVC-FN7
Type	Vaneaxial
Capacity, cfm	150
Total pressure, in W.G.[(2)]	0.57
Motor, hp	1/12
Chiller Room Exhaust Fan	
Equipment Mark No.	2HVC-FN8
Type	Centrifugal
Capacity, cfm	2,700
Total pressure, in W.G.[(2)]	1.00
Motor, hp	1

TABLE 9.4-2 (Historical)
(Cont'd.)

Division I Electrical Tunnel Smoke Removal Fan	
Equipment Mark No.	2HVC-FN9
Type	Centrifugal
Capacity, cfm	10,000
Total pressure, in W.G.[(2)]	4.20
Motor, hp	15
Division II Electrical Tunnel Smoke Removal Fan	
Equipment Mark No.	2HVC-FN10
Type	Centrifugal
Capacity, cfm	3,600
Total pressure, in W.G.[(2)]	3.80
Motor, hp	5
Normal Switchgear Building Supply Air Unit	
The unit includes the following components:	
1. Fans:	
Equipment Mark No.	2HVC-FN13A, 13B, 13C
Quantity	3 (50% capacity each)
Type	Vaneaxial
Capacity, each, cfm	20,000
Total pressure, each, in W.G.	4.90
Motor, each, hp	30
2. Filter:	
Equipment Mark No.	2HVC-FLT4
Type	Disposable
Media	Fiberglass
Efficiency, NBS dustspot, %	50
3. Cooling Coil:	
Equipment Mark No.	2HVC-CLC1
Type	Finned, tubular
Cooling medium	Chilled water
Cooling capacity, mbh	1,946

TABLE 9.4-2 (Historical)
(Cont'd.)

<u>Normal Switchgear Building</u>
<u>Return Air/Exhaust Fans</u>

Equipment Mark No.	2HVC-FN19A, 19B, 19C
Quantity	3 (50% capacity each)
Type	Centrifugal
Capacity, each, cfm	15,775
Total pressure, each, in W.G.(2)	2.00
Motor, each, hp	10

<u>Normal Switchgear Building</u>
<u>Ventilation Equipment Penthouse</u>
<u>Supply Fans</u>

Equipment Mark No.	2HVC-FN20A, 20B, 20C
Quantity	3 (50% capacity each)
Type	Propeller, roof mounted
Capacity, each, cfm	4,250
Total pressure, each, in W.G.(2)	0.12
Motor, each, hp	3/4

<u>Normal Switchgear Building</u>
<u>Battery Room Exhaust Fans</u>

Equipment Mark No.	2HVC-FN15A, 15B
Quantity	2 (100% capacity each)
Type	Vaneaxial
Capacity, each, cfm	3,450
Total pressure, each, in W.G.	1.79
Motor, each, hp	2

<u>Normal Switchgear Building</u>
<u>MG Set Penthouse Supply Air Units</u>

Quantity	2 (100% capacity each)

The units include the following components:

1. Fans:

Equipment Mark No.	2HVC-FN16A, 16B
Quantity	2 (one/unit)
Type	Propeller
Capacity, each, cfm	10,750
Total pressure, each, in W.G.(2)	0.73
Motor, each, hp	5

TABLE 9.4-2 (Historical)
(Cont'd.)

2. Filters:	
Equipment Mark No.	2HVC-FLT5A, 5B
Quantity	2 (one/unit)
Type	Disposable
Media	Fiberglass
Efficiency, NBS dustspot, %	50
<u>Unit Heaters</u>	
Equipment Mark No.	2HVC-UHE103, 104, 109, 114, 118, 119, 120
Quantity	7
Type	Electric
Capacity, each, kW	12
Equipment Mark No.	2HVC-UHE101, 105, 107, 110, 111, 112, 113, 115, 116, 117
Quantity	10
Type	Electric
Capacity, each, kW	20

[1] Total static pressure.
[2] Fan external static pressure.

TABLE 9.4-3 (Historical)

DESIGN DATA OF PRINCIPAL EQUIPMENT -
REACTOR BUILDING HVAC SYSTEM

<u>Drywell Cooling</u>

1. Unit Coolers - Elevation 240'

Equipment Mark No.	2DRS-UC1A,1B,1C,1D
Quantity	4

Each unit cooler includes the following components:

a. Fan

Type	Vaneaxial
Capacity, cfm	16,750
Total pressure, in W.G.	UC1A : 4.81 UC1B : 3.27 UC1C : 3.32 UC1D : 3.93
Motor, hp	20

b. Cooling Coil

Type	Finned, tubular
Cooling medium	Closed loop cooling water (CCP)
Cooling capacity, mbh	889.0

2. Unit Coolers - Elevation 278'-6"

Equipment Mark No.	2DRS-UC2A,2B,2C,2D
Quantity	4

Each unit cooler includes the following components:

a. Fan

Type	Vaneaxial
Capacity, cfm	11,000
Total pressure, in W.G.	2.43
Motor, hp	10

b. Cooling Coil

Type	Finned, tubular
Cooling medium	Closed loop cooling water (CCP)
Cooling capacity, mbh	583.0

3. Unit Coolers - Elevation 288'-3"

Equipment Mark No.	2DRS-UC3A,3B
Quantity	2 (100% capacity each)

TABLE 9.4-3 (Historical)
(Cont'd.)

Each unit cooler includes the following components:	
a. Fan	
Type	Vaneaxial
Capacity, cfm	8,500
Total pressure, in W.G.	4.5
Motor, hp	15
b. Cooling Coil	
Type	Finned, tubular
Cooling medium	Closed loop cooling water (CCP)
Cooling capacity, mbh	451.0
<u>Primary Containment Purge</u>	
1. Supply Air Fan	
Equipment Mark No.	2CPS-FNI
Type	Centrifugal
Capacity, cfm	3,500
Total pressure, in W.G.(1)	7.98
Motor, hp	10
<u>All other reactor building areas</u>	
1. Supply Ventilation Air Handling Unit	
The unit includes the following components:	
a. Prefilter	
Quantity	6
Equipment Mark No.	2HVR-FLT4,5,6,7,8,9
Type	Disposable
Media	Fiberglass
Efficiency, NBS dustspot, %	50
b. Filter	
Quantity	6
Equipment Mark No.	2HVR-FLT10,11,12,13,14,15
Type	Disposable
Media	Fiberglass
Efficiency, NBS dustspot, %	65
c. Heating Coil	
Equipment Mark No.	2HVR-CH1
Type	Finned, tubular
Heating medium	Glycol
Heating capacity, mbh	12,968

TABLE 9.4-3 (Historical)
(Cont'd.)

d.	Cooling Coil	
	Equipment Mark No.	2HVR-CLC2
	Type	Finned, tubular
	Cooling medium	Service water
	Cooling capacity, mbh	1,154.0
e.	Fan	
	Quantity	3 (50% capacity each)
	Equipment Mark No.	2HVR-FN1A,1B,1C
	Type	Vaneaxial
	Capacity, each, cfm	70,000
	Total pressure, each, in W.G.	9.60
	Motor, each, hp	150
2.	Refueling Floor Exhaust Fans	
	Quantity	2 (100% capacity each)
	Equipment Mark No.	2HVR-FN5A,5B
	Type	Vaneaxial
	Capacity, each, cfm	70,000
	Total pressure, each, in W.G.	6.30
	Motor, each, hp	100
3.	Below Refueling Floor Exhaust Fans	
	Quantity	2 (100% capacity each)
	Equipment Mark No.	2HVR-FN2A,2B
	Type	Vaneaxial
	Capacity, each, cfm	70,000
	Total pressure, each, in W.G.	8.20
	Motor, each, hp	125
4.	Reactor Head Evacuation Filter Unit	
	Equipment Mark No.	2HVR-FLT3
	The unit includes the following components:	
a.	Heating Coil	
	Type	Electric
	Capacity, kW	7
b.	Prefilter	
	Type	Disposable
	Media	Fiberglass
	Efficiency, NBS dustspot, %	50

TABLE 9.4-3 (Historical)
(Cont'd.)

c. Charcoal Adsorber	
Type	Gasketless
Media	Charcoal
Retention, %	99
d. High-Efficiency Final Filter	
Type	HEPA
Media	Fiberglass
Efficiency, NBS dustspot, %	99.97
5. Reactor Head Evacuation Fan	
Equipment Mark No.	2HVR-FN6
Type	Centrifugal
Capacity, cfm	1,000
Total pressure, in W.G.[(1)]	13.40
Motor, hp	5
6. Emergency Recirculating Unit Coolers	
Equipment Mark No.	2HVR*UC413A, 413B
Quantity	2 (100% capacity each)
Each unit cooler includes the following components:	
a. Fan	
Type	Vaneaxial
Capacity, cfm	70,000
Total pressure, in W.G.	9.00
Motor, hp	150
b. Cooling Coil	
Type	Finned, tubular
Cooling medium	Service water
Cooling capacity, mbh	1,330.0
7. RHS Pump Rooms A, B, and C Unit Coolers	
Equipment Mark No.	2HVR*UC401A - 401F
Quantity	6 (100% capacity each, 2 per room)
Each unit cooler includes the following components:	
a. Fan	
Type	Propeller
Capacity, cfm	10,000
Total pressure, in W.G.	0.81
Motor, hp	2

TABLE 9.4-3 (Historical)
(Cont'd.)

b. Cooling Coil	
Type	Finned, tubular
Cooling medium	Service water
Cooling capacity, mbh	185.0
8. LPCS Pump Room Unit Coolers	
Equipment Mark No.	2HVR*UC402A, 402B
Quantity	2 (100% capacity each)
Each unit cooler includes the following components:	
a. Fan	
Type	Propeller
Quantity (per unit cooler)	2
Capacity, each, cfm	7,800
Total pressure, each, in W.G.	1.87
Motor, each, hp	5
b. Cooling Coil	
Type	Finned, tubular
Cooling medium	Service water
Cooling capacity, mbh	285
9. HPCS Pump Room Unit Coolers	
Equipment Mark No.	2HVR*UC403A, 403B
Quantity	2 (100% capacity each)
Each unit cooler includes the following components:	
a. Fan	
Type	Propeller
Quantity (per unit cooler)	2
Capacity, each, cfm	13,600
Total pressure, each, in W.G.	1.92
Motor, each, hp	7.5
b. Cooling Coil	
Type (cooling medium)	Finned, tubular
Cooling capacity, mbh	500.0

TABLE 9.4-3 (Historical)
(Cont'd.)

10. General Areas Unit Coolers - Elevations 175'-0" & 261'-0"

Equipment Mark No.	2HVR*UC404A, 404B, 404C, 404D 2HVR*UC411A, 411B, 411C 2HVR*UC414A, 414B
Quantity	9

Each unit cooler includes the following components:

a. Fan

Type	Propeller
Capacity, cfm	7,400
Total pressure, in W.G.	1.55
Motor, hp	3

b. Cooling Coil

Type	Finned, tubular
Cooling medium	Service water
Cooling capacity, mbh	135.0

11. RHS Heat Exchanger Room A Unit Cooler

Mark No.	2HVR*UC405

The unit cooler includes the following components:

a. Fan

Type	Vaneaxial
Capacity, cfm	3,600
Total pressure, in W.G.	1.53
Motor, hp	3

b. Cooling Coil

Type	Finned, tubular
Cooling medium	Service water
Cooling capacity, mbh	65.0

12. RHS Heat Exchanger Room B Unit Cooler

Equipment Mark No.	2HVR*UC406

The unit cooler includes the following components:

a. Fan

Type	Vaneaxial
Capacity, cfm	3,600
Total pressure, in W.G.	1.23
Motor, hp	2

TABLE 9.4-3 (Historical)
(Cont'd.)

b. Cooling Coil	
Type	Finned, tubular
Cooling medium	Service water
Cooling capacity, mbh	65.0
13. General Areas Unit Coolers - Elevations 215'-0" & 240'-0"	
Equipment Mark No.	2HVR*UC407A - 407E 2HVR*UC410A, 410B, 410C
Quantity	8
Each unit cooler includes the following components:	
a. Fan	
Type	Propeller
Capacity, cfm	4,400
Total pressure, in W.G.	0.77
Motor, hp	1.5
b. Cooling Coil	
Type	Finned, tubular
Cooling medium	Service water
Cooling capacity, mbh	80.0
14. North Electrical MCC Area Unit Coolers	
Equipment Mark No.	2HVR*UC408A, 408B
Quantity	2 (100% capacity each)
Each unit cooler includes the following components:	
a. Fan	
Type	Vaneaxial
Capacity, cfm	10,000
Total pressure, in W.G.	1.57
Motor, hp	5
b. Cooling Coil	
Type	Finned, tubular
Cooling medium	Service water
Cooling capacity, mbh	185.0
15. South Electrical MCC Area Unit Coolers	
Equipment Mark No.	2HVR*UC409A, 409B
Quantity	2 (100% capacity each)

TABLE 9.4-3 (Historical)
(Cont'd.)

Each unit cooler includes the following components:

a. Fan	
Type	Vaneaxial
Capacity, cfm	10,000
Total pressure, in W.G.	1.27
Motor, hp	5
b. Cooling Coil	
Type	Finned, tubular
Cooling medium	Service water
Cooling capacity, mbh	185.0

16. RCIC Pump Room Unit Coolers

Equipment Mark No.	2HVR*UC412A, 412B
Quantity	2 (100% capacity each)

Each unit cooler includes the following components:

a. Fan	
Type	Propeller
Capacity, cfm	7,400
Total pressure, in W.G.	1.55
Motor, hp	3
b. Cooling Coil	
Type	Finned, tubular
Cooling medium	Service water
Cooling capacity, mbh	135.0

17. SGTS Filter Rooms A and B Unit Coolers

Equipment Mark No.	2HVR*UC415A, 415B
Quantity	2 (one per room)

Each unit cooler includes the following components:

a. Fan	
Type	Propeller
Capacity, cfm	5,000
Total pressure, in W.G.	0.80
Motor, hp	5
b. Cooling Coil	
Type	Finned, tubular
Cooling medium	Service water
Cooling capacity, mbh	100.0

TABLE 9.4-3 (Historical)
(Cont'd.)

18. SGTS Building Exhaust Fans	
Equipment Mark No.	2HVR-FN7, FN8
Quantity	2
Type	Propeller, roof mounted
Capacity, each, cfm	3,000
Total pressure, each, in W.G.[1]	0.10
Motor, each, hp	1/3
19. North Duct Air Heater	
Equipment Mark No.	2HVR-CH2
Type	Electric
Capacity, kW	135
20. South Duct Air Heater	
Equipment Mark No.	2HVR-CH3
Type	Electric
Capacity, kW	90
21. Unit Heaters	
Equipment Mark No.	2HVR-UHE401,402,403, 404,409,410,411,412, 413,414,415,416,417, 418,419,420,459,465
Quantity	18
Capacity each, kW	7.5
Equipment Mark No.	2HVR-UHE405,406,407, 408,433,434,435,436, 453,454,455,456,457, 458,460,461,462,463, 464
Quantity	19
Capacity, each, kW	12.5
Equipment Mark No.	2HVR-UHE421,422,423, 424,425,427,437,438, 439,440,441,442
Quantity	12
Capacity, each, kW	20.0
Equipment Mark No.	2HVR-UHE426,428,429, 430,431,432,451,452
Quantity	8

TABLE 9.4-3 (Historical)
(Cont'd.)

Capacity, each, kW	30.0
Equipment Mark No.	2HVR-UHE443,444,445, 446,447,448,449,450
Quantity	8
Capacity, each, kW	40.0

(1) Fan external static pressure.

TABLE 9.4-4 (Historical)

DESIGN DATA OF PRINCIPAL EQUIPMENT -
RADWASTE BUILDING HVAC SYSTEM

Supply Air System

The system includes the following components:

1. Prefilter	
Equipment Mark No.	2HVW-FLT1
Type	Disposable
Media	Fiberglass
Efficiency, NBS dustspot, %	35
2. Heating Coil	
Equipment Mark No.	2HVW-CH1
Type	Finned, tubular
Heating medium	Glycol
Heating capacity, mbh	4,410.0
3. Filter	
Equipment Mark No.	2HVW-FLT2
Type	Disposable
Media	Fiberglass
Efficiency, NBS dustspot, %	65
4. Cooling Coil	
Equipment Mark No.	2HVW-CLC1
Type	Finned, tubular
Cooling medium	Chilled water
Cooling capacity, mbh	2,076.0
5. Fans	
Equipment Mark No.	2HVW-FN1A, 1B
Quantity	2 (100% capacity each)
Type	Vaneaxial
Capacity, each, cfm	47,800
Total pressure, each, in W.G.	8.4
Motor, each, hp	100

General Area Exhaust System

The system includes the following components:

1. Prefilters	
Equipment Mark No.	2HVW-FLT5A, 5B
Quantity	2 (100% capacity each)
Type	Disposable
Media	Fiberglass
Efficiency, NBS dustspot, %	35

TABLE 9.4-4 (Historical)
(Cont'd.)

2. High-Efficiency Final Filters	
Equipment Mark No.	2HVW-FLT6A, 6B
Quantity	2 (100% capacity each)
Type	HEPA
Media	Fiberglass
Efficiency, NBS dustspot, %	99.97
3. Fans	
Equipment Mark No.	2HVW-FN2A, 2B
Quantity	2 (100% capacity each)
Type	Vaneaxial
Capacity, each, cfm	47,800
Total pressure, each, in W.G.	10.7
Motor, each, hp	150
<u>Equipment Exhaust System</u>	
The system includes the following components:	
1. Prefilters	
Equipment Mark No.	2HVW-FLT3A, 3B
Quantity	2 (100% capacity each)
Type	Disposable
Media	Fiberglass
Efficiency, NBS dustspot, %	35
2. High-Efficiency Final Filters	
Equipment Mark No.	2HVW-FLT4A, 4B
Quantity	2 (100% capacity each)
Type	HEPA
Media	Fiberglass
Efficiency, NBS dustspot, %	99.97
3. Fans	
Equipment Mark No.	2HVW-FN3A, 3B
Quantity	2 (100% capacity each)
Type	Centrifugal
Capacity, each, cfm	4,900
Total pressure, each, in W.G.(1)	10.30
Motor, each, hp	20
<u>Smoke Removal Fan</u>	
Equipment Mark No.	2HVW-FN5
Type	Centrifugal, in-line
Capacity, cfm	4,400
Total pressure, in W.G.(1)	1.00
Motor, hp	2

TABLE 9.4-4 (Historical)
(Cont'd.)

Liner Filling Hood Exhaust System

The system includes the following components:

The unit includes the following components:

1. Prefilter	
Equipment Mark No.	2HVW-FLT7
Type	Disposable
Media	Fiberglass
Efficiency, NBS dustspot, %	78
2. High-Efficiency Filters	
Equipment Mark No.	2HVW-FLT8
Quantity	2
Type	HEPA
Media	Fiberglass
Efficiency, NBS dustspot, %	99.97
3. Fan	
Equipment Mark No.	2HVW-FN4
Type	Centrifugal
Capacity, cfm	800
Total pressure, in W.G.[(1)]	11.00
Motor, hp	5

Radwaste Decon General Areas Air Conditioning Units

Equipment Mark No.	2HVW-ACU1A, 1B
Quantity	2 (100% capacity each)
Type	Central station, drawthrough

Each unit includes the following components:

1. Filter	
Type	Disposable
Media	Fiberglass
Efficiency, NBS dustspot, %	35
2. Heating Coil	
Type	Electric
Heating capacity, kW	340.0
3. Cooling Coil	
Type	Finned, tubular
Cooling medium	Chilled water
Cooling capacity, mbh	1,420

TABLE 9.4-4 (Historical)
(Cont'd.)

4. Supply Air Fan	
Type	Centrifugal
Capacity, cfm	27,030
Total pressure, in W.G.	3.0
Motor, hp	30
Radwaste Decon Clean Areas Return Air/Exhaust Fans	
Equipment Mark No.	2HVW-FN11A, 11B
Quantity	2 (100% capacity each)
Type	Vaneaxial
Capacity, each, cfm	8,400
Total pressure, each, in W.G.	2.00
Motor, each, hp	5
Radwaste Control Room Air Conditioning Units	
Each air conditioning unit is a split-type unit consisting of an air handling unit and two roof-mounted air-cooled condensing units.	
1. Air Handling Units	
Equipment Mark No.	2HVW-ACU2A, 2B
Quantity	2 (100% capacity each)
Type	Central station, drawthrough
Each unit includes the following components:	
a. Filter	
Type	Disposable
Media	Fiberglass
Efficiency, NBS dustspot, %	35
b. Heating Coil	
Type	Electric
Heating capacity, kW	36.0
c. Cooling Coil	
Type	Finned, tubular
Cooling medium	Refrigerant R-22
Cooling capacity, mbh	349.165
d. Supply Air Fan	
Type	Centrifugal
Capacity, cfm	12,400
Total pressure, in W.G.	2.0
Motor, hp	10

TABLE 9.4-4 (Historical)
(Cont'd.)

2. Condensing Units (Roof Mounted)	
Equipment Mark No.	2HVW-CND1A,1B,2A,2B
Quantity	4 (50% capacity each)
Type	Condenser
Each unit includes the following components:	
a. Fan	
Type	Propeller
Quantity	2
Capacity, total, cfm	8,800
Motor, each, hp	0.5
b. Compressor	
Quantity	1
Power input, kW	17
<u>Radwaste Control Room Return Air/Exhaust Fans</u>	
Equipment Mark No.	2HVW-FN12A, 12B
Quantity	2 (100% capacity each)
Type	Vaneaxial
Capacity, each, cfm	10,700
Total pressure, each, in W.G.	0.82
Motor, each, hp	3.0
<u>Radwaste Decon Dirty Areas Return Air/Exhaust System</u>	
The system includes the following components:	
1. Return Air/Exhaust Fans	
Equipment Mark No.	2HVW-FN10A, 10B
Quantity	2 (100% capacity each)
Type	Vaneaxial
Capacity, each, cfm	18,180
Total pressure, each, in W.G.	6.50
Motor, each, hp	30
2. High-Efficiency Final Filters	2HVW-FLT100A, 100B
Equipment Mark No.	2 (100% capacity each)
Quantity	HEPA
Media	Fiberglass
Efficiency, NBS dustspot, %	99.97
<u>Chemistry Laboratory Air Conditioning Unit</u>	
Equipment Mark No.	2HVW-ACU3
Quantity	1 (100% capacity)
Type	Packaged A/C unit

TABLE 9.4-4 (Historical)
(Cont'd.)

The unit includes the following components:	
1. Compressor	
Type	Semi-Hermatic
Refrigerant	R-22
V/O/Hz	575/3/60
2. Fan	
Type	Centrifugal
RPM	1750
Drive	Belt driven
3. Air-Cooled Condenser	
Equipment Mark No.	2HVW-CND3
Summer Ent. DB Temp. °F	100
Winter Ent. DB Temp. °F	-10
4. Filter	
Type	Disposable
Efficiency, NBS dustspot, %	40
5. Humidifier	
Type	Infrared
Capacity, lb/hr	11
kW	4.8
6. Reheat Coil	
Type	Electric
Capacity, kW	9
<u>Chemistry Laboratory Hood Exhaust Fans</u>	
Equipment Mark No.	2HVW-FN14 & 15
Quantity	2 (100% capacity each)
Type	Vaneaxial
Capacity, cfm	922
Total pressure, in W.G.	.65
Motor, each, hp	1/4
<u>Post-accident Sampling Equipment Exhaust System</u>	
1. Exhaust Fan	
Equipment Mark No.	2HVW-FN13
Quantity	1
Type	Regenerative blower
Capacity, cfm	40
Static pressure, in. W.G.[(1)]	4.5
Motor, hp	0.34

TABLE 9.4-4 (Historical)
(Cont'd.)

2. High-Efficiency/Charcoal Combination Filter	
Equipment Mark No.	2HVW-FLT101
Quantity	1
Type	HEPA/charcoal
Media	Fiberglass/charcoal
Efficiency of the combination filter, %	99
<u>Unit Heaters</u>	
1. Equipment Mark No.	2HVW-UHE301, 302, 303, 304, 305, 306
Quantity	6
Type	Electric
Capacity, each, kW	40
2. Equipment Mark No.	2HVW-UHE309, 310, 311
Quantity	3
Type	Electric
Capacity, each, kW	30
3. Equipment Mark No.	2HVW-UHE312
Type	Electric
Capacity, kW	12.5
4. Equipment Mark No.	2HVW-UHE307, 308
Quantity	2
Type	Electric
Capacity, each, kW	7.5
<u>Duct Air Heaters</u>	
1. Equipment Mark No.	2HVW-CH3
Type	Electric
Capacity, kW	40
2. Equipment Mark No.	2HVW-CH6
Type	Electric
Capacity, kW	12
3. Equipment Mark No.	2HVW-CH7
Type	Electric
Capacity, kW	102
4. Equipment Mark No.	2HVW-CH12
Type	Electric
Capacity, kW	45

TABLE 9.4-4 (Historical)
(Cont'd.)

5.	Equipment Mark No.	2HVW-CH13
	Type	Electric
	Capacity, kW	30

(1) Fan external static pressure

TABLE 9.4-5 (Historical)

DATA OF PRINCIPAL EQUIPMENT
TURBINE BUILDING HVAC SYSTEM

Supply Air System

The system includes the following components:

1. Prefilter	
Equipment Mark No.	2HVT-FLT3, 4
Quantity	2
Type	Disposable
Media	Fiberglass
Efficiency, NBS dustspot, %	50
2. Filter	
Equipment Mark No.	2HVT-FLT5, 6
Quantity	2
Type	Disposable
Media	Fiberglass
Efficiency, NBS dustspot, %	65
3. Heating Coil	
Equipment Mark No.	2HVT-CH1
Type	Finned, tubular
Heating medium	Glycol
Heating capacity, mbh	7,412.0
4. Cooling Coil	
Equipment Mark No.	2HVT-CLC1
Type	Finned, tubular
Cooling medium	Chilled water
Cooling capacity, mbh	4,464.0
5. Fans	
Equipment Mark No.	2HVT-FN1A, 1B, 1C
Quantity	3 (50% capacity each)
Type	Vaneaxial
Capacity, each, cfm	40,000
Total pressure, each, in W.G.	7.26
Motor, each, hp	75

Exhaust Air System

The system includes the following components:

1. Fans - Turbine Building Exhaust	
Equipment Mark No.	2HVT-FN2A, 2B, 2C
Quantity	3 (50% capacity each)
Type	Vaneaxial

TABLE 9.4-5 (Historical)
(Cont'd.)

Capacity, each, cfm	40,000
Total pressure, each, in W.G.	10.24
Motor, each, hp	125
2. Fans - Main Stack Exhaust	
Equipment Mark No.	2HVT-FN10A, 10B
Quantity	2 (100% capacity each)
Type	In-line centrifugal
Capacity, each, cfm	1,400
Total pressure, each, in W.G.[2]	3.00
Motor, each, hp	1.5
3. Unit Heaters - Main Stack	
Equipment Mark No.	2HVT-UHE250, 252
Quantity	2
Type	Electric
Capacity, each, kW	12.5
4. Unit Heater - Main Stack	
Equipment Mark No.	2HVT-UHE251
Type	Electric
Capacity, kW	7.5
Ventilation Fans - Elevator Machine Rooms	
1. Fan - Elevator Machine Room 1	
Equipment Mark No.	2HVT-FN5
Type	Propeller, wall mounted
Capacity, cfm	1,500
Total pressure, in W.G.[2]	0.34
Motor, hp	1/2
2. Fan - Elevator Machine Room 2	
Equipment Mark No.	2HVT-FN6
Type	Propeller, wall mounted
Capacity, cfm	1,500
Total pressure, in W.G.[2]	0.30
Motor, hp	1/3
3. Fan - Elevator Machine Room 3	
Equipment Mark No.	2HVT-FN7
Type	Propeller, roof mounted
Capacity, cfm	1,500
Total pressure, in W.G.[2]	0.17
Motor, hp	1/4
4. Fan - Load Center Room	
Equipment Mark No.	2HVT-FN8
Type	Propeller

TABLE 9.4-5 (Historical)
(Cont'd.)

	Total pressure, in W.G.[2]	0.5
	Motor, hp	3.0
5.	Relief Vents	
	Equipment Mark No.	2HVT-RFV1, 2
	Quantity	2
	Capacity, cfm, each	1,500
6.	Air Transfer Fan - Main Steam Tunnel	
	Equipment Mark No.	2HVT-FN11
	Type	Centrifugal
	Capacity, cfm	10,000
	Total pressure, in W.G.[1]	3.75
	Motor, hp	10.0

Charcoal Decay-Bed Room Air Conditioning Unit

Equipment Mark No.	2HVT-ACUS1
Type	Package, vertical cabinet

The unit includes the following components:

1.	Supply Fan	
	Type	Centrifugal
	Capacity, cfm	6,200
	Total pressure, in W.G.[1]	1.45
	Motor, hp	3
2.	Filter	
	Type	Disposable
	Media	Fiberglass
	Efficiency, NBS dustspot, %	95
3.	Cooling Coil	
	Type	Finned, tubular
	Cooling medium	Refrigerant R-22
	Cooling capacity, mbh	171.5

Sample Room Air Conditioning Unit

Equipment Mark No.	2HVT-ACUS2
Type	Package, vertical cabinet

The unit includes the following components:

TABLE 9.4-5 (Historical)
(Cont'd.)

1. Supply Fan	
Type	Centrifugal
Capacity, cfm	7,000
Total pressure, in W.G.[(1)]	0.97
Motor, hp	7.5
2. Filter	
Type	Disposable
Media	Fiberglass
Efficiency, NBS dustspot, %	95
3. Cooling Coil	
Type	Finned, tubular
Cooling medium	Refrigerant R-22
Cooling capacity, mbh	269.0
Ventilation Equipment Area Air Conditioning Unit	
This unit is a split type, air conditioning unit consisting of an air handling unit and an air-cooled condensing unit.	
1. Air Handling Unit	
Equipment Mark No.	2HVT-ACUS4
The unit includes the following components:	
a. Supply Fan	
Type	Centrifugal
Quantity	1
Capacity, each, cfm	9,000
Total pressure, each, in W.G.[(2)]	0.5
Motor, each, hp	7.5
b. Filter	
Type	Disposable
Media	Fiberglass
Efficiency, NBS dustspot, %	40
c. Cooling Coil	
Type	Finned tubular
Cooling medium	Refrigerant R-22
Cooling capacity, mbh	637.8
2. Condensing Unit	
Equipment Mark No.	2HVT-CND4
Type	Condenser

TABLE 9.4-5 (Historical)
(Cont'd.)

The unit includes the following components:

a. Fan

Type	Propeller
Quantity	6
Capacity, total, cfm	39,000
Motor, each, hp	0.5

b. Compressor

Quantity	2
Power input, total, kW	61.9

Unit Coolers

1. Generator Area

Equipment Mark No.	2HVT-UC222A through 222F
Quantity	6

Each unit cooler includes the following components:

a. Fans

Quantity	2
Type	Propeller
Capacity, each, cfm	5,225
Total pressure, each, in W.G.[2]	0.70
Motor, each, hp	2.0

b. Cooling Coil

Type	Finned, tubular
Cooling medium	Service water
Cooling capacity, mbh	191.0

2. North MSR Area

Equipment Mark No.	2HVT-UC221A, 221B
Quantity	2

Each unit cooler includes the following components:

a. Fans

Quantity (per unit cooler)	2
Type	Propeller
Capacity, each, cfm	6,600
Total pressure, each, in W.G.[1]	0.61
Motor, each, hp	1.5

TABLE 9.4-5 (Historical)
(Cont'd.)

b. Cooling Coil	
Type	Finned, tubular
Cooling medium	Service water
Cooling capacity, mbh	242.0
3. South MSR Area	
Equipment Mark No.	2HVT-UC223A, 223B
Quantity	2
Each unit cooler includes the following components:	
a. Fans	
Quantity (per unit cooler)	2
Type	Propeller
Capacity, each, cfm	6,600
Total pressure, each, in W.G.[(1)]	0.61
Motor, each, hp	1.5
b. Cooling Coil	
Type	Finned, tubular
Cooling medium	Service water
Cooling capacity, mbh	242.0
4. Reboiler Room	
Equipment Mark No.	2HVT-UC219
The unit cooler includes the following components:	
a. Fan	
Type	Propeller
Quantity (per unit cooler)	1
Capacity, each, cfm	4,175
Total pressure, each, in W.G.[(1)]	0.74
Motor, each, hp	1.5
b. Cooling Coil	
Type	Finned, tubular
Cooling medium	Service water
Cooling capacity, mbh	70.0
5. Clean Steam Reboiler Room	
Equipment Mark No.	2HVT-UC220
The unit cooler includes the following components:	

TABLE 9.4-5 (Historical)
(Cont'd.)

a. Fan	
Type	Propeller
Capacity, cfm	3,075
Total pressure, in W.G.[1]	1.25
Motor, hp	1.5
b. Cooling coil	
Type	Finned, tubular
Cooling medium	Service water
Cooling capacity, mbh	50.0
6. Switchgear Room West	
Equipment Mark No.	2HVT-UC224
The unit cooler includes the following components:	
a. Fan	
Type	Vaneaxial
Capacity, cfm	6,500
Total pressure, in W.G.	1.00
Motor, hp	3
b. Cooling Coil	
Type	Finned, tubular
Cooling medium	Service water
Cooling capacity, mbh	114.0
7. Generator Leads Cooler Area	
Equipment Mark No.	2HVT-UC217A, 217B
Quantity	2
Each unit cooler includes the following components:	
a. Fan	
Type	Propeller
Quantity (per unit cooler)	1
Capacity, each, cfm	8,400
Total pressure, each, in W.G.[1]	0.65
Motor, each, hp	3
b. Cooling Coil	
Type	Finned, tubular
Cooling medium	Service water
Cooling capacity, mbh	154.0

TABLE 9.4-5 (Historical)
(Cont'd.)

8. Heater Bay A

Equipment Mark No.	2HVT-UC215A, 215B
Quantity	2

Each unit cooler includes the following components:

a. Fan

Type	Propeller
Quantity (per unit cooler)	2
Capacity, each, cfm	6,600
Total pressure, each, in W.G.[1]	0.61
Motor, each, hp	1.5

b. Cooling Coil

Type	Finned, tubular
Cooling medium	Service water
Cooling capacity, mbh	242.0

9. Heater Bay B

Equipment Mark No.	2HVT-UC214A, 214B
Quantity	2

Each unit cooler includes the following components:

a. Fan

Type	Propeller
Quantity (per unit cooler)	2
Capacity, each, cfm	6,600
Total pressure, each, in W.G.[1]	0.61
Motor, each, hp	1.5

b. Cooling Coil

Type	Finned, tubular
Cooling medium	Service water
Cooling capacity, mbh	242.0

10. Heater Bay C

Equipment Mark No.	2HVT-UC213A, 213B
Quantity	2

Each unit cooler includes the following components:

TABLE 9.4-5 (Historical)
(Cont'd.)

a. Fan	
Type	Propeller
Quantity (per unit cooler)	2
Capacity, each, cfm	6,600
Total pressure, each, in W.G.[1]	0.61
Motor, each, hp	1.5
b. Cooling Coil	
Type	Finned, tubular
Cooling medium	Service water
Cooling capacity, mbh	242.0
11. North Area of Condenser	
Equipment Mark No.	2HVT-UC216A through 216E
Quantity	5
Each unit cooler includes the following components:	
a. Fan	
Type	Propeller
Quantity (per unit cooler)	3
Capacity, each, cfm	7,333
Total pressure, each, in W.G.[1]	0.63
Motor, each, hp	2
b. Cooling Coil	
Type	Finned, tubular
Cooling medium	Service water
Cooling capacity, mbh	394.0
12. Condenser Tube Removal Area	
Equipment Mark No.	2HVT-UC218A through 218E
Quantity	5
Each unit cooler includes the following components:	
a. Fan	
Type	Propeller
Quantity (per unit cooler)	3
Capacity, each, cfm	7,333
Total pressure, each, in W.G.[1]	0.63
Motor, each, hp	2

TABLE 9.4-5 (Historical)
(Cont'd.)

b. Cooling Coil	
Type	Finned, tubular
Cooling medium	Service water
Cooling capacity, mbh	394.0
13. Switchgear Room East	
Equipment Mark No.	2HVT-UC225
The unit cooler includes the following components:	
a. Fan	
Type	Vaneaxial
Capacity, cfm	6,500
Total pressure, in W.G.	1.10
Motor, hp	3
b. Cooling Coil	
Type	Finned, tubular
Cooling medium	Service water
Cooling capacity, mbh	114.0
14. Condensate Pump Area	
Equipment Mark No.	2HVT-UC207A, 207B
Quantity	2
Each unit cooler includes the following components:	
a. Fan	
Type	Propeller
Quantity (per unit cooler)	3
Capacity, each, cfm	7,700
Total pressure, each, in W.G.[1]	0.78
Motor, each, hp	3
b. Cooling Coil	
Type	Finned, tubular
Cooling medium	Service water
Cooling capacity, mbh	424.0
15. Condensate Pump Area	
Equipment Mark No.	2HVT-UC208A, 208B
Quantity	2
Each unit cooler includes the following components:	

TABLE 9.4-5 (Historical)
(Cont'd.)

a.	Fan	
	Type	Propeller
	Quantity (per unit cooler)	2
	Capacity, each, cfm	7,150
	Total pressure, each, in W.G.[1]	0.66
	Motor, each, hp	2
b.	Cooling Coil	
	Type	Finned, tubular
	Cooling medium	Service water
	Cooling capacity, mbh	262.0
16.	Condensate Pump Area	
	Equipment Mark No.	2HVT-UC209A, 209B
	Quantity	2
	Each unit cooler includes the following components:	
a.	Fan	
	Type	Propeller
	Quantity (per unit cooler)	2
	Capacity, each, cfm	5,913
	Total pressure, each, in W.G.[1]	0.63
	Motor, each, hp	1.5
b.	Cooling Coil	
	Type	Finned, tubular
	Cooling medium	Service water
	Cooling capacity, mbh	217.0
17.	Offgas Rooms	
	Equipment Mark No.	2HVT-UC205
	The unit cooler includes the following components:	
a.	Fan	
	Type	Propeller
	Capacity, cfm	4,175
	Total pressure, in W.G.[1]	0.74
	Motor, hp	1.5
b.	Cooling Coil	
	Type	Finned, tubular
	Cooling medium	Service water
	Cooling capacity, mbh	70.0

TABLE 9.4-5 (Historical)
(Cont'd.)

18. Regeneration Area	
Equipment Mark No.	2HVT-UC204
The unit cooler includes the following components:	
a. Fan	
Type	Propeller
Capacity, cfm	4,175
Total pressure, in W.G.[(1)]	0.74
Motor, hp	1.5
b. Cooling Coil	
Type	Finned, tubular
Cooling medium	Service water
Cooling capacity, mbh	70.0
19. Heater Bay A - Elevation 250'-0"	
Equipment Mark No.	2HVT-UC203A, 203B
Quantity	2
Each unit cooler includes the following components:	
a. Fan	
Type	Propeller
Quantity (per unit cooler)	3
Capacity, each, cfm	7,700
Total pressure, each, in W.G.[(1)]	0.78
Motor, each, hp	3
b. Cooling Coil	
Type	Finned, tubular
Cooling medium	Service water
Cooling capacity, mbh	424.0
20. Heater Bay B - Elevation 250'-0"	
Equipment Mark No.	2HVT-UC202A, 202B
Quantity	2
Each unit cooler includes the following components:	
a. Fan	
Type	Propeller
Quantity (per unit cooler)	2
Capacity, each, cfm	7,700

TABLE 9.4-5 (Historical)
(Cont'd.)

	Total pressure, each, in W.G.[1]	1.0
	Motor, each, hp	3
b.	Cooling Coil	
	Type	Finned, tubular
	Cooling medium	Service water
	Cooling capacity, mbh	424.0
21.	Heater Bay C	
	Equipment Mark No.	2HVT-UC201A, 201B
	Quantity	2
	Each unit cooler includes the following components:	
a.	Fan	
	Type	Propeller
	Quantity (per unit cooler)	3
	Capacity, each, cfm	7,700
	Total pressure, each, in W.G.[1]	1.0
	Motor, each, hp	3
b.	Cooling Coil	
	Type	Finned, tubular
	Cooling medium	Service water
	Cooling capacity, mbh	424.0
22.	Reactor Feed Pump Area	
	Equipment Mark No.	2HVT-UC206A,C,E
	Quantity	3
	Each unit cooler includes the following components:	
a.	Fan	
	Type	Propeller
	Quantity (per unit cooler)	2
	Capacity, each, cfm	10,300
	Total pressure, in W.G.[1]	0.61
	Motor, each, hp	3
b.	Cooling Coil	
	Type	Finned, tubular
	Cooling medium	Service water
	Cooling capacity, mbh	378

TABLE 9.4-5 (Historical)
(Cont'd.)

Equipment Mark No.	2HVT-UC206F
Quantity	1
The unit cooler includes the following components:	
a. Fan	
Type	Propeller
Quantity (per unit cooler)	2
Capacity, each, cfm	10,300
Total pressure, each, in W.G.[1]	0.75
Motor, each, hp	3
b. Cooling Coil	
Type	Finned, tubular
Cooling medium	Service water
Cooling capacity, mbh	378.0
Equipment Mark No.	2HVT-UC206B, 206D
Quantity	2
Each unit cooler includes the following components:	
a. Fan	
Type	Propeller
Quantity (per unit cooler)	2
Capacity, each, cfm	11,000
Total pressure, each, in W.G.[1]	0.64
Motor, each, hp	3
b. Cooling Coil	
Type	Finned, tubular
Cooling medium	Service water
Cooling capacity, mbh	378.0
23. Condenser Tube Removal Area	
Equipment Mark No.	2HVT-UC212A, 212B
Quantity	2
Each unit cooler includes the following components:	
a. Fan	
Type	Propeller
Quantity (per unit cooler)	2
Capacity, each, cfm	7,150

TABLE 9.4-5 (Historical)
(Cont'd.)

Total pressure, each, in W.G.[1]	0.66
Motor, each, hp	2
b. Cooling Coil	
Type	Finned, tubular
Cooling medium	Service water
Cooling capacity, mbh	262.0
24. Main Steam Lead Enclosure	
Equipment Mark No.	2HVT-UC211
The unit cooler includes the following components:	
a. Fan	
Type	Propeller
Capacity, cfm	4,175
Total pressure, in W.G.[1]	0.74
Motor, hp	1.5
b. Cooling Coil	
Type	Finned, tubular
Cooling medium	Service water
Cooling capacity, mbh	70.0
25. Air Compressor Area	
Equipment Mark No.	2HVT-UC226
The unit cooler includes the following components:	
a. Fan	
Type	Propeller
Quantity	2
Capacity, each, cfm	7,150
Total pressure, each, in W.G.[1]	0.54
Motor, each, hp	2
b. Cooling Coil	
Type	Finned, tubular
Cooling medium	Service water
Cooling capacity, mbh	200.0

TABLE 9.4-5 (Historical)
(Cont'd.)

26. Steam Tunnel

Equipment Mark No.	2HVT-UC210A

The unit cooler includes the following components:

a. Fan

Type	Vaneaxial
Capacity, cfm	10,450
Total pressure, in W.G.[1]	1.85
Motor, hp	5

b. Cooling Coil

Type	Finned, tubular
Cooling medium	Service water
Cooling capacity, mbh	191.0

27. Steam Tunnel

Equipment Mark No.	2HVT-UC210B

The unit cooler includes the following components:

a. Fan

Type	Propeller
Quantity (per unit cooler)	2
Capacity, each, cfm	5,225
Total pressure, each, in W.G.[1]	0.70
Motor, each, hp	2

b. Cooling Coil

Type	Finned, tubular
Cooling medium	Service water
Cooling capacity, mbh	191.0

<u>Unit Heaters</u>

1. Generator Area

a.

Equipment Mark No.	2HVT-UHE237, 238, 239, 240, 243, 244, 245, 246
Quantity	8
Type	Electric
Capacity, each, kW	30

TABLE 9.4-5 (Historical)
(Cont'd.)

2.	East of Turbine Area	
a.	Equipment Mark No.	2HVT-UHE227
	Type	Electric
	Capacity, kW	20
b.	Equipment Mark No.	2HVT-UHE228,241
	Quantity	2
	Type	Electric
	Capacity, each, kW	50
3.	Ventilation Exhaust Equipment Area	
	Equipment Mark No.	2HVT-UHE230 through 235
	Quantity	6
	Type	Electric
	Capacity, each, kW	20
4.	North Moisture Separator Reheater Area	
	Equipment Mark No.	2HVT-UHE236
	Type	Electric
	Capacity, kW	20
5.	South Moisture Separator Reheater Area	
	Equipment Mark No.	2HVT-UHE242
	Type	Electric
	Capacity, kW	20
6.	Clean Steam Reboiler Area	
	Equipment Mark No.	2HVT-UHE229
	Type	Electric
	Capacity, kW	7.5
7.	Elevator Machine Room 1	
	Equipment Mark No.	2HVT-UHE257
	Type	Electric
	Capacity, kW	7.5
8.	Elevator Machine Room 2	
	Equipment Mark No.	2HVT-UHE258
	Type	Electric
	Capacity, kW	12.5

TABLE 9.4-5 (Historical)
(Cont'd.)

9.	Elevator Machine Room 3	
	Equipment Mark No.	2HVT-UHE255
	Type	Electric
	Capacity, kW	12.5
10.	Ventilation Supply Equipment Area	
	Equipment Mark No.	2HVT-UHE219, 220
	Quantity	2
	Type	Electric
	Capacity, kW	30
11.	Generator Lead Coolers Area	
	Equipment Mark No.	2HVT-UHE221, 225, 226
	Quantity	3
	Type	Electric
	Capacity, each, kW	7.5
12.	Charcoal Decay Bed Room	
	Equipment Mark No.	2HVT-UHE253, 254
	Quantity	2
	Type	Electric
	Capacity, each, kW	20
13.	Condenser Tube Removal Area	
	Equipment Mark No.	2HVT-UHE223, 224
	Quantity	2
	Type	Electric
	Capacity, each, kW	7.5
14.	East of Tube Removal Area	
	Equipment Mark No.	2HVT-UHE218, 222
	Quantity	2
	Type	Electric
	Capacity, each, kW	7.5
15.	Railroad Passage	
	a. Equipment Mark No.	2HVT-UHE211, 212
	Quantity	2
	Type	Electric
	Capacity, each, kW	40

TABLE 9.4-5 (Historical)
(Cont'd.)

b.	Equipment Mark No.	2HVT-UHE210, 249
	Quantity	2
	Type	Electric
	Capacity, each, kW	50
16.	Offgas Area	
	Equipment Mark No.	2HVT-UHE208, 209
	Quantity	2
	Type	Electric
	Capacity, each, kW	7.5
17.	Generation Area	
	Equipment Mark No.	2HVT-UHE207
	Type	Electric
	Capacity, kW	7.5
18.	Condensate Pump Area	
	a. Equipment Mark No.	2HVT-UHE217
	Type	Electric
	Capacity, kW	7.5
	b. Equipment Mark No.	2HVT-UHE213
	Type	Electric
	Capacity, kW	20
19.	Reactor Feed Pumps Area	
	Equipment Mark No.	2HVT-UHE205, 206
	Quantity	2
	Type	Electric
	Capacity, each, kW	7.5
20.	Condenser Tube Removal Area	
	Equipment Mark No.	2HVT-UHE216
	Type	Electric
	Capacity, kW	7.5
21.	Heater Bay A	
	Equipment Mark No.	2HVT-UHE204
	Type	Electric
	Capacity, kW	7.5

TABLE 9.4-5 (Historical)
(Cont'd.)

22. Heater Bay B	
Equipment Mark No.	2HVT-UHE203
Type	Electric
Capacity, kW	7.5
23. Heater Bay C	
Equipment Mark No.	2HVT-UHE202
Type	Electric
Capacity, kW	7.5
24. North and South of Main Steam Lead Enclosure	
Equipment Mark No.	2HVT-UHE201, 214, 215
Quantity	3
Type	Electric
Capacity, each, kW	7.5

(1) Total static pressure.
(2) Fan external static pressure.

TABLE 9.4-6 (Historical)

DESIGN DATA OF PRINCIPAL EQUIPMENT -
SERVICE BUILDING HEATING AND VENTILATING SYSTEM

Access Passageway	
Supply Air Fan	
Equipment Mark No.	2HVE-FN3
Type	Propeller, roof mounted
Capacity, cfm	1,900
Total pressure, in W.G.[1]	0.42
Motor, hp	1/2
Exhaust Fan	
Equipment Mark No.	2HVE-FN4
Type	Propeller, roof mounted
Capacity, cfm	1,700
Total pressure, in W.G.[1]	0.14
Motor, hp	1/2
Unit Heaters	
Equipment Mark No.	2HVE-UHE513, 514
Quantity	2
Type	Electric
Capacity, each, kW	7.5
Duct Air Heater	
Equipment Mark No.	2HVE-CH1
Type	Electric
Capacity, kW	35
Foam Room	
Exhaust Fan	
Equipment Mark No.	2HVE-FN2
Quantity	1
Type	Propeller, roof mounted
Capacity, cfm	4,300
Total pressure, in W.G.[1]	0.20
Motor, hp	3/4

TABLE 9.4-6 (Historical)
(Cont'd.)

Unit Heaters	
Equipment Mark No.	2HVE-UHE506, 507, 508, 509
Quantity	4
Type	Electric
Capacity, each, kW	7.5
I&C Shop	
I&C Air Conditioning Unit	
Equipment Mark No.	2HVE-ACU1
Type	Package, rooftop
The unit includes the following components:	
Supply Fan:	
Type	Centrifugal
Capacity, cfm	4,000
Total pressure, in W.G.[(1)]	0.75
Motor, hp	3
Filter:	
Type	Disposable
Media	Fiberglass
Efficiency, %	10
Cooling Coil:	
Type	Finned tubular
Cooling medium	Refrigerant
Cooling capacity, mbh	180
Heating Coil:	
Type	Electric
Capacity, kW	49
Baseboard Heaters	
Equipment Mark No.	2HVE-H1, H2, H3
Quantity	3
Type	Electric
Capacity, kW	1.5
Equipment Mark No.	2HVE-H4, H5, H6
Quantity	3
Type	Electric
Capacity, kW	2.5

TABLE 9.4-6 (Historical)
(Cont'd.)

Service Water Valve Pit

Unit Heaters

Equipment Mark No.	2HVE-UHE510, 515, 516, 517
Quantity	4
Type	Electric
Capacity, each, kW	7.5

Entrance Corridor

Unit Heaters

Equipment Mark No.	2HVE-UHE511, 512
Quantity	2
Type	Electric
Capacity, each, kW	7.5

(1) Fan external static pressure.

TABLE 9.4-7 (Historical)

DESIGN DATA OF PRINCIPAL EQUIPMENT -
DIESEL GENERATOR BUILDING HVAC SYSTEM

Diesel Generator Rooms Normal Ventilation Exhaust Fans (Diesel engines not operating)	
Equipment Mark No.	2HVP-FN3A, 3B, 4
Quantity	3 (1 fan/room)
Type	Vaneaxial
Capacity, each, cfm	1,540
Total pressure, each, in W.G.	0.75
Motor, each, hp	1
Diesel Generator Rooms Emergency Ventilation Exhaust Fans (Diesel engines operating)	
Equipment Mark No.	2HVP*FN1A, 1B, 1C, 1D, 2A, 2B
Quantity	6 (2 fans/room)
Type	Vaneaxial
Capacity, each, cfm	45,500
Total pressure, each, in W.G.	2.88
Motor, each, hp	30
Diesel Generator Building Control Rooms Unit Coolers	
Equipment Mark No.	2HVP*UC1A, 1B, 2
Quantity	3 (1 unit/control room)
Each unit cooler consists of the following components:	
1. Fan:	
Type	Vaneaxial
Capacity, cfm	3,400
Total pressure, in W.G.	3.4
Motor, hp	5
2. Cooling coil:	
Type	Finned, tubular
Cooling medium	Service water
Cooling capacity, mbh	59.0
3. Filter:	
Type	Disposable
Media	Fiberglass
Efficiency, NBS dustspot, %	50

TABLE 9.4-7 (Historical)
(Cont'd.)

Makeup Air System

The system consists of the following components:

1. Fan:

Equipment Mark No.	2HVP-FN5
Type	Vaneaxial
Capacity, cfm	4,620
Total pressure, in W.G.	2.55
Motor, hp	5

2. Heater:

Equipment Mark No.	2HVP-CH1
Type	Electric
Capacity, kW	125

3. Filter:

Equipment Mark No.	2HVP-FLT1
Type	Disposable
Media	Fiberglass
Efficiency, NBS dustspot, %	50

Unit Heaters

Equipment Mark No.	2HVP-UHE601 through 608
Quantity	8
Type	Electric
Capacity, each, kW	20

TABLE 9.4-8 (Historical)

DESIGN DATA OF PRINCIPAL EQUIPMENT -
MISCELLANEOUS BUILDINGS HVAC SYSTEMS

Screenwell Building

1. Supply Air System:

a. Fans:

Equipment Mark No.	2HVY-FN9A, 9B, 9C
Quantity	3 (50% capacity each)
Type	Vaneaxial
Capacity, each, cfm	40,000
Total pressure, each, in W.G.	5.18
Motor, each, hp	50

b. Filter:

Equipment Mark No.	2HVY-FLT2
Type	Disposable
Media	Fiberglass
Efficiency, NBS dustspot, %	50

2. Circulating Water Pump Area Exhaust Fans:

Equipment Mark No.	2HVY-FN5A, 5B
Quantity	2 (100% capacity each)
Type	Vaneaxial
Capacity, each, cfm	60,000
Total pressure, each, in W.G.	3.64
Motor, each, hp	50

3. Screen Backwash Pump Area Fan:

Equipment Mark No.	2HVY-FN10
Quantity	1
Type	Tubeaxial
Capacity, cfm	5,600
Total pressure, in W.G.[(2)]	0.45
Motor, hp	1.5

4. Ventilation Exhaust Fans:

Equipment Mark No.	2HVY-FN3A, 3B
Quantity	2
Type	Propeller, roof mounted
Capacity, each, cfm	9,350
Total pressure, each, in W.G.[(2)]	0.091
Motor, each, hp	1

TABLE 9.4-8 (Historical)
(Cont'd.)

5. Unit Heaters:	
a. Equipment Mark No.	2HVY-UHE808, 809
Quantity	2
Type	Electric
Capacity, each, kW	7.5
b. Equipment Mark No.	2HVY-UHE810 through 819
Quantity	10
Type	Electric
Capacity, each, kW	50
c. Equipment Mark No.	2HVY-UHE821, 822, 823
Quantity	3
Type	Electric
Capacity, each, kW	20
6. Relief Vents:	
Equipment Mark No.	2HVY-RFV1, RFV2
Quantity	2
Type	Hood, roof mounted
Capacity, each, cfm	60,000
<u>Service Water Pump Bays</u>	
1. Unit Coolers:	
Equipment Mark No.	2HVY*UC2A, 2B, 2C, 2D
Quantity	4
Each unit cooler consists of the following major components:	
a. Fan:	
Type	Vaneaxial
Capacity, cfm	30,000
Total pressure, in W.G.	5.0
Motor, hp	40
b. Filter:	
Type	Disposable
Media	Fiberglass
Efficiency, NBS dustspot, %	50
c. Cooling Coil:	
Type	Finned, tubular
Cooling medium	Service water
Cooling capacity, mbh	460.0

TABLE 9.4-8 (Historical)
(Cont'd.)

2. Smoke Exhaust Fan:	
Equipment Mark No.	2HVY-FN17
Type	Centrifugal
Capacity, cfm	6,000
Total pressure, in W.G.[(2)]	2.13
Motor, hp	5
3. Unit Heaters:	
Equipment Mark No.	2HVY-UHE807, 820
Quantity	2
Type	Electric
Capacity, each, kW	7.5
<u>Fire Pump Rooms</u>	
1. Diesel Fire Pump Room Supply Fan:	
Equipment Mark No.	2HVY-FN11
Type	Vaneaxial
Capacity, cfm	10,100
Total pressure, in W.G.	1.54
Motor, hp	5
2. Diesel Fire Pump Room Exhaust Fan:	
Equipment Mark No.	2HVY-FN7
Type	Propeller, roof mounted
Capacity, cfm	1,300
Total pressure, in W.G.[(2)]	0.26
Motor, hp	0.5
3. Motor Fire Pump Room Unit Cooler:	
Equipment Mark No.	2HVY-UC1
The unit cooler consists of the following major components:	
a. Fan:	
Type	Propeller
Capacity, cfm	8,200
Total pressure, in W.G.[(1)]	0.53
Motor, hp	3.0
b. Cooling Coil:	
Type	Finned, tubular
Cooling medium	Fire protection water
Cooling capacity, mbh	123.0

TABLE 9.4-8 (Historical)
(Cont'd.)

4. Unit Heater:	
Equipment Mark No.	2HVY-UHE805
Type	Electric
Capacity, kW	12.5
5. Relief Vent:	
Equipment Mark No.	2HVY-RFV3
Type	Hood, roof mounted
Capacity, cfm	8,200
<u>Demineralized Water Storage Tank Building</u>	
1. Ventilation Exhaust Fan:	
Equipment Mark No.	2HVY-FN8
Type	Propeller, roof mounted
Capacity, cfm	4,300
Total pressure, in W.G.[(2)]	0.13
Motor, hp	3/4
2. Unit heaters:	
Equipment Mark No.	2HVY-UHE801, 802, 803, 804
Quantity	4
Type	Electric
Capacity, each, kW	30
<u>Condensate Storage Tank Building</u>	
1. Ventilation Exhaust Fans:	
Equipment Mark No.	2HVY-FN4A, 4B
Quantity	2
Type	Propeller, roof mounted
Capacity, each, cfm	16,600
Total pressure, each, in W.G.[(2)]	0.10
Motor, each, hp	2
2. Condensate Tanks Overflow Exhaust Fans:	
Equipment Mark No.	2HVY-FN18A, 18B
Quantity	2 (100% capacity each)
Type	Vaneaxial
Capacity, each, cfm	2,160
Total pressure, each, in W.G.	4.50
Motor, each, hp	5

TABLE 9.4-8 (Historical)
(Cont'd.)

3. Unit Heaters:	
Equipment Mark No.	2HVY-UHE881 through 886
Quantity	6
Type	Electric
Capacity, each, kW	20
Electrical Bays	
1. Supply Air Fan:	
Equipment Mark No.	2HVY-FN16
Quantity	1
Type	Propeller, wall mounted
Capacity, cfm	4,300
Total pressure, in W.G.[(2)]	0.46
Motor, hp	1
2. Exhaust Fans:	
Equipment Mark No.	2HVY-FN15A, 15B
Quantity	2
Type	Propeller, roof mounted
Capacity, each, cfm	17,000
Total pressure, each, in W.G.[(2)]	0.90
Motor, each, hp	7.5
3. Unit Heaters:	
Equipment Mark No.	2HVY-UHE841 through 849
Quantity	9
Type	Electric
Capacity, each, kW	12.5
4. Relief Vent:	
Equipment Mark No.	2HVY-RFV5
Type	Hood, roof mounted
Capacity, cfm	4,300
Screenhouse	
1. Unit Heaters:	
Equipment Mark No.	2HVY-UHE903, 904, 905, 906
Quantity	4
Type	Electric
Capacity, each, kW	12.5

TABLE 9.4-8 (Historical)
(Cont'd.)

<u>Chiller Building</u>

1.	Exhaust Fans:	
	Equipment Mark No.	2HVY-FN19A, 19B
	Quantity	2
	Type	Propeller, roof mounted
	Capacity, each, cfm	3,600
	Total pressure, each, in W.G.[2]	0.10
	Motor, each, hp	1/2
2.	Unit Heaters:	
	Equipment Mark No.	2HVY-UHE900, 901, 902
	Quantity	3
	Type	Electric
	Capacity, each, kW	20

(1) Total static pressure.
(2) Fan external static pressure.

TABLE 9.4-9 (Historical)

DESIGN DATA OF PRINCIPAL EQUIPMENT -
AUXILIARY BOILER BUILDING HEATING AND VENTILATING SYSTEM

Air Handling Units	
Equipment Mark No.	2HVI-HVU1A, 1B
Quantity	2 (100% capacity each)
Type	Packaged, roof-mounted
Each unit includes the following components:	
Fan	
Type	Centrifugal
Capacity, cfm	23,000
Total pressure, in W.G.[1]	2.00
Motor, hp	20
Filter	
Type	Disposable
Media	Fiberglass
Efficiency, NBS dustspot, %	40
Heating coil	
Type	Electric
Capacity, kW	100.0
Return/Exhaust Fans	
Equipment Mark No.	2HVI-FN2A, 2B
Quantity	2 (100% capacity each)
Type	Vaneaxial
Capacity each, cfm	23,000
Total pressure, each, in W.G.	6.0
Motor, each, hp	40
Unit Heaters	
Equipment Mark No.	2HVI-UHE701, 702, 703, 704
Quantity	4
Type	Electric
Capacity, each, kW	20

[1] Fan external static pressure.

TABLE 9.4-10 (Historical)

DESIGN DATA OF PRINCIPAL EQUIPMENT -
AUXILIARY SERVICE BUILDING HVAC SYSTEM

<u>Auxiliary Service Building Air Conditioning Unit</u>	
Equipment Mark No.	2HVL-ACUI
Type	Package, rooftop
The unit includes the following components:	
1. Supply fan:	
Type	Centrifugal
Capacity, cfm	10,000
Total pressure, in W.G.(1)	2.0
Motor, hp	15
2. Filter:	
Type	Disposable
Media	Fiberglass
Efficiency, NBS dustspot, %	35
3. Cooling coil:	
Type	Finned, tubular
Cooling medium	Refrigerant
Cooling capacity, mbh	306.0
4. Heating coil:	
Type	Electric
Capacity, kW	51.7
<u>Auxiliary Service Building Exhaust Fan</u>	
Equipment Mark No.	2HVL-FN5
Type	Centrifugal, floor mounted
Capacity, cfm	2,500
Total pressure, in W.G.(1)	1.25
Motor, hp	1.0
<u>Auxiliary Service Building Duct Air Heaters</u>	
Equipment Mark No.	2HVL-CHI
Type	Electric
Capacity, kW	78
Equipment Mark No.	2HVL-CH2
Type	Electric
Capacity, kW	12

TABLE 9.4-10 (Historical)
(Cont'd.)

Clean Access Area Exhaust Fan	
Equipment Mark No.	2HVL-FN4
Type	In-line centrifugal
Capacity, cfm	4,000
Total pressure, in W.G.[1]	3.00
Motor, hp	5
Clean Access Area Duct Air Heaters	
Equipment Mark No.	2HVL-CH3, 4
Quantity	2
Type	Electric
Capacity, each, kW	60
CO_2 Tank Room Exhaust Fan	
Equipment Mark No.	2HVL-FN1
Type	Propeller, roof mounted
Capacity, cfm	1,700
Total pressure, in W.G.[1]	0.23
Motor, hp	1/4
CO_2 Tank Room Gravity Intake Hood	
Equipment Mark No.	2HVL-HDI
Type	Roof mounted
Capacity, cfm	1,700
CO_2 Tank Room Unit Heaters	
Equipment Mark No.	2HVL-UHE901, 902
Quantity	2
Type	Electric
Capacity, each, kW	12.5

[1] Fan external static pressure

TABLE 9.4-11 (Historical)

DESIGN DATA OF PRINCIPAL EQUIPMENT
PLANT CHILLED WATER SYSTEM

<u>Control Building Chilled Water System</u>	
1. Liquid Chillers:	
Equipment Mark No.	2HVK*CHL1A, 1B
Quantity	2 (100% capacity each)
Type	Centrifugal
Refrigerant	R-11
Capacity, each, tons	145
Entering chilled water temperature, °F	55
Leaving chilled water temperature, °F	45
Chilled water flow rate, each, gpm	340
Condenser water flow rate, each, gpm	340
2. Chilled Water Pumps:	
Equipment Mark No.	2HVK*P1A, 1B
Quantity	2 (100% capacity each)
Type	Centrifugal
Capacity, each, gpm	350
Total head, each, ft	85
Motor, each, hp	15
3. Expansion Tanks:	
Equipment Mark No.	2HVK*TK1A, 1B
Quantity	2 (one per system)
Capacity, each, gal	30
Design pressure, psig	125
<u>Ventilation Chilled Water System</u>	
1. Liquid Chillers:	
Equipment Mark No.	2HVN-CHL1A, 1B, 1C
Quantity	3 (50% capacity each)
Type	Hot water absorption
Capacity, each, tons	400
Hot water flow rate, each, gpm	576
Entering hot water temperature, °F	250
Leaving hot water temperature, °F	225
Entering chilled water temperature, °F	58

TABLE 9.4-11 (Historical)
(Cont'd.)

	Leaving chilled water temperature, °F	48
	Chilled water flow rate, each, gpm	960
	Condenser water flow rate, each, gpm	1,550
2.	Chilled Water Pumps:	
	Equipment Mark No.	2HVN-P1A, 1B
	Quantity	2 (100% capacity each)
	Type	Centrifugal
	Capacity, each, gpm	1,920
	Total head, each, ft	150
	Motor, each, hp	125
3.	Service Water Pumps:[1]	
	Equipment Mark No.	2HVN-P2A, 2B
	Quantity	2 (100% capacity each)
	Type	Centrifugal
	Capacity, each, gpm	3,100
	Total head, each, ft	90
	Motor, each, hp	125
4.	Expansion Tank:	
	Equipment Mark No.	2HVN-TK1
	Capacity, gal	400
	Design pressure, psig	150

[1] These pumps are booster pumps, delivering service water for use as absorption chillers condenser water.

TABLE 9.4-12 (Historical)

DESIGN DATA FOR THE PLANT GLYCOL AND HOT WATER HEATING SYSTEMS

Turbine Building	
1. Glycol Heating Pumps:	
Equipment Mark No.	2HVG-P1A, 1B
Quantity	2
Type	Horizontal centrifugal
Capacity, each, gpm	470
Total head, each, ft	75
Motor, each, hp	15
2. Glycol Heat Exchanger:	
Equipment Mark No.	2HVG-E1
Quantity	1
Type	Two-pass tube; one-pass shell; fixed tube sheet at both ends
Design pressure, psig	Shell: 350 Tube: 125
Design temperature, °F	Shell: 300 Tube: 275
Total duty, mbh	Shell: 8,812 Tube: 8,812
3. Air Separator:	
Equipment Mark No.	2HVG-ASP1
Quantity	1
Type	Rolairtrol
Capacity, gpm	850
Maximum working pressure, psig	125
Maximum operating temperature, °F	350
4. Heating Coils:	
Equipment Mark No.	2HVT-CH1
Quantity	4 units right hand
Type	Aerofin Type C
Capacity, total, cfm	80,000
Load, total, mbh	7,412
5. Glycol Addition Tank:	
Equipment Mark No.	2HVG-TK4
Quantity	1
Type	Horizontal

TABLE 9.4-12 (Historical)
(Cont'd.)

6. Glycol Loop Drainage Tank:	
Equipment Mark No.	2HVG-TK7
Quantity	1
Type	Horizontal
Capacity, gal	1,100
7. Expansion Tank:	
Equipment Mark No.	2HVG-TK1
Quantity	1
Type	Vertical
Capacity, gal	184
8. Hot Water Heating Pumps:	
Equipment Mark No.	2HVH-P1A, 1B
Quantity	2
Type	Horizontal centrifugal
Capacity, each, gpm	1,086
Total head, each, ft	170
Motor, each, hp	75
9. Building Heating Intermediate Heat Exchangers:	
Equipment Mark No.	2HVH-E1A, 1B
Quantity	2
Type	CEU - Horizontal
Design pressure, psig	Shell: 270 Tube: 350
Design temperature, °F	Shell: 418 Tube: 400
Total duty, mbh	Shell: 17,184 Tube: 17,184
10. Building Heating Auxiliary Heat Exchangers:	
Equipment Mark No.	2HVH-E3A, 3B
Quantity	2
Type	CEU - Horizontal
Design pressure, psig	Shell: 175 Tube: 350
Design temperature, °F	Shell: 377 Tube: 400
Total duty, mbh	Shell: 17,184 Tube: 17,184

TABLE 9.4-12 (Historical)
(Cont'd.)

11. Air Separator:	
Equipment Mark No.	2HVH-ASP1
Quantity	1
Type	Rolairtrol
Capacity, gpm	1,900
Maximum working pressure, psig	350
Maximum operating temperature, °F	650
12. Makeup Water Pumps:	
Equipment Mark No.	2HVH-P2A, 2B
Quantity	2
Type	Metering
Capacity, each, gph	40
Pressure, each, psig	300
Motor, each, hp	1/2
13. Expansion Tank:	
Equipment Mark No.	2HVH-TK1
Quantity	1
Type	Horizontal
Capacity, gal	430
<u>Reactor Building (Standby Gas Treatment Building)</u>	
1. Glycol Heating Pumps:	
Equipment Mark No.	2HVG-P2A, 2B
Quantity	2
Type	Horizontal centrifugal
Capacity, each, gpm	822
Total head, each, ft	115
Motor, each, hp	40
2. Glycol Heat Exchanger:	
Equipment Mark No.	2HVG-E2
Quantity	1
Type	Two-pass tube; one-pass shell; fixed tube sheet at both ends
Design pressure, psig	Shell: 350 Tube: 125
Design temperature, °F	Shell: 375 Tube: 275
Total duty, mbh	Shell: 15,422 Tube: 15,422

TABLE 9.4-12 (Historical)
(Cont'd.)

3.	Air Separator:	
	Equipment Mark No.	2HVG-ASP2
	Quantity	1
	Type	Rolairtrol
	Capacity, gpm	850
	Maximum working pressure, psig	125
	Maximum operating temperature, °F	350
4.	Heating Coils:	
	Equipment Mark No.	2HVR-CH1
	Quantity	4 units left hand 4 units right hand
	Type	Aerofin Type C
	Capacity, total, cfm	140,000
	Load, total, mbh	12,968
5.	Glycol Addition Tank:	
	Equipment Mark No.	2HVG-TK5
	Quantity	1
	Type	Horizontal
6.	Glycol Loop Drainage Tank:	
	Equipment Mark No.	2HVG-TK8
	Quantity	1
	Type	Horizontal
	Capacity, gal	1,300
7.	Expansion Tank:	
	Equipment Mark No.	2HVG-TK2
	Quantity	1
	Type	Vertical
	Capacity, gal	184
Radwaste Building		
1.	Glycol Heating Pumps:	
	Equipment Mark No.	2HVG-P3A, 3B
	Quantity	2
	Type	Horizontal centrifugal
	Capacity, each, gpm	235
	Total head, each, ft	90
	Motor, each, hp	7 1/2

TABLE 9.4-12 (Historical)
(Cont'd.)

2. Glycol Heat Exchanger:	
Equipment Mark No.	2HVG-E3
Quantity	1
Type	Two-pass tube; one-pass shell; fixed tube sheet at both ends
Design pressure, psig	Shell: 350 Tube: 125
Design temperature, °F	Shell: 375 Tube: 275
Total duty, mbh	Shell: 4,410 Tube: 4,410
3. Air Separator:	
Equipment Mark No.	2HVG-ASP3
Quantity	1
Type	Rolairtrol
Capacity, gpm	300
Maximum working pressure, psig	125
Maximum operating temperature, °F	350
4. Heating Coils:	
Equipment Mark No.	2HVW-CH1
Quantity	2 units right hand
Type	Aerofin Type C
Capacity, total, cfm	47,800
Load, total, mbh	4,410
5. Glycol Addition Tank:	
Equipment Mark No.	2HVG-TK6
Quantity	1
Type	Horizontal
6. Glycol Loop Drainage Tank:	
Equipment Mark No.	2HVG-TK9
Quantity	1
Type	Horizontal
Capacity, gal	500
7. Expansion Tank:	
Equipment Mark No.	2HVG-TK3
Quantity	1
Type	Vertical
Capacity, gal	50

9.5 OTHER AUXILIARY SYSTEMS

9.5.1 Fire Protection System

9.5.1.1 Design Bases

The overall Unit 2 fire protection program is based on an evaluation of potential fire hazards throughout the plant and the effect of fires relative to maintaining the ability to perform safe shutdown functions and to minimize radioactive releases to the environment. The Unit 2 fire protection program conforms with the requirement of GDC 3 of Appendix A to 10CFR50. In addition, requirements stated in the following documents were considered in the design and evaluation of the fire protection systems:

1. Appendix A to NRC BTP APCSB 9.5-1 dated August 23, 1976.

2. Basic Fire Protection for Nuclear Power Plants, April 1976, American Nuclear Insurers.

3. National Fire Codes, National Fire Protection Association, up to the 1981 Edition.

Deviations from these requirements are forwarded to the Fire Protection Program Manager to assess the following:

1. Impact on current design.

2. Position regarding the deviation (modify/justify).

3. Initiation of corrective action.

Engineering evaluations in support of the deviations are performed and maintained on file, as required.

The intent of the fire protection program is to provide the concept of the defense-in-depth principle by achieving an adequate balance in:

1. Preventing fires from starting.

2. Detecting fires quickly, suppressing those fires that occur, putting them out quickly, and limiting their damage.

3. Designing plant safety systems so that a fire that starts in spite of the fire prevention program and burns for a considerable time in spite of fire suppression does not prevent essential plant safety functions from being performed.

Questions of separation or protection of safety-related equipment are evaluated to determine the ability of plant systems to achieve and maintain safe shutdown in Final Safety Analysis Report (FSAR) Appendix 9B, in accordance with the requirements of 10CFR50 Appendix R, Section III.G, using the guidance given in NRC Generic Letter 86-10.

Fire protection system components which, as a result of their collapse due to an earthquake, may damage safety-related systems or components, are designed with seismic supports to prevent such an occurrence.

The fire hazards analysis (FHA), which includes review of safety-related components, the fire detection and suppression systems for each building, safe shutdown analysis, and radioactive release analysis, is described in Appendix 9A. The fire suppression systems are illustrated on Figures 9.5-1 through 9.5-4.

In order to develop data meaningful to the FHA, the plant has been divided into fire areas, which have been further subdivided into fire zones. The hazards analysis for each fire area/zone detailing location, combustible quality and quantity, fire load, estimated duration of possible fire, safety-related and nonsafety-related equipment, electrical cable description, detection, and suppression, is described in Tables 9A.3-1 through 9A.3-12.

A point-by-point comparison of the Unit 2 fire protection program with the position of NRC BTP CMEB 9.5-1, Revision 2, dated July 1981, Guidelines for Fire Protection for Nuclear Power Plants, is shown in Section 9A.

Throughout various sections of this analysis, references are made to specific codes and standards used in the design, installation and testing of fire protection systems provided in support of the overall program. This also includes fire prevention aspects of the program. Since these standards are reviewed periodically, the appropriate revision at the time of system design or modification would be used for future design reviews. Where appropriate, subtle changes in code provisions may be incorporated into the program.

Specific deviations to requirements stated in NFPA Standards are summarized in Table 9.5-3.

The fire protection program incorporates the attributes of noncombustible materials; fire barriers; fire-resistive materials; minimization of fire loads; fire exits; smoke removal and venting; drainage; fire pumps, hydrants, standpipe and hose system; sprinkler and spray systems; CO_2 and Halon systems; portable extinguishers; fire detection and signaling system; fire seals; breathing apparatus, emergency lights, plant Fire Brigade; fire drills; maintenance, inspection, and testing. Appropriate

backup fire suppression capability is provided throughout the plant to limit the extent of fire damage.

Storage and use of flammable liquids is in accordance with existing safety practices. Details of flammable liquids handling procedures are provided in Section 9A.3.5.4.4. The QA program is described in Section 9A.3.4.

9.5.1.2 System Description

The fire protection system consists of a reliable freshwater supply, one electric motor-driven fire pump and one diesel engine-driven fire pump (vertical turbine pumps taking suction from the screenwell pit), two 30-gpm (at 135 psig) pressure maintenance fire pumps, one 300-gal pressure maintenance pump supply tank, one 150-gal hydropneumatic tank, fire water yard mains, hydrants, standpipes, hose stations, sprinkler, water spray, preaction and deluge systems, foam-water deluge systems, low-pressure CO_2 systems, Halon 1301 systems, portable extinguishers, breathing apparatus, detection and signaling system, fire barriers, and egress facilities.

9.5.1.2.1 Water Supply

The water source for the fire protection system is Lake Ontario, which is considered to be an unlimited supply. Each fire pump takes suction from the service water intake tunnel in the Unit 2 screenwell building (see Section 9.2.5 for a description of the intake system). Trash racks and traveling screens are located upstream of the pump suctions to remove any major debris from the water. Fire pump/service water intakes are 54 in in diameter and have a capacity of 51,000 gpm. The water supply for the fire pumps is sufficient to meet the largest expected fire demand as described in Appendix 9A, Section 9A.3.6.2.9. Either fire pump is capable of providing this expected largest demand flow. The yard fire protection loop for Unit 2 is interconnected with the Unit 1 fire loop by two normally closed valves, one post-indicating valve and one motor-operated valve (MOV). The existing fire pumps at Unit 1 can be utilized for system pressure maintenance and firefighting at Unit 2, if necessary.

9.5.1.2.2 Fire Pumps

One electric motor-driven and one diesel engine-driven fire pump are provided. Each pump is rated at 2,500 gpm (at 125 psig), and is located in a 3-hr rated enclosure in the screenwell building. Pumps and discharge lines to the underground loop are provided with sectionalizing shutoff valves, so no single impairment incapacitates more than one pump.

System pressure is maintained continuously between 120 and 135 psig by jockey pumps and a hydropneumatic tank. The fire pumps are automatically started by actuation of pressure switches located on the discharge side of the pumps or manually from the

control room, and stopped manually at the fire pump room. If the system pressure drops and cannot be maintained by the jockey pumps, the electric motor-driven pump and the diesel engine-driven fire pump are automatically started to provide required system pressures and flows. Except for the items listed in Table 9.5-3, fire pumps comply with NFPA Standard 20.

9.5.1.2.3 Yard Piping

The plant underground fire protection system piping is cement-lined, ductile iron pipe with mechanical joints and cast-iron fittings. Looped mains with post-indicator sectional valves or key-operated valves with valve boxes are provided to isolate portions of the system for maintenance or repair, without shutting off the supply of primary and backup fire suppression systems serving other areas that contain or expose safety-related equipment. Yard piping complies with NFPA Standard 24, with the exceptions discussed in Section 9A.3.6.2.1 and Table 9.5-3. Hydrants are provided on the yard main at approximately 250-ft intervals. Fire hose and other equipment necessary to establish an effective hose stream are available for use by the Fire Brigade. Yard piping and hydrant locations are discussed in Appendix 9A (Section 9A.3.6.2) and shown on Figure 9A.3-1.

9.5.1.2.4 Hose Stations

Standpipe and hose systems comply with NFPA Standard 14. Individual standpipes are 4 in in diameter for multiple hose connections and 2-1/2 in in diameter for single hose connections. Hose stations equipped with 100 ft of 1 1/2-in NFPA compliant fire hose are provided in each building. In some cases, 150 ft of hose is provided in accordance with Tables 9.5-3 and 9.5-3a. Hose station piping in safety-related areas is supported for SSE loading. Additional details of hose stations are included in Appendix 9A (Sections 9A.3.6.3.4 and 9A.3.6.3.5).

9.5.1.2.5 Wet-Pipe Sprinkler Systems

Wet-pipe sprinkler systems comply with NFPA Standard 13. Wet-pipe sprinkler systems with closed sprinklers are provided in the turbine building (lube oil reservoir room, and clean and dirty oil storage rooms), screenwell building (diesel fire pump room), service building, radwaste building (solid waste process and storage areas, truck dock, liquid radwaste fiberglass tank areas, and cable trays), control building (cable chases and above cable risers), reactor building (above cable risers), auxiliary bays (above cable risers), decontamination area, electrical tunnels, the electrical bay, and the CST building. Operation of the sprinkler system is signaled locally and in the main control room. Additional details are provided in Appendix 9A.

9.5.1.2.6 Dry-Pipe Sprinkler System

Except for the items listed in Table 9.5-3, the dry-pipe sprinkler system conforms to the requirements of NFPA Standard 13. Dry-pipe sprinkler systems are provided to protect the railroad bay areas in the reactor building and turbine building. Dry-pipe sprinkler system operation is signaled locally and in the main control room. Additional details are included in Appendix 9A.

9.5.1.2.7 Preaction Sprinkler Systems

Except for the items listed in Table 9.5-3, preaction sprinkler systems comply with NFPA Standards 13 and 15, as applicable. Preaction systems with closed-sprinklers and deluge valves are provided in the diesel generator rooms, turbine building (el 277 ft 6 in and 250 ft, general area, and cable tray protection), radwaste building (dry compacted waste storage and gear lube oil areas), and reactor building (cable tray protection). System piping integrity is pneumatically supervised. Operation of preaction sprinkler systems is signaled locally and in the main control room. Additional details are included in Appendix 9A.

9.5.1.2.8 Water Deluge Systems

Except for the items listed in Table 9.5-3, water deluge systems comply with NFPA Standards 13 and 15 as applicable. Water deluge systems are hydraulically designed, utilizing open directional solid cone spray nozzles, and are actuated automatically or manually. These systems are provided as follows:

1. Automatically-actuated, open-nozzle water deluge systems are provided to protect yard transformers, reactor feed pumps, RCIC room in the reactor building, hydrogen seal oil unit, turbine building truck aisle, and radwaste extruder.

2. With the exception of filtration units 2HVC-FLT1A, 2HVC-FLT1B, and 2HVR-FLT3, manually-actuated, open-nozzle water deluge systems are provided to protect charcoal filters in the control building and standby gas treatment building, and turbine generator oil piping and bearings in the turbine building.

Operation of each water deluge system is signaled locally and in the main control room. Additional details are included in Appendix 9A.

9.5.1.2.9 Carbon Dioxide Systems

CO_2 systems comply with NFPA Standard 12. The low-pressure CO_2 system consists of two 13-ton storage tanks (300 psig, 0°F), refrigeration unit, valves, and piping that conveys CO_2 to fixed nozzles at individual hazards. Total-flooding CO_2 systems are designed to be automatically actuated by cross-zoned smoke detectors (unless otherwise stated). However, the automatically-

actuated CO_2 systems have been placed in alarm-only mode due to life safety concerns until modifications to improve personnel safety are completed. Total-flooding systems are provided for:

1. Switchgear rooms located in the normal switchgear and turbine buildings.

2. Standby switchgear rooms A and B, and HPCS switchgear room in the control building.

3. 600-V switchgear room in the reactor building.

4. Radwaste switchgear room in the decontamination building.

5. Lube oil reservoir in the turbine building (manually-actuated system used for inerting the vapor space in 2LOS-TK1).

6. Alternator-exciter enclosure in the turbine building (extended discharge system, automatically actuated by cross-zoned thermal and photoelectric detectors in conjunction with the local application system for turbine generator bearing no. 11 and 12).

Manually-actuated local application systems are provided to protect turbine generator bearings and oil piping in the turbine building.

CO_2 hose stations are provided in the turbine, control, reactor, normal switchgear, and diesel generator buildings. Operation of each CO_2 system is signaled locally and in the main control room. Initiation of a total-flooding or local application system also energizes an alarm at or near the hazard. Additional details are included in Appendix 9A.

9.5.1.2.10 Halon 1301 Systems

Halon 1301 systems conform to the design and installation requirements of NFPA Standard No. 12A, 1980 Edition. These systems are provided to protect against cable fires in the floor sections of the power generation control complex (PGCC), the computer room (including beneath the raised floor area), and radwaste control room. Halon 1301 discharge is actuated either automatically by fire detectors or manually from the main control room or at local fire panels. The main control room PGCC system is actuated automatically by thermal detection. The radwaste control room and main computer room systems are actuated automatically by cross-zoned smoke detection. Operation of each Halon system is signaled locally and in the main control room. Additional data are included in Appendix 9A and NEDO-10466-A[1].

9.5.1.2.11 Portable Extinguishers

Except for the items listed in Table 9.5-3, portable extinguishers conform to the requirements of NFPA Standard 10. Type, size, and placement of extinguishers are determined after evaluation of the combustible present in each area. Additional details of portable extinguishers are included in Appendix 9A.

9.5.1.2.12 Breathing Apparatus

Self-contained breathing apparatus (SCBA) is provided in accordance with the National Institute for Occupational Safety and Health (NIOSH) guidelines. An onsite compressor is available to replenish exhausted air bottles.

9.5.1.2.13 Fire Detection Systems

Fire detection systems conform to the requirements of NFPA Code Standards 72D and 72E (except as noted in Table 9.5-3).

The thermal and smoke detection systems function to detect products of combustion, alarming both locally and in the main control room. Where suppression is automatic, the detection system functions to actuate associated suppression systems (e.g., turbine building preaction systems). In some cases, the control system includes appropriate components for the actuation of suppression systems locally and from the main control room.

Thermal and smoke detectors that alarm locally and in the main control room are also provided in general areas where the FHA does not justify the need for a fixed suppression system.

Additional details regarding fire detection systems are included in Section 9A.3.6.1.

9.5.1.2.14 Fire Barriers

Fire barriers are provided to contain the fire within the fire area. Exposed structural steel which is part of the barriers is fireproofed. UL fire-rated doors are provided in the fire-rated openings, except as detailed in Section 9A.3.5.1.4. Fire-rated seals are provided at every penetration in the fire-rated barriers. Additional details, including figures showing the locations of fire-rated walls and doors, are included in Appendix 9A.

9.5.1.2.15 Egress

Egress is provided from each fire area. Two-hr rated fire barriers with Class B doors are provided to enclose the stairways and elevator shafts to minimize fire spread potential. Two personnel egress paths from each fire area are provided except where a 50-ft or less common path of travel is available from any point in the fire area and the fire area is a low or ordinary hazard occupancy. Where the common path of travel is greater than 50 ft and only one exit is provided, justification for this

is based upon the occupancy classification and the number and frequency of occupants in accordance with NFPA 101 and 29CFR1910.

9.5.1.2.16 Building Construction

Noncombustible and fire-resistive building and interior finish materials are used wherever practical throughout the plant, particularly in structures containing safety-related systems and components. The flame spread and smoke and fuel contribution rating for permanent construction materials of major plant structures are below a rating of 25, except as discussed in Section 9A.3.5.1.7. All metal deck roof construction is FM Class 1 construction.

9.5.1.2.17 Drainage

Floor drains are described in Sections 9.3.3 and 9A.3.5.1.12. In areas with larger flows (deluge systems), pooling is expected but not to a degree to cause equipment flooding. Areas subject to combustible liquid spills utilize drainage systems which are trapped to prevent the spread of fire through drainage piping.

9.5.1.2.18 Yard Transformers

Yard transformers are separated by fire barrier walls. Transformers are protected by automatic water spray systems. Curbed, crushed-stone filled basins provide drainage at the transformers. Additional details are included in Appendix 9A.

9.5.1.2.19 Electrical Cable Protection

Electrical cables meet or exceed the requirements of IEEE-383-1974. Electrical cables are installed in noncombustible trays. Cable trays are installed in electrical tunnels, cable routing areas, and the majority of plant buildings. Generally, redundant cable trays routing circuits associated with systems necessary to achieve and maintain hot and cold shutdown are separated by 3-hr rated fire barriers. Protection of multiple tray stacks may be supplemented with wet-pipe, preaction, or water spray systems. Cables in the switchgear areas are protected by total-flooding CO_2 systems. Suppression systems for cable trays in other areas are provided on the basis of FHA and/or cable tray protection criteria.

Additional data are included in Appendix 9A. Electrical cable tray separation criteria are described in Section 8.3.1.4.

9.5.1.2.20 Seismic Design Requirements

The fire protection systems in safety-related areas are seismically supported so that failures of the fire suppression system do not incapacitate safety-related systems or components.

Additional details are included in Appendix 9A, Section 9A.3.1.3.3.

9.5.1.2.21 Ventilation

Electrical tunnels, all areas of the control building, and the normal switchgear building have smoke removal systems which have separate smoke exhaust fans, isolation dampers, and controls for the smoke removal mode. Smoke removal for other buildings is accomplished through the use of normal exhaust systems and smoke and heat vents. All areas having the potential for airborne contamination have radiation monitors. Additional details of ventilating and smoke removal systems are included in Section 9.4 and Appendix 9A, Section 9A.3.5.6.

9.5.1.3 Safety Evaluation (Fire Hazards Analysis)

The fire protection program allows the plant to maintain the ability to perform safe shutdown functions and minimize radioactive releases to the environment in the event of a fire. The safe shutdown analysis is described in Appendix 9B, and the radioactive release analysis is contained in the FHA described in Appendix 9A.

Potential fire hazards throughout the plant and the effect of postulated fires on safety-related plant areas are analyzed. The evaluation of analysis includes the consideration of fire loading, maximum fire intensity, and automatic and manual firefighting activities.

9.5.1.4 Inspection and Testing Requirements

NFPA standards are used as a basis for the development of periodic operational checks, inspections, and servicing required to maintain fire protection systems, including the alarm detection systems.

9.5.1.5 Personnel Qualification and Testing

Qualification and testing of personnel are described in Chapter 13.

9.5.2 Communication Systems

The plant communication systems are designed to provide reliable in-plant communication, communication with Unit 1, and plant-to-offsite communication during normal conditions and under maximum potential noise levels. The communication systems also provide for emergency alarms and evacuation signals. The systems for in-plant and Unit 2 to Unit 1 communications consist of:

1. A dial telephone system.

2. A portable radio communication system.

3. A page party/public address (PP/PA) communication system with emergency evacuation signals and other emergency alarms.

4. A maintenance and calibration communication (M/CC) system.

5. A sound-powered communication (SPC) system.

6. Strobe lights.

Plant-to-offsite communication is provided through a commercial telephone system, interconnected with the plant telephone system, and portable radios. Plant-to-offsite communication capabilities during emergency conditions are described in the Site Emergency Plan.

Two other communication systems are installed, including a low power digital cellular telephone system (LPDCT) for general communication, and a remote monitoring system (RMS) for dose rate monitoring (capable of audio communication). These systems are not credited with supporting communications during emergency or fire-related events.

9.5.2.1 Design Bases

9.5.2.1.1 Dial Telephone System

A dial telephone system is provided for communication between selected office areas and selected locations inside and outside the Station. The dial telephone system is connected to a telephone tie system for offsite communication, including communication with the local law enforcement authority, local fire department, and others. The telephone system main equipment is powered from the plant normal uninterruptible power supply (UPS) system.

9.5.2.1.2 Radio Communication Systems

A hand-held portable radio communication system is provided for communication between Station personnel within the plant. A plant-to-offsite radio console is provided for communication outside the Station, in case the dial telephone system between the Station and the points outside the Station becomes inoperable.

9.5.2.1.3 Page Party/Public Address System

A PP/PA system with five party channels and one page channel is provided for communication between various Station buildings and locations. The system has the following characteristics:

1. Satisfactory voice communications are possible even under extremely noisy conditions.

2. Simultaneous conversations may take place on the page and all party channels without any interference.

3. Plant emergency alarm and evacuation signals are provided by this system.

4. The system is powered from the plant normal UPS system.

9.5.2.1.4 Maintenance and Calibration Communication System

A M/CC system is provided for voice communication in areas requiring communication for testing, instrument calibration, and maintenance, and for use during construction and startup. This system uses a completely separate wiring and raceway system and has the following characteristics:

1. Portable communication equipment is provided using permanent plug-in jack outlets.

2. A group of jack outlets are interconnected for communication between areas requiring this system.

3. This system allows numerous simultaneous connections with several persons communicating on one party line.

4. The system is powered from the plant normal 120-V ac power system.

9.5.2.1.5 Sound-Powered Communication System

A SPC system is provided for voice communication in case of total loss of electric power to the PP/PA and M/CC systems. This system utilizes portable sound-powered headsets and utilizes M/CC system jack outlets and a central switching panel. This system requires no plant electrical power. In case of a loss of electrical power, this system can be used by ensuring that power to the M/CC central switching panel has been disconnected. The system can then operate on any channel of the M/CC system.

9.5.2.1.6 Strobe Lights

In areas where satisfactory voice communications are not possible due to the extremely noisy conditions, strobe lights (key off the PP/PA system) are installed to warn personnel to vacate the area long enough to receive the messages passed while in the noisy areas.

9.5.2.2 System Description

The plant communication system plans and arrangements are shown on Figures 9.5-5 through 9.5-39.

9.5.2.2.1 Dial Telephone System

The dial telephone system consists of dial-type telephone sets located in selected office areas and selected areas within the Station. In areas of extreme noise level, the telephone sets are provided with acoustical booths. The system is integrated as part of the telephone tie system. All calls within the tie system are connected directly to the intended telephone set within the Station. Calls originating outside the Station may direct dial or use the system operator to access Station telephones. All service-type building telephones and certain selected area telephones provide direct dialing of the outgoing calls. A direct-dialing telephone link is also provided solely for load dispatching purposes. Special emergency communication systems are described in the Site Emergency Plan.

The telephone system main equipment is powered from the 120-V ac plant normal UPS system.

9.5.2.2.2 Radio Communication Systems

The portable radio communication system utilizes hand-held portable radios operated on VHF band frequencies. The radios are powered by rechargeable batteries. The system utilizes a leaky wire antenna system throughout the plant with repeaters which are fed from an UPS. The radios are used for maintenance, operating communications, and communication among the plant security force.

A plant-to-offsite radio communication system is provided by a console located in the control room. This system provides communication to Oswego Fire, Offsite Administration, Offsite Radiation Teams, and Power Control. Under emergency conditions, or in case the dial telephone system between the Station and the points outside the Station becomes inoperable, this serves as the alternate means of communication.

9.5.2.2.3 Page Party/Public Address Communication System

The PP/PA system, consisting of one page channel and five party channels, is installed throughout the plant. The PP/PA system is all solid state and includes handset stations, unit speaker amplifiers, loudspeaker stations, cables, terminal boxes, and muting facilities. Speakers of various types are provided throughout the Station for paging, public address, code call, and carrying the emergency alarms and evacuation signals. Each speaker is located to ensure adequate sound distribution throughout the area that the speaker covers. Handset stations are provided throughout the plant. Each handset has access to all the five party lines as well as the page line. The page channel is used from any handset station to call personnel over the speakers, to issue station-wide instructions, or for intercommunication between two or more handset stations. All

system speakers carry the conversation during the page mode of operation.

The party channels are used for intercommunication after the page call is completed, thereby making the page channel available to others. Each handset has a party channel selector switch and a separate page/party spring-loaded selector switch. The page/party selector switch spring returns to the party line position, but it can be maintained in the page position if required. To call an individual, an available party channel is selected by turning the party channel selector switch. The individual is then paged throughout the plant using the page/party selector. Further conversation is carried on over the selected party channel. The page channel may be used for conversation and emergency instructions as a sixth line of communication. While paging, handsets mute nearby speakers to eliminate system acoustical feedback. The PP/PA system is operable in extremely noisy conditions. Local soundproofing is provided as necessary.

The evacuation warning signal, fire alarm signal, and other emergency alarms are sounded through the PP/PA system. The signals are generated by multitone generators that can produce up to five distinctive tones (steady, pulsed, siren, warble, and yelp) over the page circuit. There are two tone generators, each located in separate relay and control cabinets, one located in the control building, and the other in the turbine building. The signals can only be initiated from the control consoles located in the control room or the remote shutdown room, and are carried over the paging channel to all the speakers. The tone generator signal will override any page being carried on the page channel.

The loudspeaker stations are grouped into two separate independent paging systems to provide redundant paths of communications throughout the plant. This dual system is designed to minimize the total isolation of any single area. The signal lines of each of the paging systems are physically separated to provide isolation of one paging line from the other. This improves the operating reliability of the paging aspects of the plant communication system making it less susceptible to common mode failure hazards.

The page lines of the communication system are electrically supervised for continuity. Each of the two paging systems has a supervisory signal generator, signal detecting and relaying equipment, and an annunciator for monitoring and alarming the page system lines. The main purpose of this monitoring system is to check the integrity of the page lines for fire alarm purposes. Selected branches of each of the page lines are independently alarmed at the control and remote shutdown consoles so that an Operator can readily identify the affected paging line. The control room and remote shutdown room consoles each have a switch to merge/isolate the independent page lines via tie relay

cabinets that are located at three different elevations in the turbine building.

Handset stations are located so that they will meet the minimum requirements for manual fire alarm pull stations.

The foregoing features have been incorporated in the plant communication system to meet the intent of NFPA 72D code requirements for fire protection signaling systems.

The PP/PA system is powered from three 120-V ac normal UPS systems: 2VBB-UPS1B, 2VBB-UPS1C, and 2VBB-UPS1D. The handsets and the speaker amplifiers are fed from either UPS system.

The PP/PA relay and control cabinets with tone generators receive power supply from 2VBB-UPS1D.

The PP/PA system is capable of operating merged or isolated with the existing Unit 1 communication system. The merge/isolation operation is controlled from the communication console in Unit 1 or Unit 2 by selector switches with indicating lamps. The PP/PA system has muting facilities that operate directly or indirectly from the hook switches and silence one or more nearby loudspeakers to prevent acoustical feedback when the associated handset is lifted.

9.5.2.2.4 Maintenance and Calibration Communication System

The M/CC system is primarily intended to be used for voice communication during maintenance, instrument calibration, and adjustment of equipment or systems. The system consists of plug-in jack outlets, a central selector switch panel, a dc power supply cabinet, and portable headsets with built-in audio amplifiers. The jack stations are located near groups of major equipment, control panels, relay panels, instrument racks and panels, valve groups, and such other locations throughout the plant. The jack stations may be interconnected by selecting the switch position on the switch associated with each of the jack stations to be interconnected. The central selector switch panel is located in the auxiliary relay room. This can interconnect all the jack stations at a time or can interconnect them in groups of 10. There are 11 separate and independent channels for this intercommunication, one of which is reserved for the SPC.

All components of the M/CC system receive power from a dc power supply cabinet with 120-V ac input and 11-circuit, 6-V dc output. The 120-V ac input is received from the plant normal 120-V ac distribution system. In selecting a switch position on the central switching panel, the dc power supply is also connected to the circuit interconnecting the jack outlets. Portable headsets with built-in audio amplifiers are provided which are plugged into any of the jack outlets to allow communication with others. The jack stations that are to be in communication with one another must first be selected at the selector switch panel.

Simultaneous conversation may take place on each channel without interference from the other channels.

9.5.2.2.5 Sound-Powered Communication System

The SPC system consists of sound-powered headsets and utilizes the receptacles and central switching panel of the M/CC system. In case of a loss of electrical power, the SPC system can be used by ensuring that power to the M/CC central switching panel has been disconnected. In case of a total loss of electric power to PP/PA and M/CC systems, the SPC system can be used on any channel of the M/CC system for communication. This system requires no plant electric power; however, plant operating personnel must ensure that the dc power supply has been disconnected from the circuit interconnecting these jack stations.

9.5.2.3 Inspection and Testing Requirements

The design of the communication systems permits routine surveillance and testing without disrupting normal communication facilities. The page line of the PP/PA system is electrically supervised permitting immediate corrective action to be taken if the page line becomes faulted. The evacuation warning signal, fire alarms, and other emergency alarms are tested in accordance with the Emergency Plan. Functional tests are performed under conditions that approximate the maximum plant noise levels being generated during the various operating conditions, including fire, to demonstrate the system capabilities. Power sources are monitored by indicating instruments. Battery cells are checked periodically for voltage and specific gravity.

9.5.2.4 System Evaluation

The PP/PA system with evacuation and fire alarms, the M/CC system, the dial telephone system, and the portable radio communication systems provide adequate communication facilities for communication during normal conditions under maximum potential noise levels. The paging system with the multitone generator provides emergency evacuation signals and other alarms. This system is electrically supervised so that any fault developed in the system could be detected and rectified immediately. The SPC system provides voice communication in case of total loss of electric power to the PP/PA system and M/CC system. The dial telephone system, interconnected with the telephone tie system, provides plant-to-offsite communication, including communication with local law enforcement authority, fire department, and others, during normal and emergency conditions. The system works even under extremely noisy conditions. The telephones in extremely noisy areas are provided with acoustical booths. Under emergency conditions, or in case the dial telephone system between the Station and the points outside the Station becomes inoperable, the plant-to-offsite radio communication system serves as the alternate means of communication.

The dial telephone system and the PP/PA system are powered from three normal UPS systems: 2VBB-UPS1B, 2VBB-UPS1C, and 2VBB-UPS1D. The UPS systems are fed from three sources: normal ac, bypass ac, and dc. System 2VBB-UPS1B is fed from 600-V load centers 2NJS-US4 or 2NJS-US3 via automatic transfer switch 2VBB-TRS1 (normal), 2NJS-US6 (bypass), and 125-V dc battery 2BYS-BAT1C (backup) via dc switchgear 2BYS-SWG001C. System 2VBB-UPS1C is fed from 600-V load centers 2NJS-US3 (normal), 2NJS-US5 (bypass), and 125-V dc battery 2BYS-BAT1A (backup) via dc switchgear 2BYS-SWG001A. System 2VBB-UPS1D is fed from 600-V load centers 2NHS-MCC006 (normal), 2NJS-US6 (bypass), and 125-V dc battery 2BYS-BAT1B (backup) via dc switchgear 2BYS-SWG001B. The normal and the bypass ac sources are normally energized from the normal Station service transformer. In case of loss of power from the normal Station service transformer, these are automatically transferred to the offsite power sources through the reserve Station service transformers. In case of LOOP, the bypass sources 2NJS-US5 and 2NJS-US6 are connectable to the standby diesel generators, except when a LOCA condition exists. In case of a LOOP coincident with failure of one diesel generator, the other diesel generator will supply the UPS system via its associated stub bus. In case of loss of all ac sources, the UPS systems are energized from the dc backup sources. The backup batteries are rated for 2 hr. Separate cable trays are used to run cables associated with two UPS systems. Thus, no additional Operator action is necessary for establishing communication with any working station under above conditions. The M/CC system is powered from the plant normal ac system.

The portable radio communication system is powered by rechargeable batteries. The SPC system requires no plant electric power.

During a design basis seismic event, in the case that all other communication systems are unavailable, necessary communication will be maintained by using the portable radios.

Communication equipment will be tested during preoperational testing to ensure effective communication.

The intraplant communication systems will not be subjected to any common mode failure through damage to the system wiring since the PP/PA, dial telephone, and M/CC systems are run in separate raceways. The communication system wiring is not treated as safety related.

Only the telephone system has interconnecting wiring. However, outside the Station the telephone lines are run in two directions, east and west, to different telephone company switchboards for redundancy. Failure of one communication system will not affect the performance of any other communication system since these are independent of each other.

The areas of the plant where it may be necessary for plant personnel to communicate with the control room or the emergency shutdown panel during and/or following transients and/or accidents in order to mitigate the consequences of the event, and the types of communication systems available at each of these areas, are identified on Figures 9.5-5 through 9.5-39.

The communication systems will provide satisfactory voice communication in noisy surroundings up to 120 db. For PP/PA system coverage, the output of speakers in a given area will exceed ambient noise. The soundproof telephone booths provided in areas with high ambient noise level are designed to provide a nominal 12-db noise reduction inside the booths.

9.5.3 Lighting Systems

The Station lighting systems are designed to provide sufficient illumination in all areas of the Station, indoors and outdoors, under all design conditions of plant operation.

9.5.3.1 Design Basis

The Station lighting systems consist of:

1. Normal lighting system.
2. Emergency lighting system.
3. Essential lighting system.
4. Egress lighting system.
5. 8-hr battery-pack lighting system.

The normal lighting system provides adequate illumination in all areas of the Station under normal operating conditions. The emergency lighting system provides adequate illumination in areas required for operating the safety-related equipment during emergency conditions. The essential lighting system provides partial illumination for certain critical areas of the Station requiring continuous lighting such as the control room, and for passageways to and from areas where safety-related equipment is located, with the exception of those passageways where 8-hr battery-pack lighting is provided to meet the requirements of 10CFR50 Appendix R. In these passageways, access and egress lighting is provided by 8-hr battery-pack lighting in the event of loss of normal lighting. The egress lighting system provides adequate illumination for all egress signs and egress routes inside the plant. The 8-hr battery-pack lighting provides illumination in all areas required for operation of safe shutdown equipment and in access and egress routes thereto.

The normal lighting system usually receives power from the normal Station service transformer via 13.8-kV switchgears and normal

600-V load centers. In case of loss of power from the normal Station service transformer, this system receives power from the offsite power sources. The emergency lighting system normally receives power from the offsite power sources via Class 1E 4.16-kV switchgears and 600-V load centers. In case of LOOP, the emergency lighting system is fed from the standby diesel generators. The essential lighting system receives power from the Station normal UPS systems, which also feed the egress lighting system. The 8-hr battery-pack lighting receives power from its own battery packs.

The intensities of illumination in different areas are equal to or greater than those recommended by the Illumination Engineering Society Lighting Handbook, with the exception of the service water tunnel, which does not normally require access.

Fluorescent, incandescent, and high-pressure sodium lamps are used for Station lighting. Fluorescent lamps are used for all offices and for most of the operating areas. Incandescent lamps are used in the primary containment, fuel handling and storage areas, and in all other areas where lighting is infrequently required. High-pressure sodium lamps are used in all high bay lighting. No mercury-containing lamps, such as fluorescent lamps or high-energy discharge lamps, are used in the containment structure, refueling floor, and places where mercury-contaminated liquids could find their way into the primary coolant system.

Enclosed and gasketed fixtures are used in all areas where decontamination takes place and in all hosedown areas.

Fixtures used in areas such as the lube oil storage room are explosion-proof type.

9.5.3.2 System Description

Normal Lighting System

The normal lighting system provides adequate lighting in all areas of the Station under normal operating conditions. The normal lighting system is fed from Station normal 600-V load centers that supply power to the main lighting distribution panels located in the areas they serve. The main distribution panels feed the dry-type, 600-208/120-V, 3-phase, 4-wire, lighting distribution transformers. The lighting distribution transformers are located adjacent to the branch distribution panels in the area being lighted, except in case of reactor primary containment lighting. The distribution transformers and panels feeding the reactor primary containment area lighting are located in the secondary containment area close to electrical penetrations. Receptacles requiring 120-V service are supplied from 208/120-V, 3-phase, 4-wire distribution panels provided with ground fault interrupter-type circuit breakers.

The Station normal 600-V load centers feeding the main lighting distribution panels receive power from Station normal 13.8-kV buses.

Emergency Lighting System

The emergency lighting system provides lighting required for operating the safety-related equipment during emergency conditions in the control room, diesel generator rooms, emergency switchgear areas, remote shutdown room, and relay room. The emergency lighting system is a Class 1E system except for the lighting fixtures and dimmers. The lighting fixtures and dimmers are seismically supported. The emergency lighting system is divided into three separate divisions corresponding to Divisions I, II, and III of the plant emergency ac distribution system and is fed from the corresponding Class 1E 600-V load centers (Division I and II) and 600-V motor control center (MCC) (Division III). The Class 1E load centers feed Class 1E main lighting distribution panels located in the areas that they serve. The main distribution panels feed the dry-type, 600-208/120-V, 3-phase, 4-wire lighting distribution transformers. The lighting distribution transformers are located adjacent to branch distribution panels in the area being lighted. In case of a LOOP, the emergency lighting system is automatically connected to the emergency diesel generators. The emergency lighting system fixtures are constantly energized.

Essential Lighting System

The essential lighting system provides partial lighting for certain critical areas of the Station requiring continuous lighting, such as the control room, relay and computer room, standby diesel generator rooms, emergency switchgear rooms, service water pump room, and for passageways to and from areas where safety-related equipment is located, with the exception of those areas and passageways where 8-hr battery-pack lighting is provided to meet the requirements of 10CFR50 Appendix R. In these areas and passageways, access and egress lighting is provided by 8-hr battery-pack lighting in the event of loss of normal lighting. The essential lighting system receives power from Station normal UPS systems 2VBB-UPS1B, 2VBB-UPS1C, and 2VBB-UPS1D. The UPS systems feed the main essential lighting distribution panels which feed the branch distribution panels located in the areas being lighted. The essential lighting fixtures are constantly energized.

Although the electrical equipment in the essential lighting system may be of different dimensions than Class 1E equipment, and lacks the qualification documentation of Class 1E emergency lighting equipment, in all other significant respects it is identical. Specifically, the essential lighting equipment was purchased from the same vendor and utilizes the same construction (although it may be dimensionally different), such as electrical box wall thickness, breakers, and terminal connectors. The

essential lighting equipment is mounted the same as the emergency lighting system; i.e., they are seismically mounted in QA Category I areas.

The essential lighting system is connectable to emergency diesel generators except during a LOCA condition.

Egress Lighting System

The egress lighting system provides adequate lighting for all egress signs inside the plant, exit doors, hallways, corridors, passageways, stairways, and other areas leading to the outside building exits. The system is designed specifically for inside building egress emergency conditions in accordance with related standards, codes, and OSHA requirements. Internally-illuminated exit signs are located at those doorways and protected ways of travel which open onto Station roads and walkways. All exit facilities are provided with adequate illumination, both vertical and horizontal. Minimum intensity of illumination measured at the floor level for all exit paths is maintained at 0.5 foot-candle.

The egress lighting system receives power from the Station normal UPS system as a part of the essential lighting system. The egress lighting fixtures are constantly energized.

8-hr Battery-Pack Lighting

Eight-hr battery-pack lighting is provided in all areas of the plant required for operation of any safe shutdown equipment, and in access and egress routes thereto, to meet the requirements of 10CFR50 Appendix R. The 8-hr battery-pack lighting also provides required illumination for access/egress to certain areas of the plant if the normal lighting in these areas is not available.

Eight-hr battery-pack lighting is provided in the control room to illuminate to 1 foot-candle. The control room is provided with emergency lighting powered from redundant divisions of the onsite power systems. This is restored within 10 sec from the LOOP, and no Operator action is required during this 10-sec period.

All battery-pack lighting is Exide Model B-200, or similar, which provides high-efficiency lighting and instantaneous load transfer upon loss of ac supply. Each battery pack is capable of feeding 4-12 W lamps for 8 hr. The battery packs are seismically supported.

All areas of the Station are illuminated by one or more of the above lighting systems to achieve the required level of illumination and availability of lighting. Approximate percentages of lighting provided by each of the above lighting systems in different areas of the Station are given in Table 9.5-1. In critical areas illuminated by more than one of the systems, the lighting fixtures of the essential lighting system

and the emergency lighting system are interleaved with those of the normal lighting system to obtain a balanced distribution of light from the combinations. The emergency lighting system, 8-hr battery-pack lighting system, and the essential lighting system jointly provide sufficient illumination in all critical areas to enable operating personnel to safely shut down and maintain the Station in a safe shutdown condition following any accident and/or LOOP. Though all of the above lighting systems are provided in critical areas of the plant, the illumination provided by the emergency lighting and the 8-hr battery-pack lighting systems is adequate to safely shut down the plant during an accident and/or LOOP.

The following types of lamps are used for Station lighting:

1. High-pressure sodium lamps are used for general area lighting throughout the plant, for all high bay lighting (above fixture mounting height [FMH] of 25 ft) and for all low bay lighting (FMH from 10 to 25 ft).

2. Fluorescent lamps are used for lighting all offices and other areas having FMHs of 8 ft and less. For FMHs between 8 and 10 ft, high-pressure sodium lamps are preferred over other types of lamps. In the operating areas such as the control room, relay and computer room, remote shutdown room, and switchgear rooms, fluorescent lamps are used.

3. Incandescent lamps are used in the primary containment, count room and lab, water wash hosedown areas, primary containment access hatches, main steam tunnel, new fuel storage vault, spent fuel pool filter room, and in all other areas where lighting is infrequently required. Extended-service incandescent lamps are used in areas involving high radiation.

The types of lamps and fixtures used in different areas of the Station and the desired average foot-candle are given in Table 9.5-2.

9.5.3.3 Safety Evaluation

The normal Station lighting system provides adequate lighting in all areas of the Station under normal operating conditions of the plant. The normal lighting system receives power from the unit generator through the normal Station service transformers and normal 13.8-kV buses, under normal operating conditions of the plant. In case of a loss of power from the normal Station service transformers, these 13.8-kV buses are automatically transferred to the reserve Station service transformers, which are energized from the 115-kV offsite power sources and the normal Station lighting system, then receive power from the offsite power sources.

The emergency lighting system provides adequate lighting to all areas required for operating the safety-related equipment during emergency conditions of plant operation.

Redundant divisions of the emergency lighting system, fed from redundant divisions of plant emergency ac distribution system, illuminate essential areas so that failure of power supply to any one division will not cause total failure of lighting in these areas during an emergency. The emergency lighting system is a Class 1E system except for the lighting fixtures and dimmers, which are seismically supported. Each lighting circuit is provided with two coordinated Class 1E circuit breakers so that failure in any lighting circuit will not affect any other Class 1E devices or system (see Figure 8.3-4).

All critical areas of the Station requiring continuous lighting, with the exception of those areas and passageways where 8-hr battery-pack lighting is provided, are also provided partial illumination by the essential lighting system. The essential lighting system receives power from the Station normal UPS system.

The egress lighting system provides adequate lighting for all egress signs inside the plant, exit doors, hallways, corridors, passageways, and stairways, etc., leading to the outside building exits, with the exception of those areas and passageways where 8-hr battery-pack lighting system is provided. In these areas and passageways, the 8-hr battery-pack lighting system provides the required egress lighting in the event of loss of normal lighting. The system is designed for inside building egress emergency conditions in accordance with OSHA requirements. The egress lighting system receives power from the Station normal UPS systems which also feed the essential lighting system. Seismically-supported 8-hr battery packs provide necessary illumination for all areas needed for operation of safe shutdown equipment and in access and egress routes thereto.

The Unit 2 lighting systems provide an integrated design that provides adequate Station lighting in plant areas for normal, transient, and accident conditions. The emergency lighting system is supplied power by the emergency diesel generators and provides adequate emergency Station lighting in all critical areas that need to be accessed for transient and accident conditions. The essential lighting system (which can also be supplied power from the diesel generators except during LOCA) provides a backup to the normal lighting system in plant areas during certain transients, and those areas necessary for equipment control, maintenance, and access routes to these areas, with the exception of those areas and passageways where 8-hr battery-pack lighting system is provided. In those areas and passageways where 8-hr battery packs are provided, the 8-hr battery-pack lighting system provides a backup to the normal lighting system. A combination of the essential lighting, emergency lighting, and 8-hr battery-pack lighting are used for

firefighting. However, only the emergency and 8-hr battery-pack lighting systems are required to safely shut down the plant. The electrical equipment for the essential lighting system (except for the UPS and qualification documentation) is identical in all significant respects to the Class 1E equipment used in the emergency lighting system. Equipment (except UPS) was purchased from the same vendor and utilizes the same fabrication methods as the Class 1E equipment, although there may be dimensional or rating differences. Main and distribution lighting are identical in terms of material specifications and fabrication methods, and are seismically mounted in safety-related areas. Both the emergency and essential lighting circuit breakers and terminal connectors are identical or are the vendor's equivalent of breakers/connectors, which are manufactured to the same criteria and are mounted identically. Cable and conduit for both the essential and emergency lighting systems are identical and mounted the same in safety-related areas. The Station normal UPS (located in the normal switchgear building) for essential lighting are 75 kVA/60 kW rated and are not seismically mounted. If the UPS power supply to the essential lighting system were to be interrupted due to a seismic event, the reactor could be shut down from the control room using the emergency lighting system only. Although access to other areas of the plant would not be required to achieve shutdown following the seismic event, egress lighting would be available from the 8-hr battery-pack lighting. The Class 1E UPSs are 25 kVA manufactured by Elgar Corporation, and are seismically mounted in the control building. The normal lighting system is used for normal operations, maintenance, and access routes to these areas. The following discussion provides more details on the integration of the lighting design.

1. <u>Firefighting Activities</u>

   Based on Appendixes 9A and 9B, it has been determined that the plant can be safely shut down in the event of any single fire. Control of safe shutdown equipment is performed in the control room or remote shutdown rooms for any postulated fire, except as discussed below.

   a. In the event of a control room or relay room fire, equipment is operated from the diesel generator rooms, other areas of the control building, the reactor building, and the service water pump rooms.

   b. In the event of a reactor building fire on el 289 ft (fire area FA 87), some manual valve operations need to be performed in the reactor building to initiate cooling utilizing RHR heat exchangers, if the SFC system was inoperable.

   The activities listed in items a and b are performed within 8 hr. Once these activities are initiated (e.g., valve lineups), safe shutdown equipment is controlled from the remote shutdown room, control room, or diesel generator

rooms which utilize emergency and 8-hr battery-pack lighting systems (Table 9.5-1). Areas in access routes to perform activities in items a and b are provided lighting by 8-hr battery-pack lighting systems. Note that the battery-pack lights provide backup lighting in the event of fire damage to electrical circuits.

Most firefighting activities are controlled from the main control room. Automatic suppression systems or manually-initiated suppression systems (such as foam water sprays) can be initiated from the control room or local panels. Additionally, backup hose stations are provided throughout the plant. The fire protection panels in the control room are provided lighting via either the emergency or the essential lighting systems or both. In addition, emergency and 8-hr battery-pack lighting are provided in the control room.

Summary

Since firefighting activities, including safe shutdown, can be accomplished with emergency lighting and 8-hr battery-pack lighting, these systems conform to SRP 9.5.3.

2. Control and Maintenance of Safety-Related Equipment

Lighting for control and maintenance of safety-related equipment in safety-related buildings and access routes is listed in Table 9.5-1. Safety-related equipment will be maintained in accordance with maintenance procedures. Certain designated areas within the plant, such as the instrument shop on el 261 ft in the service building, and the machine shop on el 261 ft in the radwaste building, are used to supplement in-place maintenance or "local" maintenance activities. All of the above-listed areas are provided lighting from the emergency or essential lighting systems or both.

Control of almost all safety-related equipment is normally performed from the control room. Other safety-related equipment controls can be performed outside the main control room. These areas include:

a. Diesel generator control rooms

b. Remote shutdown rooms

c. Standby switchgear rooms

d. Reactor building and auxiliary bays

e. Service water pump rooms

All of the above-listed areas and access routes are provided lighting from one or a combination of the emergency, essential, and 8-hr battery-pack lighting systems.

Summary

Since areas needed for control and maintenance of safety-related equipment and their access routes are provided with one or a combination of emergency, essential and 8-hr battery-pack lighting systems, and since only the emergency and 8-hr battery-pack lighting systems are required to safely shut down the plant, these systems conform to the SRP 9.5.3.

3. Transients

Plant transients are described in Chapter 15. During plant transients including LOOP, all equipment operations to achieve safe shutdown are normally performed from the control room. The control room is provided with a combination of emergency, essential, and 8-hr battery-pack lighting.

However, local controls are provided for certain equipment if it is desirable to operate equipment locally. As shown on Table 9.5-1, the essential lighting system is generally provided throughout the plant, which ensures adequate lighting for local control panels. Eight-hr battery-pack lighting is also provided in all areas of the plant required for operation of safe shutdown equipment and in access and egress routes thereto.

Summary

Since plant transients can be successfully accommodated by equipment operations to achieve safe shutdown from the control room, and since emergency, essential and 8-hr battery-pack lighting systems are provided in the control room, the lighting systems conform to SRP 9.5.3. Only the emergency and 8-hr battery-pack lighting systems are required to safely shut down the plant.

4. Shutdown From Outside of Control Room (Without a Fire)

The operation of the RSP is described in Chapter 7. In the event that Operators were required to leave the control room (for an unspecified reason) without a fire in the control room, safe shutdown can be achieved from the remote shutdown room except when the shutdown cooling valves need to be energized at the MCCs.

The remote shutdown rooms are provided with lighting from normal, emergency and 8-hr battery-pack lighting systems. Other areas required to achieve safe shutdown are provided

with one or a combination of normal, emergency, essential and 8-hr battery-pack lighting systems. Safe shutdown access routes to remote shutdown rooms are provided with 8-hr battery-pack lighting.

<u>Summary</u>

Since remote shutdown room and access routes utilize one or a combination of emergency and 8-hr battery-pack lighting, the possibility of a shutdown from outside the control room (without a fire) is in conformance with SRP 9.5.3.

5. <u>Accidents</u>

Plant accidents are described in Chapter 15. In the event of an accident, safety-related controls are provided in the control room to safely shut down. During accidents (and accidents with seismic events), the reactor building is considered uninhabitable for some time due to high radiation. Other areas of the plant (except the control and relay rooms) may also be uninhabitable depending on the severity and type (LOCA, fuel handling accident) of accident. Safety-related equipment is qualified for accident scenarios, and necessary safe shutdown equipment and controls to mitigate the consequences of the accident are located in the control room. The control room is provided with emergency and 8-hr battery-pack lighting.

Certain other activities may be required to be performed outside of the control room. Such activities include performing functions in accordance with the Emergency Plan (Section 13.3). Such activities are generally used to assess the accident releases and provide Operations personnel with information about the accident. Such activities have been reviewed, and these areas have been determined to be vital areas in accordance with NUREG-0737 requirements. These areas including access routes are described in Chapter 12. All of these areas with Unit 2 described as vital areas are provided with emergency or essential lighting and/or 8-hr battery packs. Additionally, the Technical Support Center (TSC) will be provided with a normal offsite and emergency diesel generator supply from Unit 1.

<u>Summary</u>

Since accidents are mitigated through actions in the control room, which is provided with emergency and 8-hr battery-pack lighting, this design is in conformance with SRP Section 9.5.3.

The normal, essential, 8-hr battery-pack and emergency lighting systems include all components necessary to provide adequate lighting during normal and emergency plant operating conditions.

Any additional lighting required for short excursions into the plant will be provided to personnel by portable equipment (i.e., hand-held flashlight and/or lanterns). The integrated Unit 2 lighting system provides adequate Station lighting for vital areas within Unit 2 and access routes from onsite sources during the full spectrum of accident, or transient conditions.

9.5.3.4 Inspection and Testing Requirements

Since the lighting system is on at all times, any malfunction is easily identified. The self-contained battery-pack units are tested periodically. Relamping is done as required.

9.5.4 Standby Diesel Generator Fuel Oil Storage and Transfer System

Unit 2 is provided with three standby diesel generators, including one dedicated for the HPCS system. Each operates on No. 2D diesel fuel oil. Each diesel engine has an independent fuel oil storage and transfer system to supply sufficient fuel to the diesel engine during a LOCA, as well as during LOOP.

9.5.4.1 Design Bases

The design bases for each standby diesel generator fuel oil storage and transfer system are:

1. Provide fuel oil storage capacity for each diesel generator, based on continuous diesel generator operation for 7 days, without interconnection to any other onsite fuel oil system. The 7-day fuel oil supply is based on time-dependent load for the standby diesel generators and rated capacity of 2600 kW for the HPCS diesel generator. The time-dependent load for the standby diesel generators includes the capacity to power the engineered safety features (ESF) plus a minimum capacity margin of 10 percent. The time-dependent load is based on the most severe loading condition.

2. Provide pumps, piping, valves, and strainers that are designed, constructed, and tested in accordance with ASME Boiler and Pressure Vessel Code, Section III, Subsection ND, 1977 Edition. The fuel oil storage tanks and fuel oil day tanks are classified as ASME III, Division I, Class 3, and are constructed in accordance with the rules of ASME III, Division I, Subsection ND. The engine-mounted piping and components of the Division III (HPCS) diesel generator are designed, fabricated, inspected, installed, and tested in accordance with the requirements of ANSI B31.1. Sections 3.2.1 and 3.2.2 give details of the system seismic and quality group classification bases.

3. Provide a system conforming to ANS Standard 59.51 (previously ANSI Standard N195-1976), Fuel Oil Systems for Standby Diesel Generators, and meeting Category I and Safety Class 3 requirements.

9.5.4.2 System Description

The standby diesel generator fuel oil storage and transfer system is shown on Figure 9.5-40. The system consists of:

1. Three diesel fuel oil storage tanks, one for each diesel engine. The steady-state temperature of the fuel in the storage tank is ground temperature (approximately 50°F). Each storage tank is sized to store sufficient fuel oil for continuous operation of its respective diesel engine for 7 days (minimum required 7-day supply of fuel oil is 47,824 gal for each of the standby diesel generator fuel oil storage tanks, and 35,342 gal for the HPCS diesel generator fuel oil storage tank).

   Interior and exterior surfaces are not coated but are prepared in accordance with ANSI N45.2.1 - Cleaning of Fluid Systems and Associated Components during Construction of Nuclear Power Plants - June 1, 1973. The cleaning of the internal surfaces of these carbon steel vessels is in accordance with ANSI N45.2.1 (Class C) requirements. A diesel fuel oil stabilizer, such as NUTMEG fuel preserve (NFP), is added to the fuel oil storage tanks at a treatment rate of approximately 1 gal per 2,000 gal of diesel fuel oil and is reinhibited at yearly intervals as required to maintain fuel quality. Any makeup fuel is reinhibited during diesel fuel oil addition. NFP can prevent tank failures indefinitely when this treatment routine is used with a fresh tank. Overtreatment will not adversely affect the storage, flow, or burning properties of the fuel oil. NFP contains various multipurpose agents. The preservative additive prevents formation and settling out of organic sludge, and also acts as a rust preventive agent protecting the storage tanks in the water bottom layer. NFP contains metal deactivators and metal suppressing agents which retard oxidation and polymerization of the fuel which can result because trace amounts of copper may be present in the fuel. A water absorptive agent in NFP keeps trace amounts of water dispersed in the diesel fuel oil. NFP contains an EPA-registered bactericide agent which prevents bacteria and slime formation and destroys any existing organisms. NFP, with its rigidly formulated multipurpose agents, ensures the startup of the standby diesel generators. Bell System telephone companies, utilities and both small and large consumers of No. 2 diesel fuel oil are recognized users of NFP. The

external surfaces of the fuel oil storage tanks require no special coating but are free from oil, grease, loose rust, and loose paint. The tanks are buried in concrete below the diesel generator building. The fill, vent, and sounding line connections at the storage tanks also are buried in concrete to prevent corrosion. Since galvanic reactions are unlikely to occur in such an environment, cathodic protection of the fuel oil storage tanks is not required. After the interior and exterior surfaces are cleaned, tested, and dried, they are inspected in accordance with Subsection 3.1 of ANSI N45.2.1. The fill of each tank extends below the diesel generator mat beyond the exterior wall line, thereby positioning the tank fill line, sounding line, and vent line outside the building. Each storage tank is filled from its own tank truck fill station located in the yard. The storage tanks are constructed with baffles, 10 reinforcement stiffeners, 4 reinforcement rings, and 15-degree off-center drains to minimize turbulence within the tanks during filling. The 4-in fill lines for the three divisional fuel oil storage tanks are located 51 ft 3 in and 55 ft 3 in from the first and second pump suctions, respectively. Seven 3/4 in x 8 in stiffener rings are spaced between the fill line and the first pump suction in the Division I and II fuel oil storage tanks. Five 3/4 in x 8 in stiffener rings are evenly spaced between the fill line and the first pump suction in the Division III fuel oil storage tank. Since the fill line and pump suctions are located on opposite ends of each storage tank, sediment agitated between the stiffeners during filling will not affect the pump suction inlets. Plant procedures limit the fill rate so as to minimize turbulence. The separate fill lines are capped when not in use and are each provided with a locked-closed isolation valve and a strainer capable of filtering out sediment. Minor stirring of the sediment may occur in the fuel oil storage tank when fuel oil is recirculated through the 2-in fuel oil day tank overflow line. For all divisions, the overflow line is located 3 ft 10 in and 7 ft 10 in from the first and second pump suctions, respectively. Two 3/4 in x 8 in stiffener rings are located in the vicinity of the two pump suctions. These stiffener rings, along with the fuel oil pump stabilizer assembly, minimize any turbulent effects around the pump suctions. Each storage tank also has a manhole for maintenance access from within the diesel generator building, an external vent, and a sounding tube for manual confirmation of fuel oil level. Each storage tank has a 1/16-in corrosion allowance.

2. Six electric motor-driven, vertical, turbine-type fuel oil transfer pumps. The pumps are mounted in duplex sets on top of each fuel oil storage tank and each

duplex set is connected in parallel to its respective day tank to permit the transfer of fuel oil by the pumps. Each fuel oil transfer pump discharge line is equipped with a simplex-type sediment strainer sized for full pump flow. Although ANSI Standard N195-1976 recommends the use of duplex strainers in diesel fuel oil systems, one simplex strainer per pump accomplishes the same intent. By administrative operating procedure, the operation of one diesel fuel oil transfer pump shall serve the diesel generator with the other pump in standby mode. When high differential pressure across the transfer pump discharge strainer indicates a clogged condition, an alarm in the control room will alert the Operator to initiate the operation of the standby pump. Approximately 334 gal of diesel fuel oil are available for the Division I and II diesels, and 213 gal for the Division III diesel, between the low level alarm setpoint and the diesel generator feed line connection. These volumes of diesel fuel oil allow each of the diesel engines to operate for 1 hr at the continuous rating of 4400 kW for the Division I and II diesels, and of 2600 kW for the Division III diesel, with a capacity margin of 10 percent.

3. Three diesel fuel oil day tanks, one for each diesel engine. Each day tank is located in the day tank room above the engine generator control panel room of its associated diesel generator. The elevated location of the tank provides adequate NPSH to the engine-driven fuel pump of the diesel engine. Each day tank is supplied with a manhole for maintenance access, an external vent, a sounding tube for manual confirmation of fuel oil level, and an overflow line for returning excess fuel oil to the fuel oil storage tank.

   The fuel oil capacity of each day tank is 675 gal including a dead volume of approximately 69 gal. Based on a fuel consumption of 5.057 gpm at a rated 4400 kW plus a margin of 10 percent for the Division I and II diesels, and 3.217 gpm at a rated 2600 kW plus a margin of 10 percent for the Division III diesel, at the highest allowed API gravity, the 1-hr running time volumes, including the dead volume in the tanks, are 403 gal and 282 gal, respectively.

Each fuel oil transfer pump is capable of supplying the maximum fuel demand of a standby diesel generator. For each storage tank, administrative operating procedures determine which of the two transfer pumps starts automatically when fuel oil in its corresponding day tank falls to the pump-on level, and stops automatically when fuel oil rises to the pump-off level. The second pump is on standby and can be started by an Operator should the need arise. Administrative operating procedures also

address alternating the lead and standby pumps, which is done manually. Fuel oil from the day tank flows by gravity to the suction of the engine-driven fuel pump which boosts the pressure to that required by the fuel injection header. For the two standby diesel generators, fuel oil is supplied to the engine-driven booster pump and to the standby booster pump through a four-element duplex strainer.

The four-element duplex strainer is located on the base of the engine. Four shells with cleanable-type wire mesh elements are attached to a common manifold. A control valve in the center of the manifold permits flow to two elements on either side of the valve, or to all four elements. Normal operating position of the valve exists with two elements in operation and two elements in standby. A differential pressure indicator and alarm monitor this strainer with an annunciator on the unit control panel. When the alarm occurs at 5 psi differential, an Operator turns the valve handle to clean the elements that were in operation while placing the two standby elements into operation.

The engine-driven booster pump is located on the left side of the engine and is driven off the back of the jacket water pump drive at 1750 rpm. Pump output at full speed is approximately 12.5 gpm at 50 psig.

The standby booster pump is mounted on the left side of the engine near the filters and strainers and is driven by a 1-hp motor at 1800 rpm. Oil is circulated at 12.5 gpm @ 50 psig. The pump starts and primes the engine-driven pump when the start signal is given for the engine to start. The pump stops from a speed signal given from the engine. The pump also starts if fuel pressure in the main header at the low-pressure control downstream of the engine-driven pump falls to 25 psi. A relief valve set at 50 psi directs oil from the pump outlet back to the inlet side. A bypass line and a check valve around this pump allow the main pump to pick up fuel from the main header.

A 50-psi relief valve and a 35-psi relief valve in the booster pumps' discharge lines regulate the supply to the fuel pumps. A four-element duplex filter ensures clean fuel to the pumps and nozzles.

Duplex fuel filters are located beside the strainers on the engine and are alike except for the elements. Fuel oil is filtered just prior to entering the engine supply header. A differential pressure indicator and alarm monitor this filter with an annunciator on the unit control panel. When the alarm occurs at 10 psi differential, the Operator will place the other filter in service and replace the other filter.

Fuel injection nozzle injects high-pressure fuel from the pump into the cylinder. Because of the timing of the fuel pump, this fuel is released in the cylinder during the compression stroke. Spray holes in the tip of the nozzle atomize the fuel into a very

fine mist in a symmetrical pattern. This mist mixes with the air in the cylinder to form a combustible mixture. This mixture is then ignited by the heat of compression caused by the piston compressing the air and fuel in the cylinder.

A small head tank (5-gal capacity) is located on the generator end of the engine above and between the cylinder banks. In the system it is between the fuel pump headers. A flowing vent is located in the top of this tank and joins the flowing vents from the fuel pumps at the flowing vent reservoir to return draining fuel to the day tank.

Fuel oil supply pressure, after the filter, is indicated by a pressure indicator on the engine gauge panel. A 1:1 ratio relay transmits a signal to another pressure indicator on the unit control panel located in the diesel generator control room to indicate fuel oil pressure at the end of the injection pump fuel heater. A low-pressure alarm switch set at 10 psig in the supply header announces a low supply pressure on the unit panel.

A small shell-tube fuel oil cooler located on the end of the engine cools the fuel oil that is bypassed by the 35-psi relief valve.

The fuel oil cooler is located on the front of the engine below the engine-driven lube oil pump and is primarily required to cool oil bypassed by the 35-psi relief valve when the engine is running at idle speed. The cooler will handle 6 gpm of fuel on the shell side and 11 gpm of water on the tube side. Fuel entering at 170°F will exit at 125°F using 100°F water at full capacity.

The fuel system for the HPCS diesel generator is similar to the fuel system for the standby diesel generators as described above.

Fuel oil is supplied to the engine-mounted fuel pump from the fuel oil day tank by gravity flow. Fuel under low pressure then passes through a 10-psi relief valve and the filter elements to the fuel manifold supply line and injector inlet filter at each cylinder into the injector. A small portion of this fuel supplied to each injector is pumped into the cylinder at very high pressure through the needle valve and spray tip of the injector. The quantity of fuel injected depends upon the rotative position of the plunger as set by the injector rack and the governor. The excess fuel not used by the injector flows through the injector serving to lubricate and cool the working parts.

The fuel leaves the injector through the return fuel filter. From the return fuel filter in the injector, the excess fuel passes through the fuel return line in the manifold to the relief valve inlet of the "return fuel" through a swing check valve. This relief valve restricts the return fuel, maintaining a backpressure on the injectors. The swing check valve prevents

reversal of flow and siphoning. The fuel continues into the return line to the fuel oil day tank. Any excess fuel oil in the day tank is returned by gravity flow to the fuel oil storage tank through the day tank overflow piping.

9.5.4.3 Safety Evaluation

The system is designed in accordance with Category I, Safety Class 3 criteria. Originally, the FMEA of the standby diesel generator fuel oil storage and transfer system was contained in the Unit 2 FMEA document, which is historical. FMEAs for plant systems are now performed and controlled by the design process.

Details of the missile enclosures for diesel generator Divisions I, II, and III appear on Figure 1.2-17. The diesel generator divisions are designed to seismic and tornado criteria, and are isolated from one another by a reinforced concrete barrier. The barrier consists of a 2-ft thick reinforced wall with No. 9 bars at 5 in each way each face (EWEF), and is in compliance with SWEC 07703. SWEC 07703 is a Missile Barrier Interaction Stone & Webster Engineering Corporation (SWEC) Topical Report submitted to the NRC in September 1977.

An opening exists in the 12 1/2 column line wall which is closed off by a hollow concrete block. Although this hollow concrete block is not designed to provide missile protection, missile effects to an adjacent diesel are eliminated by the hollow concrete block's placement in reference to the barrier. The opening does not introduce a straight line from one diesel to an adjacent diesel, or from one division's starting air receiver to another division's starting air receiver. Also, high- and moderate-energy lines are not in the line of possible missiles through this opening.

In the event of fuel oil or cooling water leakage or flooding in the diesel generator building, fluid from all three divisions is collected in the floor drain system. Normally open drain valves direct the fluid to the valve pit. From the valve pit, other open drain valves direct the fluid to an oil separator.

The following systems have lines in the diesel generator room: breathing air, air startup-standby diesel generator, standby diesel generator fuel, fire protection-water, diesel generator building ventilation, instrument air, service air, and service water. All of these system lines are classified as moderate-energy lines having design temperatures and design pressures less than 200°F and 275 psig, respectively. Since the diesel generator can operate in conjunction with the operation of the fire protection sprinklers, the diesel generator is also available under water spray conditions from surrounding moderate-energy lines.

The minimum fuel oil storage capacity for each diesel generator is based on continuous operation of the diesel generator for a period of 7 days.

Each diesel generator fuel oil day tank has a capacity in accordance with requirements of the National Fire Protection Association (NFPA) Standard 37, Stationary Combustion Engines and Gas Turbines (1979), which provides for over 1 hr of continuous operation of the diesel generator at full load. Each day tank is isolated in a separate room within the associated diesel generator room and protected by fire detection and automatic sprinkler systems.

Each diesel generator day tank room contains a curb sized to contain the volumetric capacity of the fuel oil day tank in addition to an amount of fluid from the fire protection system. This total capacity is at least 110 percent of the capacity of a single day tank. This curb precludes spilling fuel oil into the diesel generator room. Each day tank room curb can be emptied into the diesel generator building floor and equipment drain system. Once fuel oil or cooling water accumulates in the floor drain sump (one sump per diesel generator division), a level switch monitors the quantity of fuel oil or cooling water collected. This fluid is then dispersed to a common oil separator. In addition to the curb arrangement, a low-level storage tank alarm and a low-level day tank alarm also alert the Operators to the possibility of a fuel oil leak in the day tank room.

The oil piping that connects the day tanks to their respective generators is physically separated from the diesel generator exhaust piping and crank case vents, which are considered to be the only potential (in situ) ignition sources. Automatic fire detection and suppression systems are provided in each diesel generator room.

The capped inlet of each storage tank fill line is located above the probable maximum flood (PMF) level, thereby preventing the entrance of water. Each storage and day tank's vent pipe is also located above the flood level and is designed to prevent rain from entering.

The fuel oil storage tank fill, vent, and sounding lines are located outside the diesel generator building and are exposed to the atmosphere after penetrating 5 ft of fill. In the event of a tornado missile resulting in the obstruction of the vent line, the fuel oil storage tank is vented by a 1-in line routed from a 4-in connection on the storage tank to the 4-in vent line on the fuel oil day tank.

The fuel oil day tank vent line is located in the diesel generator building day tank room and penetrates through the diesel generator building roof to vent into the atmosphere.

In the event of a tornado missile resulting in the obstruction of the vent line, the fuel oil day tank is vented through the 1-in connecting line mentioned above.

The fuel oil day tank is also provided with a loop seal to accommodate the sealing requirements during normal fuel oil transfer to and drawdown from the fuel oil day tank, and provide the vacuum breaking function required in the event of damage to the two normal vents. The loop seal is located entirely within the fuel oil day tank room.

The vent lines are not provided with flame arrestors because open vents may be used to provide venting capacity for tanks in which oil with a flash point of 100°F or above is stored. The standby diesel engines use No. 2D fuel oil with a flash point of 125°F.

In the event of a tornado missile resulting in the obstruction of the fuel oil storage tank fill line, filling of the storage tank can be accomplished through the diesel day tank connections located in the diesel generator building.

A sounding rod is utilized periodically to check the accuracy and operation of the tank level indicator by insertion into the sounding tube furnished in each storage and day tank. The possible accumulation of water at the bottom of each diesel fuel oil storage and day tank is also checked by applying a water-indicating paste to the sounding rod. The paste changes color when it comes in contact with water. Water is removed from the storage tanks by the use of a portable pump and from the day tanks by opening a drain valve located near the bottom of each tank.

Adequate sources of diesel quality fuel oil are available in the cities of Oswego (8 mi), Belgium (25 mi), and Syracuse (35 mi). Under extremely unfavorable environmental conditions, fuel oil will be delivered onsite via tanker truck escorted by highway snow removal equipment.

This will permit each standby diesel generator system to supply uninterrupted emergency power. Fuel oil meets or exceeds the quality requirements of ASTM D975-1981 and the diesel engine manufacturer's recommendations.

The particulate contamination (for example, algae) in the fuel oil storage tank is determined by measuring the particulate contamination in accordance with ASTM D2276-78, method A, on a monthly basis and examining the contamination by either microscopic or atomic absorption methods when the levels approach established limits. The fuel oil in the affected storage tank will then be appropriately treated (filtration or biocides) to reduce the level to acceptable concentrations if the level approaches the established limits.

9.5.4.4 Inspection and Testing Requirements

The standby diesel generator fuel oil storage and transfer system is designed to permit periodic inspection and maintenance of active components. Local display and indicating devices are provided for periodic inspection of tank oil level and operating parameters such as pump discharge pressure and pressure drop across each fuel oil strainer.

Fuel oil storage and day tanks and piping are hydrostatically tested prior to filling with fuel oil. System operability is tested in conjunction with the diesel generator. Continued system integrity is verified with periodic testing with the diesel generator.

The quantity of diesel fuel oil available in storage is checked and logged periodically and after each operation of the respective diesel generator for a period of 1 hr or longer. Water accumulation in the diesel generator fuel oil storage and day tanks is checked monthly and after each operation of the diesel engine. Samples of fuel oil from every tank are analyzed monthly for particulate contamination. New fuel will be tested for API gravity or specific gravity or absolute gravity, flash point, appearance, and kinematic viscosity prior to addition to ensure that the limits of the applicable ASTM are not exceeded. Analysis of the other properties of the fuel oil will be completed within 1 month of the fuel addition.

9.5.4.5 Instrumentation Requirements

Description

Safety-related instruments and controls are provided for automatic and manual control of the standby diesel generator fuel oil storage and transfer system. Except where noted otherwise, controls and the instruments described below are located in the associated diesel generator room. The control logic is shown on Figure 9.5-41.

Operation

Each duplex set of standby diesel generator fuel oil transfer pumps is controlled automatically by the oil level in its associated day tank. Each pump can also be controlled manually.

Monitoring

Indication is provided for the following:

1. Each fuel oil storage tank level (located outside building on exterior wall near tank fill connection).

2. Each fuel oil day tank level.

An alarm is provided for each of the following:

1. Fuel oil transfer system trouble (annunciated in main control room).

2. Fuel oil transfer system inoperable (annunciated in main control room).

3. Fuel oil storage tank level low/high.

4. Fuel oil day tank level low-low/high-high.

5. Fuel oil transfer pump strainer differential pressure high.

6. Fuel oil transfer pump flow low.

7. Fuel oil transfer pump loss of control power.

8. Fuel oil transfer pump control switch in off position.

There is a common window for each division, i.e.:

852110 - Division I fuel system trouble

852210 - Division II fuel system trouble

The alarm shown on Sheet 1 of Figure 9.5-41 going to panel 406 is a common alarm, fuel oil transfer pumps trouble.

EGFFCO1 is the computer print identification for the retransmitted alarm to the computer, where it will indicate on the alarm cathode ray tube (CRT) and print on the alarm typer.

9.5.5 Diesel Generator Cooling Water System

Each standby diesel generator has a closed loop cooling system, referred to as the jacket water system, to remove heat from the engine and maintain the cylinders, pistons, valves, and other components of the engine, as well as the lube oil and combustion air, within the desired operating temperature limits. This system also keeps the engine warm during engine standby condition.

9.5.5.1 Design Bases

The standby diesel generator jacket water system is designed to meet the following safety design bases:

1. Each standby diesel generator has a jacket water system capable of removing sufficient heat from the engine to allow continuous operation of the engine at maximum load. The cooling water transfers heat to the SWP system, which carries the heat to the UHS.

2. The jacket water system has an independent loop with an immersion heater for heating circulating water that keeps the engine warm while the engine is in standby mode. This increases the first-try starting reliability of the engine.

3. The jacket water heat exchangers are provided with separate service water supply headers and service water discharge headers so that failure in any one division will not jeopardize the safety function of any other division.

4. The components of the jacket water system are housed in the diesel generator building, which is a Category I structure capable of protecting the system from extreme natural phenomena possible at the site and from internally- and externally-generated missiles to meet GDC 2 and 4. The design bases for this structure are discussed in Chapter 3.

5. The jacket water system of each standby diesel generator is independent of the jacket water systems of the other standby diesel generators and is contained in the same section of the diesel generator building as its associated diesel generator. Thus, any failure in one diesel generator jacket water system cannot jeopardize the safety function of any other diesel generator.

6. There is no high-energy piping in the diesel generator building other than piping associated with the diesel generators themselves. Failure of any part of the moderate-energy piping system present in the diesel generator building, not associated with the diesel generator, will not jeopardize the safety functions of the diesel generator. Failure of any high- or moderate-energy piping system associated with any diesel generator itself will affect the performance of the associated diesel generator alone. This meets the requirements of BTP APCSB 3-1 and MEB-3.

7. Unit 2 diesel generators are not shared with any other plant.

8. The jacket water system is of Safety Class 3, Category I design to meet RG 1.26 and 1.29. For Division I and II, all essential auxiliary skid-mounted components and the engine-mounted intercoolers, and for Division III, the cooling water/service water heat exchangers of the jacket water system are built in accordance with ASME Boiler and Pressure Vessel Code Safety Section III, Safety Class 3. All other components of the Division I, II, and III cooling water systems are built in accordance with ANSI B31.1 or DEMA standards and meet

seismic requirements. Sections 3.2.1 and 3.2.2 give details of the system seismic and quality group classification bases.

9.5.5.2 System Description

The standby diesel generator jacket water system is an integral part of the diesel engine and supplied entirely by the engine manufacturer, Cooper Energy Services for Division I and II diesel generators, and GE (Stewart and Stevenson Services) for Division III diesel generator. The Division I and II systems differ from Division III in their arrangements and hence are described separately.

9.5.5.2.1 Division I and II Cooling Water System

The jacket water system for Division I and II diesel generators is shown on Figure 9.5-42. Division I and II have independent jacket water systems. Each system consists of the following major components:

1. A standpipe that serves as a reservoir, deaerator, and expansion tank. It holds 440 gal of water. The entire jacket water system has a capacity of 1,350 gal. Each pump connected to the standpipe has a separate suction connection, as described in the following two paragraphs. An overflow line, a return line, and a drain complete the connections to the standpipe. A level indicator, a low level alarm, and a level controller are also furnished in the standpipe.

2. An engine-driven main water pump to circulate cooling water when the diesel generator is in operation. The pump is mounted on top of the forward end housing and is driven from the forward end of the camshaft through a chain and sprocket mounted on the hub gear. The pump has a capacity of 1,100 gpm at 70 ft of H_2O and at 1,750 rpm and has a check valve on the discharge side.

3. A motor-driven circulating pump and heater to keep the engine warm by circulating warm water through the engine when the diesel generator is in standby condition. The pump has a capacity of 175 gpm at 40 ft. The driving motor is a 5-hp, 575-V, 3-phase, 1,750-rpm, ac induction motor. The heater is 18 kW, 575 V, 3 phase, ac. A low temperature control switch starts the pump and turns on the heater when the jacket water is approximately 120°F falling and turns them off at 130°F rising. A check valve on the discharge side of the heater prevents a reverse flow through the pump and heater when they are inoperative.

4. Two thermostatic valves to control the water temperature. A two-way thermostatic valve ensures

jacket water to all coolers during startup. A three-way thermostatic valve controls the flow of water through the coolers when the engine is running and after the water temperature has reached 165°F.

5. A jacket water cooler to cool the jacket water transferring heat to the service water. The cooler is a shell-and-tube type and has a removable bundle for cleaning. Jacket water passes through the shell and over the tubes as directed by crossflow baffles. Service water circulates inside the tubes. The cooler is designed for the heat duty expected under maximum engine load with appropriate fouling factors to take care of the service conditions. The cooler design conditions are as follows:

	Shell Side	Tube Side
Flow rate	422 gpm	800 gpm
Temperature in	170°F	84°F
Temperature out	115°F	109.4°F
Fouling factor	0.001	0.002
Total heat load	10,170,000 Btu/hr	

This provides excess cooling capacity over expected conditions since the maximum temperature of raw water from Lake Ontario is normally less than 77°F. The cooler is designed to ASME Section III, Safety Class 3, and TEMA Class R standards.

6. Combustion air intercoolers that warm the combustion air at startup and cool it when the diesel generator is in operation.

7. A lube oil cooler, governor oil cooler, and fuel oil cooler that use jacket water for cooling.

The jacket water system is a closed loop system as shown on Figure 9.5-42. During engine running condition, the engine-driven main water pump takes water from the standpipe and pumps it through the three-way thermostatic valve and coolers. Water temperature is controlled by the three-way thermostatic valve. Water enters the valve at Port A. At water temperature 175°F, all water is directed out Port C to the coolers. When the water temperature is between 165°F and 175°F, the valve modulates, and the flow is directed through Ports B and C to maintain the temperature at approximately 170°F. The two-way thermostatic valve is designed to ensure circulation of water to coolers during startup. This valve is opened at startup and closes at approximately 165°F. This would not prevent the system from reaching operating temperature. This valve ensures proper

jacket water circulation until the jacket water reaches operating temperature.

From the coolers or thermostatic valve, water flows into two main jacket water headers. Jacket water flows from the main headers to each cylinder through individual connections, and also to the turbocharger and the heater portion of the combustion air intercoolers. Water flows to the heater portion of the combustion air intercoolers constantly and provides cooling when the engine is in full operation. The motor-driven circulation pump and heater circulate warm water through the engine jackets, intercoolers, and turbocharger when the diesel generator is in standby condition. For this circulating system to maintain a uniform temperature within the jacket water and the cooling water system, the diesel generator ambient temperature is maintained at 40°F or above.

To preclude long-term corrosion, treatment of the water used in the jacket water system includes the use of nitrite inhibitors, in agreement with the engine manufacturer's recommendations, and periodic testing of the water to ensure that the water quality is maintained at the level recommended by the manufacturer. Since the entire jacket water system is enclosed, maintained in warm condition by the circulating pump and heater, and installed in a heated building (see Section 9.5.5.5), use of any antifreeze compound is not required.

Any leakage in the system causes loss of jacket water pressure or low level in the jacket water standpipe and is annunciated by the low pressure or low level alarm.

The capacity of the system will adequately maintain the required pump NPSH and makeup water for 7 days of continuous operation of the diesel engine at full load. According to the vendor's calculation, the NPSH available in the system when full is approximately 28.9 ft with water temperature at 170°F. The required NPSH for the pump is approximately 10 ft. Even with the loss of approximately 40 gal of water, where the jacket water standpipe low-level alarm is set, there is more than adequate suction head available on the pump to prevent any pump cavitation or loss of flow. The expected loss of cooling water for 7 days is less than 40 gal. Any loss of water through seepage, leakage, or flow out of the system will be noticed through routine checks. If needed, the cooling water system can be manually refilled.

Locating the jacket water standpipe on the engine provides a positive suction head for the jacket water pumps. The two-way thermostatic valve passes jacket water to all coolers during engine startup. The butterfly valve bypasses water through the engine at all times during engine operation. These systems ensure that all the components and piping of the jacket water system are filled with water at all times.

9.5.5.2.2 Division III Cooling Water System

The jacket water system for the Division III diesel generator is shown on Figure 9.5-43. The system consists of the following major components:

1. The entire jacket water system capacity is 318 gal. A jacket water expansion tank which also serves as a reservoir and a deaerator. The cooling water expansion tank is located on the auxiliary equipment skid. The tank has sufficient capacity to adequately maintain the required pump NPSH and makeup water for 7 days of continuous operation of the diesel engine at full load. In accordance with the equipment manufacturer, the expected loss of cooling water within 7 days is less than 40 gal. The tank has two suction lines for two engine-driven water pumps, a return line, an overflow, and a drain. A level indicator and a low level alarm switch are also furnished in the expansion tank.

2. Two engine-driven jacket water pumps to circulate jacket water through the engine when the engine is running. The pumps are mounted on the accessory drive housing and are driven by the governor drive gear.

3. A temperature regulating valve that regulates the flow of water through the jacket water heat exchanger to maintain the jacket water at a constant temperature.

4. A jacket water heat exchanger which cools the jacket water by imparting its heat to the service water. This is a shell-and-tube type heat exchanger with a removable bundle for cleaning.

   The heat exchanger design conditions are as follows:

	Shell Side	Tube Side
Flow rate	1,100 gpm	800 gpm
Temperature in	190°F	95°F
Temperature out	174.4°F	116.5°F
Fouling factor	0.0005	0.0015
Total heat load	8,580,000 Btu/hr	

   This provides excess cooling capacity. The heat exchanger is built to ASME Section III, Safety Class 3 and TEMA Class C standards.

5. Combustion air aftercoolers that warm the combustion air at startup and cool it when the engine is in operation.

6. A lube oil cooler that uses jacket water for cooling.

7. An immersion heater to heat the jacket water when the engine is in standby condition. A heater control switch turns the heater on when the water temperature falls to 125°F, and off when water temperature rises to 155°F. The heater is 15 kW, 575 V, 3 phase, ac.

The engine cooling water system is designed to operate as a "flooded" system. Venting is provided between the engine coolant outflow piping, the lube oil cooler, and the cooling water expansion tank. As shown on Figure 9.5-43, the entrapped air is vented via vent lines from the engine block, lube oil cooler water side piping, and expansion tank. Venting of the heat exchanger is not required.

The jacket water system is a closed loop system. During engine running condition, heated water from the engine discharge manifold flows to the temperature regulating valve. The temperature regulating valve regulates the flow of water through the jacket water heat exchanger and maintains the engine jacket water at a constant temperature. If the water temperature is below 165°F, all water passes directly to the lube oil cooler. At water temperatures between 165°F and 180°F, the valve regulates the flow through the jacket water cooler and the bypass line. Jacket water flows from the lube oil cooler to the engine-driven centrifugal pumps that pump the water into the engine jacket water main headers. From the main headers, jacket water also flows through the aftercoolers located in the turbocharger air discharge duct to cool the air before it enters the engine air box.

When the engine is in standby condition, the immersion heater heats the jacket water. The heated jacket water circulates through the lube oil cooler by thermosyphon action to warm the lubricating oil that is being circulated through the engine to keep the engine warm. The jacket water, heated by the immersion heater, maintains the lube oil temperature at a minimum of 85°F. For the keep-warm system to maintain a uniform temperature within the diesel engine jacket water and throughout the cooling water system, the Division III diesel generator ambient temperature is kept above 40°F.

To preclude long-term corrosion, treatment of the water used in the jacket water system includes the use of nitrite inhibitors, in agreement with the engine manufacturer's recommendations, and periodic testing of the coolant to ensure that the water quality is maintained at the level recommended by the engine manufacturer.

The engine cooling water is treated with inhibitor. Thus, each time the engine is run, all parts of the cooling system are wetted with inhibitor, which provides a protective coating inside the pipes. Running the engine once a month will provide adequate corrosion protection, and no decrease in cooling system life is anticipated.

Use of an antifreeze compound is not required since the entire cooling water system is enclosed, located indoors, and maintained warm by the immersion heater when the engine is in standby condition.

Any loss of water through seepage, leakage, or flow out the pressure relief cap will be noticed through routine checks of the expansion tank sight glass. If needed, the cooling water system can be manually refilled through the filler opening at the top of the expansion tank.

The diesel generator jacket water system includes two locally mounted temperature switches in the engine outlet line. The first switch is used to alarm on the local control panel in the event of high coolant temperature. The second switch is used to automatically shut down the engine in the event of high-high coolant temperature. This trip is automatically bypassed on a LOCA signal or with a LOOP signal.

Any leakage in the system causes loss of jacket water pressure or low level in the jacket water expansion tank. A low jacket water pressure or low expansion tank water level is alarmed in the diesel generator control room and in the main control room.

9.5.5.3 Instrumentation and Control Requirements

Description

Instruments and controls are provided for automatic and manual control of the emergency diesel generators jacket water systems. Except where noted, the controls and monitors described below are located in the respective emergency diesel generator room.

Operation

During operation, engine temperature is controlled automatically by thermostatic control valves that regulate the flow of jacket water through the water cooler (heat exchanger).

During standby, Division I and II engine temperature is maintained and controlled automatically by a motor-driven jacket water circulating pump and electric heater. The circulating pump and heater are started or stopped automatically when the jacket water temperature is low or normal, respectively.

During standby, the Division III engine temperature is maintained and controlled automatically by an electric heater. The heater is controlled automatically by the engine jacket water temperature. The heated water circulates through the lube oil cooler by thermosyphon action to warm the circulating lube oil.

The jacket water system is provided with safety shutdown for high jacket water temperature. This trips the diesel engines

automatically during test or nonemergency operation if the associated jacket water outlet temperature is high. The automatic high jacket water temperature trip is automatically blocked during emergency operation (LOCA) per RG 1.9, Revision 2, Position 7, or with a LOOP signal.

Division I and II Monitoring

Indicators are provided for:

1. Jacket water inlet temperature.

2. Jacket water outlet temperature.

3. Jacket water cooler outlet temperature.

4. Jacket water standpipe reservoir level.

5. Jacket water pressure.

6. Combustion air intercooler jacket water outlet temperature.

7. Lube oil cooler jacket outlet temperature.

Alarms are provided for:

1. Emergency diesel generators shutdown, mechanical failure (main control room).

2. Emergency diesel generators mechanical failure (main control room).

3. Jacket water outlet temperature high.

4. Jacket water outlet temperature low.

5. Jacket water pressure low.

6. Jacket water standpipe reservoir level low.

7. Jacket water circulating pump pressure low.

For additional description of diesel generator alarms, see Section 8.3.1.1.2.

Division III Monitoring

Indicators are provided for:

1. Jacket water inlet temperature (local).

2. Jacket water outlet temperature (local).

3. Jacket water expansion tank level.

4. Service water inlet to heat exchanger temperature (local).

Alarms are provided for:

1. Diesel engine trouble (main control room). This alarm is annunciated when any one or more of the following local alarms are activated.

2. Jacket water outlet temperature high (local).

3. Cooling water pressure low (local).

4. Expansion tank water level low (local).

For additional description of diesel generator alarms, see Section 8.3.1.1.2.

9.5.5.4 Inspection and Testing Requirements

The jacket water system capability is tested during preoperational testing of the diesel generator. The jacket water system is tested hydrostatically. Continued integrity of the jacket water system is insured through periodic testing of the system with periodic testing of the diesel generator. Periodic testing of the diesel generator is discussed in Section 8.3. The cooling water is sampled and analyzed periodically to insure that the coolant quality meets the recommendations of the engine manufacturer. The SWP system is designed to permit periodic inspection of the diesel generator heat exchangers. The safety-related portion of the SWP system is designed to permit periodic pressure and functional testing to ensure its structural and leak-tight integrity in accordance with GDC 46. It is also designed to permit periodic operability testing with simulation of emergency reactor shutdown on LOCA conditions. Further details for testability of the SWP system are given in Sections 6.6 and 9.2.1.

9.5.5.5 Safety Evaluation

Each standby diesel generator is provided with a cooling water system that is independent of and separate from the jacket water systems of the other diesel generators. All components of each jacket water system are contained in the same section of the diesel generator building as their associated diesel generators. Therefore, any failure in one diesel generator jacket water system cannot jeopardize the safety function of any other diesel generator.

Each diesel generator jacket water system is capable of removing sufficient heat from the engine and other components to allow continuous operation of the engine at maximum load. The jacket

water transfers heat to the service water through the heat exchanger, which is designed with additional cooling capacity and a conservative fouling factor to account for various service conditions.

Each jacket water system has a separate loop with a heater to heat the circulating water during engine standby condition. This ensures that the engine is warm and increases first-try starting reliability of the engine as long as the diesel generator ambient temperature is maintained at 40°F or above. For the Division I and II jacket water system, this loop consists of a motor-driven circulating pump and a heater. For the Division III system, this consists of an immersion heater. The heater heats the jacket water that circulates through the lube oil cooler by thermosyphon action and heats the lube oil. The warm lube oil circulates through the engine and keeps it warm.

The jacket water system operates within the ranges of pressure and temperature and at the flow rate recommended by the engine manufacturer.

The jacket water quality is maintained at the level recommended by the engine manufacturer. The jacket water is treated with inhibitor compounds recommended by the manufacturer to prohibit long-term corrosion and organic fouling. Continued quality of the jacket water is ensured by periodic sampling and analysis of the water.

The system is protected against any leakage. Any external leakage will be detected by a visual inspection. Any leakage within the system is detected by a decrease in the Division III expansion tank water level or by a drop of pressure in the system. Any leakage within Division I and II is detected by a decrease in the jacket water standpipe level. These conditions are automatically monitored and annunciated in the diesel generator control room as well as in the main control room.

Cross leakage of engine coolants resulting from minor piping connection failure between diesel engine subsystems will not degrade the engine performance or reliability.

For Divisions I and II, the jacket water pressure is always lower than the lube oil pressures during both standby and operating mode. Therefore, any tube failure at this interface would cause leakage of oil into the jacket water. For Division III, jacket water leakage into the lube oil will be detected during periodic analyses of the lube oil.

For Divisions I, II and III, service water pressure is higher than the jacket water pressure. Therefore, any tube leakage at the jacket water cooler would cause leakage of service water into the jacket water. This leakage would cause dilution of the jacket water inhibitor concentration and will be detected during periodic sampling and analysis of the water.

Any tube leakage at the heat exchanger interface between jacket water and combustion air would cause jacket water leakage into the combustion air system.

For Division III, jacket water leakage into the governor is not a concern as the fluid used for the governor is self-contained and has no connection to the cooling water system.

For Divisions I, II, and III, should any of the above leakage occur the Operator would be alerted by one or more of the following alarms prior to degradation of engine performance:

Jacket water pressure low
Jacket water standpipe/expansion tank level low
Lube oil pressure low
Diesel generator service water inlet pressure low

In addition, the possibility of any tube leakage is minimized by periodic inspection, testing, and maintenance of the systems.

Any major piping failure between lube oil and jacket water subsystems could degrade engine performance or cause engine failure during standby or operating modes. This major piping failure that will cause substantial subsystem cross leakage will be detected either by means of alarms or during routine visual and laboratory checks of the engine oil or cooling systems. Should a detrimental piping failure render a diesel engine inoperable, the plant operating procedures will be followed to meet the applicable Technical Specifications.

Division I and II diesel generator jacket water heat exchangers are provided with separate and independent service water supply headers and service water discharge headers. The Division III diesel generator jacket water heat exchanger is fed from both Division I and II supply and discharge headers. This arrangement insures that failure in any one division will not jeopardize the safety function of any other division. The SWP system design bases are described in Section 9.2.1.

Each diesel generator room is provided with multiple nonsafety-related electric unit heaters, designed to maintain a normal space temperature of 70°F in the winter. The unit heaters are controlled with thermostats. Each room also has a separate QA Category I thermostat, with dual high (110°F) and low (65°F) temperature settings, for the purpose of annunciating an alarm in the main control room if space temperature falls below 65°F or rises above 110°F.

Using the Class 1E temperature indication and the alarm from the control room annunciator, the Operator can determine that the diesel generator room temperature has dropped below 65°F. When an alarm occurs, annunciator response procedures will direct the appropriate Operator response. Although the nominal room

temperature will be 70°F, the diesel generators are designed to reliably start and operate at room ambient temperatures as low as 40°F. There are keep-warm systems for jacket water and lubrication oil and alarms for these keep-warm systems in the control room.

Upon receipt of a control room annunciation that a diesel generator room temperature had fallen below 65°F, immediate steps will be taken to restore the operation of the unit heaters. During the period of time that the room temperature is below 65°F, hourly room temperature checks will be made. If the temperature continues to fall until it reaches 40°F, the diesel generator will then be either started or declared inoperable.

Should LOOP occur, concurrent with a subfreezing outdoor condition, the diesel engines will start automatically, thereby maintaining temperature. These steps will ensure that the diesel generator will be capable of starting under all anticipated temperatures of the diesel generator rooms.

There is no high-energy piping in the diesel generator building other than that associated with the diesel generators themselves. The high-energy piping associated with the diesel generators is the combustion air exhaust system piping. Failure of any of this system can only affect the associated diesel generator. The moderate-energy piping systems in the diesel generator building not associated with the diesel generators are service air, fire protection, and floor drain piping. Failure of any of these systems cannot jeopardize the safety function of the diesel generator jacket water system. The Division I and II diesel generators are designed and built to operate continuously during a discharge of the fire protection system. The Division III diesel generator is retrofitted with the capability of operating continuously during a discharge of the fire protection system. The moderate-energy piping systems associated with the diesel generators themselves are the fuel oil system, SAS system, SWP system, and combustion air intake system piping. Failure of the piping of any of these systems will affect the performance of the associated diesel generator alone.

The Division III diesel generator is equipped with a high-capacity turbocharger which is designed to withstand the rigors of light-load operation. This turbocharger is capable of 3,000 cumulative hours of operation at less than 20 percent load before overhaul is required.

Each standby diesel generator is limited in running at rated speed at no load to prevent fouling the fuel injectors. Operation at this condition may last up to 4 hr for Division III and 6 hr for Divisions I and II. After this period they will be loaded according to manufacturer's recommendation (for Division III as specified in Technical Specifications, and for Divisions I and II greater than 75 percent for 30 min). Moreover, procedures address diesel generator control during LOCA event with offsite

power available. The procedures are consistent with the emergency operating procedures (EOPs).

Originally, the FMEA evaluation of the diesel generator was contained in the Unit 2 FMEA document, which is historical. FMEAs for plant systems are now performed and controlled by the design process.

9.5.6 Diesel Generator Starting System

Each standby diesel generator has two redundant compressed air starting systems, either of which has adequate capacity to assure quick, reliable, automatic starting of the diesel generator following a LOOP.

9.5.6.1 Design Bases

The standby diesel generator starting system is designed to meet the following safety design bases:

1. Each standby diesel generator has redundant air starting systems either of which is capable of starting the engine.

2. The starting air receivers have sufficient capacity to start the engine within 10 sec. Each air starting system can crank a cold diesel generator five times without recharging the receiver tanks. Each compressor can recharge the air receiver from minimum operating pressure to the maximum operating pressure in less than 30 min for Division III and 50 min for Divisions I and II. The motors for the Division I and II motor-driven compressors are powered from emergency buses to increase the reliability of the system. The motor for the Division III motor-driven air compressor is powered from nonsafety-related bus.

3. The SAS system for each diesel generator contains air dryers to ensure clean, dry air to the air receiver tanks. The dryers for Division I and II have a design dew point of 37.4°F. The dryers for Division III have a design dew point of -40°F. The dryers contain prefilters and afterfilters to remove oil, waste, dirt, pipe scales, and any desiccant dust from the air stream.

4. For Division I and II, the essential air starting skid-mounted components of the starting system, and for Division III, the air receiver tanks are classified as Safety Class 3 and meet the requirements of ASME Boiler and Pressure Vessel Code, Section III, Safety Class 3, and are Category I. All other components of the Division I and II starting systems, except the air dryers, are built in accordance with DEMA standards and

are Category I; the air dryers are built in accordance with Italian Standard ISPESL. Other components of the Division III starting system are built in accordance with ANSI B31.1, ASME Section VIII, or DEMA standards and meet seismic requirements. The safety classification bases are discussed in Section 3.2. This complies with RG 1.26 and 1.29.

5. The components of the starting system are housed in the diesel generator building which is a Category I structure capable of protecting the system from extreme natural phenomena as established in Chapter 3. This complies with GDC 2 and 4.

6. The starting system of each standby diesel generator is independent of the starting systems of the other standby diesel generators and is located in the same section of the diesel generator building as its associated diesel generator so that any failure in one diesel generator starting system cannot jeopardize the safety function of any other diesel generator. Unit 2 is a single unit and does not share structures, systems, or components with any other unit.

9.5.6.2 System Description

Each standby diesel generator has its own starting system separate from and independent of the starting system of any other diesel generator. The starting systems for Division I, II, and III standby diesel generators are shown on Figure 9.5-40a. Though the basic system is the same for all three divisions, the components in Division III differ slightly from those of Divisions I and II, which are similar.

9.5.6.2.1 Division I and II Diesel Generator Starting System

The starting system for each of the Division I and II standby diesel generators consists of two independent, redundant subsystems either of which is capable of starting the diesel generator. Each subsystem consists of the following basic equipment with interconnecting piping, valves, filters, or strainers: 1) an air compressor, 2) an air dryer, 3) an air receiver tank, 4) a moisture separator, 5) a starting air control valve, with its associated check valve. Beyond this point, there is a common header which serves the two starting air distributors and the two sets of starting air valves (one distributor and one set of air start valves per engine bank). The air compressor, receiver, and moisture separator are skid-mounted, whereas the starting air control valve, the starting air distributor, and the air starting valves are located on the engine. The air dryer is located separately near the air compressor.

Each air compressor in each starting system is a two-stage, motor-driven compressor that delivers 32 scfm of air to its

130-cu ft air receiver tank. The driving motor is a 15-hp, 575-V, 3-phase, Class 1E induction motor fed from the respective Division I or II emergency MCC. Each compressor is capable of recharging its air receiver from 240 psig minimum operating pressure to 250 psig maximum operating pressure in less than 50 min.

Each air compressor supplies compressed air to its air receiver through a check valve, an air dryer, and a gate valve. The check valve prevents depressurization of the loop back through the compressor when it is not operating. A relief valve protects against system overpressurization. The gate valve is provided for isolating the compressor from the rest of the system. A crossover pipe interconnects the air receivers of the two subsystems within a division to provide the capability for charging both the air receivers from either compressor. The crossover pipe has a normally closed gate valve that must be manually opened to perform this function.

Each air receiver has a volume of 130 cu ft. This volume of air is enough for five consecutive starts of the engine without recharging. During each of the first three of these five consecutive starts, the engine will accelerate to rated speed and voltage within 10 sec. The Cooper Energy Services test report for Division I and II standby diesel generators indicates that each standby diesel generator had three 10-sec starts from one subsystem air receiver tank while the other subsystem air receiver tank was completely isolated.

The air receiver tank in service fed both starting air headers. Starting capability tests with both the air receiver tanks in service was not done by Cooper Energy Services. However, from the above test results, it can be inferred that each standby diesel generator starting system will have five 10-sec starts capability when fed from both air receiver tanks. The air receivers are mounted vertically on the starting air skid. Each air receiver has a top-mounted pressure relief valve for protection against overpressurization and a bottom-mounted gate valve for manual moisture blowdown. A panel on the air receiver contains a pressure gauge, a pressure switch to start and stop the compressor automatically, test valves, and shutoff valves. The pressure switch on each air receiver starts the compressor when the air receiver pressure decreases to 240 psig and stops when the air receiver pressure increases to 250 psig. The relief valves are set at 265 psig. The minimum air receiver pressure required to allow five normal starts without recharging is 225 psig. The air receiver pressure can drop to 175 psig and still provide a single start of the diesel generator. The compressors can also be started manually. The air receivers are designed, fabricated, and tested in accordance with the requirements of ASME Boiler and Pressure Vessel Code, Section III, Class 3.

A successful engine cranking cycle begins at the engine start signal and ends when the engine reaches 280 rpm. If the engine

fails to start, it will continue to crank for a total period of 10 sec from the receipt of start signal. Following this 10-sec time limit, the air start solenoids are de-energized, the following alarms are annunciated, and the engine stops cranking.

1. Standby diesel generator starting sequence incomplete - local.

2. Emergency diesel generator system trouble - control room.

From the air receiver, compressed air flows through a butterfly valve and then a moisture separator. Any remaining moisture in the air is removed by the separator, which has a water level indicator and drain. The butterfly valve, which acts as a manual isolation valve for maintenance purposes, is alarmed in the closed position. The alarm is provided since closure of the isolation valves in both subsystems would preclude starting of the diesel generator.

Compressed air is then supplied to the starting air control valve. This valve has two outlets: the main outlet and the vent outlet. The vent outlet is constantly open to provide a source of air to the pneumatic controls; the main outlet is opened on demand to provide starting air to the engine. Air is supplied to the starting air solenoids through the manual shutoff valves and the turning gear interlock valves when the turning gear is disengaged. When the engine receives a start signal, the starting air solenoids (left and right banks) are energized through shuttle valves to the respective starting air control valve. With the starting air valve open, air then flows through the filters to the respective starting air distributors. The shuttle valves provide control air for the starting air control valves and for the engine control and shutdown, from either or both of the control air headers. The shuttle valves provide output air with pressure balance on both sides, as well as with air pressure unbalance on either side of the valves. With balanced pressure from both air sources, the shuttle valves provide an output airflow derived from both sources. Air from the starting air main outlet then flows through the air filters to the starting air distributors. The starting air distributors act as timers to open and close the starting air valve in each cylinder head according to the firing order of the engine. When the starting air valves open, air is admitted into the cylinders and the engine is cranked. Either of the dual sets of the starting air control valve, air distributor, and starting air valves will crank the engine even though both sets are normally energized for reliability of starting. When the starting signal is turned off, air vents from the distributors and cylinder heads through the orificed check valve and out the starting air control valves.

The piping associated with the starting systems is designed, fabricated, and erected in accordance with ASME Boiler and

Pressure Vessel Code, Section III, Class 3 with all components fabricated from carbon steel. The piping on the engine is fabricated from stainless steel. The entire starting air system is designed to seismic Category I requirements, except the air dryers and some nonessential piping, which are seismically supported.

9.5.6.2.2 Division III Diesel Generator Starting System

The Division III standby diesel generator starting system consists of two independent, redundant subsystems, either of which is capable of starting the diesel generator. Each subsystem consists mainly of the following equipment with interconnecting piping, valves, filters, or strainers: 1) an air compressor, 2) an aftercooler, 3) an air receiver tank, 4) a starting air relay valve, 5) two starting air motors, and 6) a desiccant air dryer. The air compressor, air receiver tank, and aftercooler are located on the starting air skid, whereas the starting air relay valve and starting air motors are located on the engine. The air dryer is located on a separate skid near the air compressors.

9.5.6.2.2.1 Air Compressor

The Division III diesel generator starting system has two motor-driven air compressors. Each air compressor is a two-stage, air-cooled compressor with a 20 scfm rating and is capable of recharging the associated 64-cu ft air receiver from 215 psig minimum operating pressure to 240 psig maximum operating pressure in less than 30 min. Each of the compressors is driven by a 10-hp, 575-V, 3-phase ac motor fed from a non-1E 600-V ac bus.

The air compressor supplies compressed air to the air receiver through an aftercooler, a desiccant air dryer, a check valve, a relief valve, and a service valve. The check valve prevents depressurization of the loop back through the compressor when it is not operating. The relief valve protects against system overpressurization. The service valve is provided for isolating the compressor from the rest of the system.

9.5.6.2.2.2 Air Dryer

Air dryers to the air start system are provided to reduce the moisture content of the air and minimize condensation in the SAS system. This is to improve the reliability of the air start function of the diesel generator and to minimize the formation of rust and scale in the receiver and piping.

The diesel generator SAS system is upgraded with a desiccant-type, dual-tower, air dryer system, which includes two vessels, air aftercooler, moisture separator, pre- and postfilters, absorbent medium, piping, valves, and necessary controls.

The functions of the main components of the air dryer system are described in the following paragraphs.

The air-cooler type aftercooler-moisture separator delivers compressed air within 15 to 21°F above room ambient temperature. The separator condenses up to 90 percent of the inlet air moisture content and removes condensate with an automatic trap and drain.

The coalescing-type prefilter removes entrained liquid oil and water particles from the compressed air. The prefilter is capable of removing a minimum of 98 percent liquid oil from mist-laden air and can withstand and perform efficiently up to maximum rated flow from air surges or backflow. The prefilter is furnished with bypass valves for maintenance.

The heatless-type, dual-tower, air dryer system is furnished with active alumina-type desiccant. Incoming compressed air is dried by passing through the desiccant in one tower, while the other tower is regenerating. The desiccant regeneration is accomplished by using a small portion of the dried air exiting from the drying tower. The purge air exhausts to the atmosphere. The drying and regeneration times of 5 min each combine to complete the 10-min cycle. Switching between towers is automatic and does not interrupt the dry air supply. Valves, controls, and piping required to accomplish automatic operation are furnished with the unit, suitably mounted on the equipment. Electrical controls and circuits are installed in a NEMA Type 4 enclosure and wired in accordance with National Electrical Code requirements.

Dryer control is electrically interlocked with air compressor operation. The system is maintained at line pressure and is ready to dry the compressed air upon restart of the air compressor.

The dryer is designed for 300 psi and hydrotested at 450 psig. Each set of air dryers is equipped with bypass piping and valves for maintenance. Pressure gauges are furnished, as required, to monitor dryer operation. The air dryer is introduced between the air compressor and an air receiver.

Following are the design bases used for air dryer performance requirements:

Inlet flow rate	32 scfm
Inlet pressure	250 psig
Inlet temperature	125°F
Inlet moisture content	Saturated (at inlet pressure)

Outlet moisture content	37.4°F for Division I and II (dew point at line pressure) -40°F for Division III (dew point at line pressure)
Operation	Automatic, with locally-mounted instrumentation and chamber pressure gauge
Dryer cycle	10 min (in accordance with NEMA Standard AD1-1964)
Drying time	5 min
Absorbent type	Active alumina 10.8
Chamber regeneration	5 min
Purge flow	2 scfm (nominal)
Dryer design pressure	300 psi
Vessel design pressure	300 psig

A particulate-type afterfilter is furnished downstream of the air dryers to remove particulate matter that may escape the prefilter and dryer. The afterfilter is capable of trapping and removing particles of 1 micron and larger in size.

The air dryer system is designed to ANSI/B31.1 Code requirements.

9.5.6.2.2.3 Air Receiver

Each air receiver has a volume of 64 cu ft. Based upon testing at Unit 2, it has been shown that there is sufficient air storage capacity to start the Unit 2 engine five consecutive times, when initially charged at 150 psig, without recharging when operated in its normal configuration. The minimum allowable pressure for the Division III diesel air receiver is conservatively established at 190 psig. The air receivers are mounted vertically on the starting air skid. Each air receiver has a top-mounted pressure-relief valve for protection against overpressurization and a bottom-mounted drain valve for manual moisture blowdown. A panel on the air receiver contains a pressure gauge, a pressure switch to start and stop the compressor automatically, and a service valve. The pressure switch on each air receiver starts the compressor when the air receiver pressure decreases to 215 psig and stops when the air receiver pressure increases to 240 psig. The relief valves are set at 250 psig. The compressors can also be started manually. The air receivers are designed, fabricated, and tested in accordance with the requirements of ASME Boiler and Pressure Vessel Code, Section III, Class 3. Division III starting

subsystems have a crossover pipe downstream of the air receivers so that any subsystem can use air from the other receiver if required.

From the air receiver, compressed air flows through a service valve to the starting air relay valve. The service valve may be closed manually when maintenance is required. Closing the service valves in each subsystem would prevent the diesel generator from starting.

Air from the air receiver is constantly applied to the air relay valve and the solenoid valve to supply air to the engine control system and automatic starting system.

9.5.6.2.2.4 System Performance

When the engine receives the start signal, the normally closed solenoid valve opens and air flows to the piston for the pinion gear of the lower motor. The entry of air moves the pinion gear forward to engage with the engine ring gear. Movement of the pinion gear uncovers a port, allowing air pressure to be released to the upper motor pinion gear piston which, in turn, engages its pinion gear with the engine ring gear. Full engagement of the upper pinion gear permits air flow to the air relay valve which, in turn, releases the main starting air supply. Starting air passes through the air line lubricator, releasing an oil air mist into the starting motors. The motors drive the pinion gears, rotating the ring gear and cranking the engine. The engine will normally start with one bank of dual starting air motors. However, to ensure positive starting, both solenoids are energized simultaneously and both banks of dual starting motors crank the engine.

A successful engine cranking cycle concludes when the engine has reached a preset speed of 150 rpm as recommended by the manufacturer. If the engine fails to start within 10 sec, the engine continues to crank for a total preset period of 20 sec from the receipt of the start signal. Following this 20-sec preset time limit, the air start solenoids are de-energized, and the air supply to the air start motors is cut off.

9.5.6.2.2.5 Control and Alarm

An "Engine Fail to Start/Run" local alarm is annunciated at the end of the 20-sec cranking time to alert the Operator, along with a common "Diesel Engine Trouble" alarm in the main control room.

Motor-driven air compressor start-stop controls (MAN-off-Auto switch) are located on the diesel generators motor starter. The following controls of the air start system are located on the panel near the air compressor:

1. Air compressor start-stop controls (MAN-off-Auto switch on motor starter), and

2. Air compressor run-stop indicating lights for each compressor.

The following controls are located on the air dryer:

1. Air dryer on-off controls.
2. Air dryer on-off indicating light.

The following instrumentation is provided on the air start system:

1. An individual pressure switch for the start-stop control of each air compressor while in the automatic mode of operation,
2. An individual pressure switch for each bank of air-start motor "crank-jog" controls,
3. An individual pressure switch for each air receiver tank low-pressure alarm, and
4. Four pressure gauges, one for each air receiver tank pressure and one for each air-start motor pressure.

The engine air-start system is provided with the following alarms:

1. An engine "Fail to Start/Run" alarm at the local panel in the diesel generator control room,
2. Two engine alarms "Left Bank Starter Inlet Air Pressure Low" and "Right Bank Starter Inlet Air Pressure Low" alarm at the local panel in the diesel generator control room, and
3. A common "Diesel Engine Trouble" alarm at the main control room that annunciates when any one or both of the above local alarms are annunciated.

No control functions are supplied by the air starting system or any other air system to control emergency trip functions and/or diesel generator operation, except engine cranking.

9.5.6.2.2.6 System Qualification

The Division III starting system air receivers and the interconnecting piping and components between the air starting skid and engine are designed to Category I, ASME Section III, Safety Class 3 requirements. The air dryer system is designed to ANSI/B31.1 Code requirements. The engine-mounted piping and components, from the engine block to the engine interface, and the air starting skid-mounted piping and components, excluding

the receivers, are considered part of the engine assembly and are seismically qualified to Category I requirements. This piping and the associated components, such as valves, fabricated headers, fabricated special fittings are designed, manufactured, and inspected in accordance with the guidelines and requirements of ANSI Standard B31.1, ASME Section VIII, or DEMA standards. These engine skid-mounted starting air piping and associated components are overdesigned (subjected to low working stresses) for the application, which results in high operational reliability. The design of the engine-mounted starting air piping and components to the cited design philosophy and standards is considered equivalent to a system designed to ASME Section III, Class 3, requirements with regard to system functional operability and in-service reliability.

The check valve upstream of the air receiver tank is backed up by the air compressors. When the air tank pressure drops below 215 psig, the air compressors operate to recharge their respective tank to the fully charged condition. An alarm is provided should the compressor fail and the tank pressure fall to 200 psig. The piping, air receivers, and skid have been analyzed for response to seismic events and have been found to maintain the integrity of the air containment. Sufficient air capacity is therefore assured to start the engine immediately following a seismic event.

9.5.6.3 Instrumentation and Control

Instruments and controls are provided for automatic and manual control of each standby diesel generator starting system. The controls for each starting system are located in the associated diesel generator control room. The monitors described below are located in the main control room. The control logic is shown on Figure 9.5-41, Sheets 4 and 5.

Operation

Each diesel generator air compressor is started automatically when the associated air receiver pressure is low and stops automatically when the air pressure is normal. Each air compressor can be controlled manually.

Monitoring

Alarms are provided in the main control room for each standby diesel generator starting system inoperable and each standby diesel generator starting system trouble.

9.5.6.4 Testing and Inspection

The standby diesel generator starting system is designed to permit periodic inspection and testing of the components and systems. The starting system air dryers will be included in appropriate operation and maintenance procedures. Division III

diesel generator procedures will include a monthly visual inspection of the desiccant moisture indicator and dryer annunciator panel. Other appropriate surveillance, as recommended by the vendor, will be conducted prior to or during the refueling cycle surveillance testing of the diesel generator. Starting system capability is tested during preoperational testing of the diesel generator. Filters and strainers are checked for cleanliness during routine inspection and testing. Blowdown valves are opened periodically to blow moisture out of the air receivers. Continued integrity of the starting system is assured through periodic testing of the entire diesel generator (Section 8.3).

9.5.6.5 Safety Evaluation

Each standby diesel generator has a starting system that is independent of and separate from the starting systems of the other standby diesel generators. All components of the starting system of each standby diesel generator are located in the same section of the diesel generator building as their associated diesel generators. Therefore, any failure in one diesel generator starting system will not jeopardize the safety function of any other diesel generator. Each standby diesel generator starting system consists of two independent and redundant starting air systems, each having its own air compressor, air dryer, air receiver, air supply lines, valves, and devices to crank the engine, which increases the reliability of each starting system.

The starting air receivers have sufficient capacity to start the engine within 10 sec. Each air starting system can crank a cold diesel generator five times without recharging the receiver tanks. Each compressor can recharge the air receiver from minimum operating pressure to the maximum operating pressure in less than 30 min for Division III and 50 min for Divisions I and II. The motors for the Division I and II motor-driven compressors are powered from emergency buses to increase the reliability of the system. The air dryers with a design dew point of 37.4°F for Division I and II, and -40°F for Division III, are adequate to ensure that air to the air receivers is maintained at a dew point at least 10°F below the lowest expected ambient room temperature.

An alarm is provided in the main control room and in each standby diesel generator control room for low air receiver pressure.

The starting systems are adequately protected against accumulation of moisture, dirt, or rust. All the air receivers have bottom drains that are opened periodically to remove any moisture or oil carryover from the compressor. The system piping is installed at an elevation lower than the engine inlet and is provided with a drip leg for removal of any water that may be present in the lines. Division I and II diesel generator starting systems have, in addition, air dryers, moisture

separators and line filters to ensure clean, dry air to the air distributors. This system also has a blowdown line from the starting air headers connected to the engine turbocharger air discharge. The purpose of this line is to continuously purge the piping to prevent any condensation of moisture in the air start piping. The Division III diesel generator starting system has an air-cooled aftercooler on the compressor, air dryer, and air strainers in the line to ensure dry, clean air for starting.

For Division I and II diesel generators, once the engine has started, the air starting system becomes nonfunctional, except in that it is required to automatically shut down the engine. The air pressure necessary for the automatic shutdown function is very small compared to the starting air pressure, and the air receivers would have adequate air to perform this function for a considerable period, assuming a reasonable leakage rate in the system. Even if there is not adequate air in the receivers to supply necessary pressure to the engine, the engine would continue to operate and would have to be stopped manually when required. Also, the air compressors used in the SAS system have been seismically analyzed to prove their continuing capability during a seismic event, and the air compressor drive motors are Class 1E, connected to a Class 1E power supply.

Measures have been taken in the design of starting systems to prevent failure due to water spraying from the fire protection system. For Division I and II diesel generators, most of the components used to start the engine are pneumatically actuated, thus minimizing the number of electrical components. Starting solenoid valves are provided with NEMA 4 enclosures. Waterproof conduit and terminal fittings are provided for all wiring. The Division III diesel generator has been retrofitted with the capability of operating continuously during a discharge of the fire protection system. The Division III starting system components, such as solenoid valves, strainer, air start valve, air line lubrication, air motors, and shutoff valve, are furnished with dripproof closures.

The effects of high- and moderate-energy piping in the diesel generator building are discussed in Section 9.5.5.

Originally, the FMEA of the diesel generator was contained in the Unit 2 FMEA document, which is historical. FMEAs for plant systems are now performed and controlled by the design process.

9.5.7 Diesel Generator Lubrication System

Each standby diesel generator has an independent lubrication system to lubricate engine bearings and other moving parts. The lubrication system also keeps the engine warm to enhance immediate startup reliability, cools the pistons, and keeps the inside of the engine clean by preventing rust and corrosion.

9.5.7.1 Design Bases

Safety Design Bases

The standby diesel generator lubrication system is designed to meet the following safety design bases:

1. Each standby diesel generator has an independent lubrication system that supplies lubricating oil to the bearings and other moving parts when the generator is in operation.

2. The lubricating oil is heated and circulated through the required components to keep the engine warm and prelubricate the required components when the engine is in standby condition, to enhance reliability of the first-try starting of the engine.

3. The components of the lubrication system are housed within the diesel generator building which is a Category I structure capable of protecting the system from extreme natural phenomena possible at the site, and from internally- and externally-generated missiles to meet GDC 2 and 4. The design bases for this structure are discussed in Chapter 3.

4. The lubrication system is of Safety Class 3, Category I design to meet RG 1.26 and 1.29. Section 3.2 gives details of safety classification and seismic classification bases. For the Division I and II lubrication systems, all essential auxiliary skid-mounted components are built in accordance with ASME Boiler and Pressure Vessel Code Section III, Safety Class 3. All other Division I and II lubrication system components and all Division III lubrication system components are built in accordance with ANSI B31.1 or DEMA standards and meet seismic requirements.

5. The lubrication system of each standby diesel generator is independent of the lubrication systems of the other standby diesel generators and is contained in the same section of the diesel generator building as its associated diesel generator so that any failure in one diesel generator lubrication system cannot jeopardize the safety function of any other diesel generator. Unit 2 is a single unit and does not share safety-related structures, systems, or components with any other nuclear power unit.

6. All lubrication system electrical components, excluding annunciation circuits, are designed as Class 1E. Annunciation circuits are designed as non-Class 1E.

9.5.7.2 System Description

Each standby diesel generator has an integral lubrication system separate from and independent of the lubrication system of any other diesel generator. The entire lubrication system for each diesel generator is supplied by the diesel engine manufacturers. The systems differ in their arrangements and hence are described separately.

9.5.7.2.1 Division I and II Lubrication System

The lubrication system for Division I and II diesel generators is shown on Figure 9.5-47. The system consists of the following major components:

1. Motor-Driven Lube Oil Circulating Pump and Heater The lube oil circulating pump is used to keep the warm oil circulating through the engine any time the engine speed is below 280 rpm including startup and shutdown. When the engine speed goes above 280 rpm, the lube oil circulating pump is cut off and the engine-driven main lube oil pump circulates lube oil through the engine. When the circulating pumps are running, the heater maintains warm oil temperature. The pump is located on the auxiliary skid and is driven by a 15-hp, 575-V, 3-phase, 1,800-rpm, ac induction motor. It pumps 120 gpm at a pressure of 50 psig. The heater, rated 12 kW, 575 V, 3-phase, is controlled by a temperature switch to energize at 120°F falling and de-energize at 130°F rising when the motor-driven lube oil pump is running. The pump and heater control switches on the engine control panel are normally set on AUTO for automatic sequential operation, but may be started manually by setting the selector to HAND position. The heater will be energized only when the circulating oil pump is running. The pump has a strainer and a gate valve on the suction side, and a relief valve (set at 50 psig) and a gate valve on the discharge side. The pump's suction strainer is shared with the engine-driven main lube oil pump.

2. Engine-Driven Main Lube Oil Pump The main pump is mounted on the forward end of the engine and driven by the end of the crankshaft through a flexible coupling. The pump capacity is 530 gpm at 90 psig at rated engine speed. The pump has a strainer and check valve on the suction side and a relief valve (set at 90 psig) on the discharge side. The pump suction strainer is shared with the motor-driven circulating oil pump.

3. Thermostatic Valve The three-way thermostatic valve, located ahead of the cooler, controls the oil inlet temperature to the engine. The valve is set at 165°F. Oil entering Port A at 160°F or lower goes out Port B to bypass the cooler (Figure 9.5-47). At 170°F and

above, the oil goes out Port C to the cooler. As the oil reaches operating temperature, the valve modulates flow between Ports B and C to maintain the temperature at approximately 165°F.

4. Lube Oil Cooler The lube oil cooler is a shell-and-tube type and has removable bundles for cleaning. Lube oil passes through the shell and over the tubes as directed by the crossflow baffles. Jacket water circulates inside the tubes. The exchanger is designed for excess cooling capacity.

5. Lube Oil Filter The lube oil full flow filter contains 115 replaceable elements that operate in parallel to give the required capacity and degree of filtration. During normal running conditions with the lube oil at operating temperature and with clean elements, the pressure drop through the filter will be about 5 psi. As the elements become contaminated, the pressure drop will increase. When the pressure drop reaches 20 psi, the elements are replaced. A differential pressure indicator and alarm switch are provided which sound an alarm when the differential pressure reaches 20 psi. A bypass line with a gate valve is provided for servicing the filter while the engine is running or for emergency bypass of the lube oil filter.

6. Lube Oil Strainers Two lube oil strainers are mounted on the auxiliary skid in the oil header downstream of the lube oil filter. The strainers prevent any foreign particles such as pipe scales, weld slag, rust, or debris from a ruptured oil filter, from getting into the engine. Each strainer consists of a single case with a cover held down by studs and nuts. Plug valves are provided on either side of the strainers to allow any one strainer to be isolated, if necessary, while the engine is running.

7. Turbocharger Oil Filter All lubricating oil to the turbocharger is filtered by a duplex filter that has four elements operating in parallel. A valve can be positioned to direct oil through all four elements (normal operation) or to isolate either half for service while the engine is running.

8. Turbocharger Oil Variable Pressure Regulator The turbocharger oil variable pressure regulator is located after the turbocharger lube oil filter. The regulator maintains the turbocharger lube oil pressure at 5 psi above turbocharger-blower discharge pressure for proper turbocharger lubrication.

9. Turbocharger 1:2 Ratio Relay The turbocharger ratio relay is a proportioning unit designed to double the

input signal. The relay receives the signal from the air pressure in the left bank combustion air inlet pressure header, doubles this signal in control air, and applies it to the shuttle valve and then to the regulator. Applying this control air input signal, the regulator maintains turbocharger lube oil pressure 5 psi above turbocharger-blower discharge pressure.

10. Turbocharger Postlube Control Valves The turbocharger postlube valve controls the flow of oil from the regulating valve to the turbocharger. This valve is diaphragm operated, working against a spring pressure. The valve opens with spring pressure and closes with air pressure. A diaphragm-operated pilot valve controls air supply to the postlube control valve. The pilot valve opens with air pressure and closes with spring pressure. It is controlled by the air supply from the fuel control panel overspeed shutdown.

11. Turbocharger Low-Pressure Shutdown Valve The low oil pressure shutdown valve is a two-way, diaphragm-operated, normally open valve located on the oil header to the turbocharger. The valve protects the turbocharger bearings by stopping the engine if oil pressure drops below 4 psi with zero bias pressure.

The circulating oil pump and the main oil pump are piped in parallel. During engine startup and shutdown, the motor-driven circulating oil pump takes oil from the engine sump and circulates it through the lube oil heater, the thermostatic valve, the lube oil cooler (if necessary), the lube oil filter, the strainers, and to the main header in the engine. When the engine starts and reaches 280 rpm, the circulating oil pump stops and the main engine-driven oil pump takes oil from the sump and pumps it to the thermostatic valve. The thermostatic valve, which is set at 165°F, controls the oil inlet temperature to the engine. Oil entering the valve at 160°F or lower goes directly to the filter bypassing the cooler. Oil entering the valve at 170°F and higher goes to the cooler and then to the filter. Check valves prevent oil from flowing backwards through the circulating pump. From the filter, oil passes through the strainers to the engine main supply header.

The main header runs the length of the inside of the engine. From this header, flexible lines supply oil to the main bearings through the bearing caps. From the main bearings, oil flows through drilled passages in the crankshaft to the connecting rod bearings and through the connecting rods and pins into the pistons for cooling. From the pistons, oil drains back to the sump. The cylinders and pistons are lubricated by oil thrown from the crankpins and by oil vapor in the crankcase. Other headers tapped from the main header carry oil to the other moving parts of the engine including the turbocharger. Oil from all

moving parts, except the turbocharger, drains directly back to the sump by gravity.

The turbocharger lube oil system provides a regulated supply of lube oil whether the engine is idling during a test or running at rated speed. Oil is supplied from the engine oil header at 50 psi to the turbocharger filters. From the filters, oil flows to the regulator. The regulator is set at 5 psi at zero bias. The bias pressure required for the regulator comes from the 1:2-ratio relay. Air pressure from the left bank air pressure header supplies a signal to the relay which doubles this signal in control air and applies it to the shuttle valve and then to the regulator. From the regulator, oil flows to the turbocharger via a postlube valve which controls the flow of oil from the regulator to the turbocharger. During normal operation, the postlube valve allows lube oil to flow straight to the turbocharger. When a shutdown occurs for any reason, air is fed slowly through the orifice portion of the turbo postlube valve located on the fuel control panel. The volume bottle is filled, and air is applied to the diaphragm of the pilot valve to open it. Control air flows through the pilot valve to the postlube valve and shuts off the oil flow. Thus, the postlube valve allows oil to flow to the turbocharger for 2 to 3 min after an engine shutdown to cool the turbocharger bearings. During starting, air from the pilot valve and the volume bottle is vented through a quick release valve. When air from the postlube valve is vented through the pilot valve, this allows oil to flow to the turbocharger. Air pressure from the right bank air inlet header is applied to the shuttle valve, and if control air is lost, this pressure will reposition the shuttle valve and flow to the regulator, thus providing oil pressure to the turbocharger at a reduced but adequate rate. This arrangement is required when the engine operates in the emergency mode since loss of control air does not shut the engine down. The turbocharger has a labyrinth, pressurized oil seal and provides its own seal air pressure. At light loads, seal air pressure is nearly atmospheric; therefore, oil pressure must be reduced to prevent oil from flowing past the seals and into the air inlet system. Oil is not circulated through the turbocharger when the unit is shut down. Although the turbocharger is not lubricated during engine standby, it is lubricated as soon as the engine receives a start signal. The lube oil header is pressurized during standby, and oil is admitted to the turbocharger bearings by a quick-opening valve located approximately 2 ft from the bearings. The vendor has stated that this has not been a problem on other units due to the physical design that has been employed. This is true because the turbocharger is not driven by exhaust gases until after the engine is actually running.

From the turbocharger, lube oil is drained back to the sump via two oil-air separators that vent the air into the sump breather vent, and drain the oil to the sump.

Lubricating oil is sampled and analyzed quarterly for viscosity, insolubles, water, fuel contamination, oxidation, nitration, and metals content. If the oil is not within specifications, it is drained and replaced by fresh oil.

The engine lubricating oil sump holds sufficient oil to maintain the engine while running for a period of 7 days without addition of new oil. Additional oil may be added at the oil filler located on the engine. In accordance with manufacturer's recommendation for the Division I and II diesel generators, the normal consumption of oil would be 1 gal for every 15,000 BHP hr. Based on 4,750-kW output (generator rating 5,938 kVA at 0.8 PF, which equals about 6,600 input BHP), the consumption for 7 days would be 74 gal. Based on a sump capacity of 1,050 gal, and based on the geometry of the cross section of the sump, this amount would cause a decrease in the sump level to 1.2 in below the full mark, and the entire suction pipe would still be fully covered, and the pumping system would continue to function normally.

The diesel generator lube oil sumps are designed with capacity such that oil should not have to be added during operation for at least 7 days. Operation of all diesels for extended periods would not be required during a LOOP and a LOCA condition. Loads would be transferred from one division diesel to another to allow for addition of lube oil, inspection of the unit, etc.

In the unlikely event that lube oil must be added to a diesel while it is running, special instructions are included in the procedures covering the diesel generators. Lube oil can be added to the sumps, following safe procedures to prevent injury to the Operator or damage to the diesels. Provisions are made on the diesel sump to allow the Operator to observe the normal standby and the normal operating level of the lube oil.

Lube oil is obtained from qualified vendors in properly labeled drums. Lube oil is always transferred from these drums to the diesel and transfers to other holding devices are not utilized, to preclude the possible mixing or use of improper oil. Instructions for adding lube oil require verification of the product prior to addition. Copies of procedures will not be posted locally to preclude the use of unapproved or out-of-date procedures. Points of addition for lube oil are provided with a caution tag affixed directing the Operator to read the applicable portion of procedures prior to adding lube oil. Instructions detail procedures for adding oil in the standby and the operating condition.

Training of personnel responsible for operation and maintenance of the diesel is described in Section 8.3.1.1.2.

A crankcase breather located at the front end of the engine is provided to release high crankcase pressure. The crankcase breather is designed to vent crankcase pressure to the atmosphere

after removing most of the entrained oil from the air. Vapors escape the crankcase into the base of the breather. Most of the oil is removed from the air as vapor passes through the filters and into the filter cover. Some additional oil will condense on the filter cover and in the breather discharge piping. All oil drains back to the crankcase through the base of the breather. A condensate drain trap in the center of the breather base drains oil that condenses on breather cover and piping. The crankcase vent is located on top of the diesel generator building in a missile-protected enclosure. To mitigate the consequences of crankcase explosion, Divisions I and II diesel generators are equipped with explosion vents.

9.5.7.2.2 Division III Lubricating Oil System

The Division III diesel generator lubrication system is shown on Figure 9.5-48. It consists of four subsystems, each performing a separate function: the scavenging oil system, main lubricating system, piston cooling system, and oil circulating and soak-back system.

The scavenging oil system supplies cooled and filtered oil to the strainer sump for the main lubricating and piston cooling systems. Oil is drawn from the engine sump by the scavenging pump through the scavenging pump strainer and is pumped to the lube oil filter and lube oil cooler. The scavenging pump is a positive displacement pump driven directly by the engine. The lube oil filter is a full-flow filter with an automatic bypass to assure a continuous supply of lube oil to the engine. The lube oil cooler consists of a steel housing with brass oil cooler cores. Engine water flows through the cores while the lube oil flows around the outside of the cores through extended finned surfaces.

The main lubricating system draws oil from the strainer sump and supplies oil to the various moving parts of the engine including the turbocharger. The main lube oil pump is a positive displacement pump driven directly from the engine. It draws oil through the main and piston cooling pump strainer to ensure that no particulates move into the engine with the oil. A relief valve on the pump discharge limits the pump discharge pressure by venting excess oil to the oil pan.

The piston cooling oil system supplies oil for cooling the pistons and lubricating the piston pin bearing surfaces and cylinders. The piston cooling oil pump is a positive displacement pump driven by the engine. The pump draws oil from the strainer sump through a strainer common to both the piston cooling oil system and the main lubricating oil system. Oil is pumped through two cooling oil manifolds extending the entire length of the engine. A cooling oil pipe at each cylinder directs a stream of oil through the piston carrier to the piston pin and underside of the piston.

The lube oil circulating and soak-back system is furnished with two continuously running ac motor-driven pumps. These pumps circulate the lube oil to lubricate, and maintain oil pressure on, the accessory rack (filter/coolers), engine moving parts, and turbocharger bearings in engine standby and operating modes. A backup dc motor-driven pump is provided in parallel with each ac pump to accomplish the prelubrication function in the event of ac power loss.

One of the two ac pumps is a turbocharger lube oil pump which continuously circulates 3-gpm preheated lube oil from the engine sump to the turbocharger. This oil flow lubricates the turbocharger bearings during engine standby, supplements the oil pressure during engine fast start, and removes excessive heat from the bearings after engine is shut down. This continuous lubrication eliminates the dry-start and enhances the first-try starting reliability.

The other ac pump is a circulating oil pump which continuously circulates 6-gpm preheated oil from the engine sump, through an in-line strainer, a 30-psi relief check valve, the lube oil filter, and the lube oil cooler, to the engine oil gallery. This oil flow lubricates the crankshaft bearings. It also keeps the engine oil passages full, by gravity, during engine standby, thus minimizing the time required to build up the oil pressure during fast start.

This prelube system does not prelube the upper region of the engine. Hence, continuous operation of the system will not cause oil accumulation and potential engine damage. This system also eliminates any need for manual prelubrication.

The ac circulating oil pump is driven by a 1-hp, 575-V ac, 3-phase motor. The ac turbocharger lube oil pump is driven by a 3/4-hp, 575-V ac, 3-phase motor. Both the backup dc pumps are driven by 3/4-hp, 125-V dc motors. The operation of both pumps is monitored by an alarm switch.

A thermostatically-controlled electric heater maintains the lube oil near normal operating temperature by warming the engine jacket water. The jacket water is circulated through the lube oil cooler to warm up the lube oil. The electric heater is energized whenever the jacket water temperature falls to 125°F and turns off whenever water temperature reaches 155°F in order to maintain the lube oil temperature at a minimum of 85°F. This heated lube oil is circulated through the engine during standby to keep the moving parts warm to enhance the first-try starting reliability.

A 30-psi relief valve prevents oil backflow during engine operation if the circulating oil pump is not running. Lube oil filter and lube oil cooler are each provided with a vent to remove trapped air which may impede the oil flow. A lube oil cooler discharge line is also provided with a vent to prevent

siphoning effects that would draw oil out of the cooler into the strainer. The vents are connected to the engine camshaft housing to discharge oil flow back into the engine.

The lube oil flow path is designed to keep the engine lower gallery flood by gravity during the standby condition, thus minimizing the time required for oil pressure buildup at the turbocharge bearings and the upper deck during fast start. Bull-eye glasses are provided for visual monitoring of the oil level during the standby condition.

Nominal engine lube oil consumption for the Division III diesel engine is estimated to be between 0.75 to 1.0 gal (US) per hour at full load conditions. This figure may vary due to load variations and engine conditions. This results in the use of between 126 and 168 gal of lube oil for a 7-day period at full load.

The lube oil capacity of the system is approximately 465 gal, with an operating range of approximately 235 gal. This capacity provides adequate lubricating oil for 7 days of operation at full load; however, makeup oil could be added should the need arise.

Lubricating oil is sampled and analyzed quarterly for viscosity, insolubles, water, fuel contamination, oxidation, nitration, and metals content. If the oil is not within specifications, it is drained and replaced by fresh oil.

The engine sump has a crankcase breather to vent high crankcase pressure. A high crankcase pressure switch actuates a high crankcase pressure alarm in the diesel generator control room when the pressure reaches 1 in of water. The Division III diesel generator is equipped with explosion doors to mitigate the consequences of crankcase explosion. A lube oil separator is mounted on the turbocharger housing, and a crankcase ejector assembly is mounted on top of the separator. A line from the turbocharger discharge manifold to the ejector provides the motive force to draw oily vapor from the engine through the separator element. The oil collects on the element and drains back to the engine. The remaining gaseous vapor is discharged into the exhaust and vented to the atmosphere. The suction of the engine oil vapors through the lube oil separator also creates the required negative pressure in the crankcase.

9.5.7.3 Instrumentation Requirements

<u>Description</u>

Instruments and controls are provided for automatic and normal control of the emergency diesel generator lube oil systems. Except where noted, the controls and monitors described below are located in the respective emergency diesel generator room. The control logic is shown on Figure 9.5-41.

Operation

The motor-driven lube oil circulating pumps for Division I and II starting systems start or stop automatically when the associated engine speed is below or above 280 rpm, respectively. The pumps can also be controlled manually. The Division III lube oil circulating pump operates at all times while the diesel generator is in standby position.

The lube oil heaters are controlled automatically by the lube oil temperature. An interlock prevents energizing or automatically trips a heater when the associated lube oil circulating pump is stopped. The heater can also be controlled manually.

Division I and II diesel engines automatically trip during test or nonemergency operations when the associated lube oil temperature is high. The high oil temperature trip is automatically blocked during emergency operation (LOCA).

Division I, II, and III diesel engines automatically trip during test or nonemergency operation when the associated lube oil pressure is low. The low lube oil pressure trip is automatically blocked during emergency operation (LOCA) or with a LOOP signal.

Division I and II Monitoring

Indicators are provided for:

1. Lube oil cooler lube oil outlet temperature.
2. Engine inlet lube oil temperature.
3. Engine outlet lube oil temperature.
4. Main lube oil header pressure.
5. Turbocharger lube oil header pressure.
6. Lube oil filter differential pressure (local).

Alarms are provided for:

1. Emergency diesel generators shutdown, mechanical failure (main control room).
2. Emergency diesel generators mechanical failure (main control room).
3. Lube oil temperature high.
4. Engine lube oil pressure low.
5. Turbocharger lube oil pressure low.

6. Main and connecting rod bearing temperature high.

7. Turbocharger thrust bearing failure.

8. Lube oil temperature off-normal.

9. Lube oil filter differential pressure high.

10. Lube oil circulating pump discharge pressure low.

11. Crankcase lube oil level low.

12. Crankcase pressure high.

<u>Division III Monitoring</u>

Indicators are provided for:

1. Lube oil pressure (local).

2. Lube oil filter inlet pressure (local).

3. Lube oil filter outlet pressure (local).

Alarms are provided for:

1. Standby diesel engine trouble (main control room). This alarm is annunciated when any one or more of the following local alarms are activated.

2. Lube oil temperature high (local).

3. Lube oil temperature low (local).

4. Lube oil pressure low (local).

5. Turbocharger lube oil pressure low (local).

6. Lube oil filter differential pressure high (local).

7. Crankcase pressure high (local).

8. Dc turbo lube oil pump running (local).

9.5.7.4 Inspection and Testing Requirements

The diesel generator lubrication system capability is tested during preoperational testing of the diesel generator as a whole. Continued integrity of the lubrication system is assured through maintenance of the system and periodic testing of the entire diesel generator (Section 8.3). Lubricating oil is sampled and analyzed quarterly for viscosity, insolubles, water, fuel contamination, oxidation, nitration and metals content. If the

oil is not within specifications, it is drained and replaced by fresh oil.

9.5.7.5 Safety Evaluation

Each standby diesel generator has a lubrication system that is independent of and separate from the lubrication system of the other diesel generators. Each component of the lubrication system of each diesel generator is contained in the same section of the diesel generator building as its associated diesel generator so that any failure in one diesel generator lubrication system cannot jeopardize the safety function of any other diesel generator.

Each diesel generator lubrication system is capable of adequately lubricating the engine bearings and all other moving parts and cooling the pistons when the diesel generator is running.

Each lubrication system has an independent lube oil circulating loop, including its own motor-driven pumps and heater, to circulate warm oil through the engine to keep the engine warm and prelubricated to enhance the first-try starting reliability of the engine when it is in the standby condition. For Division III, each ac motor-driven prelubricating pump is backed up by a dc motor-driven pump. The lube oil system operates within the ranges of pressure and temperature at the flow rate recommended by the engine manufacturer.

Lubricating oil is sampled and analyzed quarterly for viscosity, insolubles, water, fuel contamination, oxidation, nitration, and metals content. If the oil is not within specifications, it is drained and replaced by fresh oil. Filters and strainers are provided to remove any particulates that might be present in the oil. Crankcase breathers vent high crankcase pressures.

The system is protected against any leakage. Any external leakage is detected by visual inspection or by the crankcase level alarm when the level falls below the required level. Any internal leakage is detected by the low lube oil pressure switches.

For Divisions I, II, and III diesel generators, the lube oil coolers have been sized to dissipate that heat from the lube oil system, which corresponds to the heat generated at the maximum load capability of the engine. The sizing for Divisions I and II has been done on the basis of a total of 0.003 of an inch fouling factor. That conservatism provides 52 percent excess heat exchanger capability when the heat exchangers are clean.

For Divisions I and II standby diesel generators, there is little possibility of the lube oil entering and collecting in the cylinders due to excessive or continuous prelubrication to the upper engine areas. If the seals such as valve stem seals fail, then some amount of leakage could escape into the combustion

chambers. With proper maintenance, there would be virtually no leakage into the combustion chambers as a result of the prelubrication process. However, the extensive operating history of the type of diesel generator has shown little, if any, prelubrication concerns of this nature.

The effects of high- and moderate-energy piping in the diesel generator building are discussed in Section 9.5.5.5.

Originally, the FMEA of the diesel generators was contained in the Unit 2 FMEA document, which is historical. FMEAs for plant systems are now performed and controlled by the design process.

9.5.8 Diesel Generator Combustion Air Intake and Exhaust System

Each standby diesel generator has a combustion air intake and exhaust system. The air intake system provides filtered air to the engine for combustion and reduces the noise level by use of filter silencers. The exhaust system directs the engine exhaust gases out of the diesel generator building and reduces the noise level of the exhaust. Intake and exhaust silencing is not a safety-related function.

9.5.8.1 Design Bases

Safety Design Bases

The standby diesel generator combustion air intake and exhaust system is designed to meet the following safety design bases:

1. Each standby diesel generator has a reliable combustion air intake and exhaust system to supply clean air for combustion and to discharge exhaust gases outside the diesel generator building.

2. The intake air system is sized to supply the air required for continuous operation of the diesel generator at maximum rated capacity with system pressure loss below the maximum pressure drop recommended by the engine manufacturer. The exhaust system is sized to discharge the exhaust gases from the diesel generator when it is operating continuously at the maximum rated capacity, with backpressure maintained within the limits recommended by the engine manufacturer.

3. The components of the combustion air intake and exhaust system are housed in separate rooms with their associated diesel generators in the diesel generator building, which is a Category I structure capable of protecting the system from extreme natural phenomena expected at the site, and from internally- and externally-generated missiles. This complies with GDC 2 and 4.

4. The combustion air intake and exhaust system of each diesel generator is independent of the combustion air intake and exhaust system of any other diesel generator, and is contained in the same section of the diesel generator building as its associated diesel generator. Therefore, any failure in one diesel generator combustion air intake or exhaust system cannot jeopardize the safety function of any other diesel generator. Unit 2 is a single unit and does not share any safety-related structure, system, or component with any other unit.

5. The combustion air intake and exhaust system (essential portion) is Safety Class 3, Category I design. All piping for the combustion air intake and exhaust system (essential portion) is built in accordance with ASME Boiler and Pressure Vessel Code Section III, Class 3. This complies with RG 1.26 and 1.29. The safety and seismic classification bases are discussed in Section 3.2.

6. The air intake and exhaust outlets are located to minimize the possibility of recirculating the exhaust gases. Pressurized gases are not stored in the vicinity of the diesel generator building nor are there any high- or moderate-energy fluid systems near the intake.

7. The combustion air intake is provided with a filter to reduce airborne particulate material when the diesel generator is operating. The air filter is highly efficient in removing all airborne dirt at all throttle settings, regardless of dirt concentration.

8. The tornado missile enclosures are located above the combustion air intake piping. These enclosures protect the combustion air intake piping from abnormal climatic conditions and are located to minimize the possibility of clogging the intake piping with snow, ice, or dust. Although the missile protection does not prevent ground level fogging and icing from coming into contact with the intake piping, Section 2.3.2.3.2, Ground Level Fogging and Icing, states that visible plumes rarely descend below a height of 300 ft aboveground and do not impinge the ground surface. In addition, ground icing due to cooling tower drift was found to be of little consequence. Therefore, abnormal climatic conditions will not prevent the operation of the diesels on demand.

9. During normal operation, the air exhaust piping is maintained at extremely high temperatures. Any snow or ice which accumulates in the vicinity of the exhaust

piping melts upon exposure to these operating temperatures. If the exhaust piping is clogged by snow, ice, or dust while the diesel generator is not in operation, the diesel exhaust valves function to open and relieve the excess pressure when the backpressure exceeds a preset level. Therefore, abnormal climatic conditions will not prevent the operation of the diesels on demand.

10. The missile enclosures appear in Figure 1.2-17 for diesel generator Divisions I, II, and III. Section 6-6 on this figure illustrates the diesel exhaust relief valve missile protection.

9.5.8.2 System Description

Each standby diesel generator associated with Divisions I, II, and III of the emergency onsite ac power system is shown on Figures 1.2-17 and 1.2-18. Each Division I and II system consists of a separate intake filter and silencer, a turbocharger, an intercooler heater, a diesel exhaust relief valve, an exhaust silencer, and associated piping. Division III consists of a separate intake filter and silencer, a turbocharger, a diesel exhaust relief valve, an exhaust silencer, and associated piping. All intake and essential exhaust piping and their associated components are fabricated and installed in accordance with ASME Section III, Class 3 requirements, and are seismic Category 1. Missile enclosures protect the intake piping, the intake components, and the exhaust piping associated with the diesel exhaust relief valves. Division III is the same, except that a filter-silencer is provided in lieu of a separate filter and silencer.

The combustion air is drawn in by the turbocharger through the protective overhang area at el 283 ft 6 in on the southern wall of the diesel generator building. The intake opening has a missile hood and a labyrinth wall to protect against missiles generated by tornados or any other source. The intake air passes through the intake air filter and silencer. The Division I and II intake air filters are located on the south wall. The filters are washable dry type. Division I and II filters have a capacity of 17,600 cfm at 100°F and will arrest about 100 percent of particles 7 microns in size and over 90 percent of particles 3 microns in size. The resistance to airflow is 1.1 in of H_2O at 500 fpm. The Division III filter is inside the diesel generator building and has a capacity of 12,000 cfm at 90°F and will remove over 99 percent of airborne dirt particles of all sizes.

The filtered air passes through the intake air piping into the turbocharger. Division I and II intake piping is 30 in in diameter; Division III piping is 24 in in diameter. The piping material is carbon steel. The intake air piping is connected to the turbocharger through a flexible expansion bellows to isolate

engine vibration. The turbocharger forces the air into two air intake manifolds of the engine via the intercooler and heater.

The intercooler and the heater are installed between each turbocharger outlet and engine intake manifold. The intercooler is the larger core in the casing with the heater being the smaller core. These are fin and tube type heat exchangers. The intercooler has cooling water circulated through it to cool heated air coming out of the turbocharger. The small heater core has warm jacket water circulated through it to heat the air for startup (if the inlet air temperature is below 105°F) and to provide additional cooling during operation. The cooling water for the intercooler is taken from the main water header just downstream of the jacket water cooler. Water for the heater is taken from the headers on the engine downstream of the circulation pump and heater. There are no automatic controls associated with the intercooler and the heater. From the intercooler and heater, combustion air passes into the air inlet manifolds from which air is distributed to the cylinders.

The Division III diesel generator combustion air system does not have a heater section but only a water-cooled aftercooler to cool the combustion air before it enters the engine.

For all loads for Division I and II and for high loads for Division III, exhaust gases from the cylinders are collected in the exhaust manifold which directs them through the turbine section of the turbocharger.

The Division III diesel engine turbocharger has a single-stage turbine with a connecting gear train. The connecting gear train is necessary for engine starting, light load operation, and rapid acceleration. Under these conditions, there is insufficient exhaust heat energy to drive the turbine fast enough to supply the necessary air for combustion. The engine drives the turbocharger through the gear train assisted by exhaust gas energy. When the engine approaches full load, the heat energy in the exhaust is sufficient to drive the turbocharger without assistance from the engine. At this point, an overrunning clutch in the drive train disengages and the turbocharger drive is mechanically disconnected from the engine gear train.

When necessary, the turbine shaft is driven by the engine gear train through a series of gears in the turbocharger. A turbocharger drive gear, which is a part of the spring drive gear assembly, meshes with the turbocharger idler gear, driving the carrier drive gear. The carrier shaft drives a sun gear on the turbine shaft through three planet gears when the turbocharger is being driven by the engine. The sun gear meshes with the planet gears which, in turn, mesh with a ring gear in the overrunning clutch assembly. The ring gear is fixed when the engine is driving the turbine because the direction of torque at the ring gear locks the overrunning clutch. When the turbine is being driven entirely by exhaust gas energy, the direction of torque is

reversed and the clutch overruns, allowing the ring gear to rotate.

Exhaust gases from the turbocharger pass through the exhaust piping to the diesel exhaust valve and exhaust silencer mounted outside of the diesel generator room. The exhaust piping is connected to the turbocharger through a flexible exhaust expansion bellows to permit expansion of the exhaust piping as well as to isolate engine vibration. The silencer and a portion of the discharge piping are susceptible to damage if struck by a missile. The damage may result in a blockage of flow of exhaust gases raising the backpressure and lowering the output of the generator. Diesel exhaust valves are provided at a point upstream of the silencer. The diesel exhaust valve functions to open when the backpressure exceeds a preset level. The use of the diesel exhaust valve has been evaluated and does not impact diesel generator performance. From the exhaust silencer the exhaust piping carries the exhaust gases to the roof of the diesel generator building where the gases are discharged horizontally away from the combustion air intakes. The exhaust piping is 30 in in diameter for Division I and II and 22 in in diameter for Division III. The exhaust piping material is alloy steel.

For Division I and II diesel generators, the combustion air requirement is 19,250 cfm each, whereas the exhaust flow is 51,720 cfm, maximum exhaust temperature being 990°F. For Division I and II diesel generators, the maximum allowable pressure drops in the intake and exhaust systems are 5 and 20 in of H_2O, respectively. Maximum exhaust backpressure is 20 in of H_2O. For the Division III diesel generator, air intake is 10,700 cfm at 90°F and exhaust flow is 23,000 cfm at 735°F. Maximum allowable pressure drop in the intake and exhaust systems for the Division III diesel generator is 6 and 5 in of H_2O, respectively. Maximum exhaust backpressure is 5 in of H_2O.

9.5.8.3 Instrumentation Requirements

<u>Description</u>

Instruments and controls are provided for automatic control of the emergency diesel generator combustion air intake and exhaust systems. The monitors described below are located in the respective emergency diesel generator control room. The control logic is shown on Figure 9.5-41.

There are no control devices in the combustion air intake and exhaust (refer to Figures 9.5-40a, 1.2-17, and 1.2-18).

<u>Operation</u>

For Division I and II, a butterfly valve located in the turbocharger air inlet piping is used for overspeed shutdown of the engine. When the butterfly valve is tripped closed by the

overspeed governor, air to the turbocharger is shut off and the engine stops. For Division III, the overspeed signal trips the lockout relay, which results in engine shutdown.

<u>Division I and II</u>

1. Each inlet air manifold temperature.

2. Each inlet air manifold pressure.

3. Each cylinder exhaust gas temperature.

4. Turbocharger inlet exhaust gas temperature.

5. Turbocharger outlet exhaust gas temperature.

6. Turbocharger discharge air pressure.

<u>Division III Monitoring</u>

There is no specific air intake exhaust gas monitoring instrumentation.

9.5.8.4 Inspection and Testing Requirement

The diesel generator combustion air intake and exhaust system is designed to be readily accessible for visual inspection. System operability is tested during preoperational testing of the diesel generator. The operating pressure and testing duration are representative of ASME Section III requirements. Continued integrity of the system is ensured through routine inspection, periodic cleaning of the inlet air filter, and flushing of the intercooler and heater as recommended by the engine manufacturer. The system is tested with periodic testing of the diesel generator as a whole. Periodic testing of the diesel generator is discussed in Section 8.3.1.

9.5.8.5 Safety Evaluation

Each standby diesel generator has a combustion air intake and exhaust system independent of and separate from the combustion air intake and exhaust system of the other diesel generators. Each component of the combustion air intake and exhaust system is contained in the same section of the diesel generator building as its associated diesel generator. Therefore, any failure in one diesel generator combustion air intake or exhaust system cannot jeopardize the safety function of any other diesel generator.

The combustion air intake system is sized to supply sufficient air for continuous operation of the diesel generator at maximum rated capacity, with system pressure loss below the maximum pressure drop recommended by the engine manufacturer. The exhaust system is sized to discharge the exhaust gases from the diesel engine when the diesel generator is operating continuously

at the rated capacity, with exhaust backpressure maintained below that recommended by the engine manufacturer.

The combustion air intake and exhaust outlets are located to minimize the possibility of recirculating the exhaust gases. The Division I and II intake openings are located at el 279 ft 6 in on the southern wall of the diesel generator building, while the Division III intake opening is located at el 282 ft on the east wall. The Division I and II exhaust outlets are located above the roof at el 292 ft 7 in, while the Division III exhaust outlet is located at el 291 ft 6 in. The exhaust gas discharges are horizontal and directed away from the intake openings. The horizontal and vertical separation, high discharge velocity of the exhaust gases away from the intake openings, and the labyrinth wall in front of the intake openings minimize the possibility of recirculating the exhaust gases. Emergency diesel generators are not protected by Unit 2 gaseous (CO_2) fire extinguishing systems. Preaction water spray systems are used.

There is no storage of gas or any other substance in the vicinity of the intake openings whose intentional or accidental release can dilute and reduce the oxygen content of the intake air below acceptable levels. The emergency diesel generators are separated from each other and from all other areas by 3-hr rated fire barriers. Separate air intakes, located at the south end of the diesel generator building, are provided for each generator. No credible fire in any generator room should affect the air intakes for the remaining two diesels.

The combustion air intake system has an air filter that is designed to reduce airborne particulate material over the entire time period that the diesel generator can operate continuously, assuming maximum concentration of airborne particulate at the intake.

To control the creation of concrete dust in the area surrounding the diesel generators, two coats of epoxy-based concrete sealer are applied to each diesel generator equipment pad. The remainder of the floors in the diesel generator rooms are painted. Additionally, the diesel generator control room floors are painted and the walls are coated with a seal coat over the entire height of the walls.

All engine-mounted electrical/electronic components are enclosed in dusttight enclosures. The diesel generator control panels are located in separate temperature-controlled and ventilated rooms. The Division I and II diesel generator control panels have NEMA ICS Type 1 enclosures. The Division III control panels, except for the generator high-voltage panels, have dusttight enclosures. The diesel generator room and control panel room ventilation air is filtered through medium-efficiency filters. The combustion intake air filters are high-efficiency filters designed to reduce airborne particulate material over the entire time period that the diesel generator can operate continuously, assuming maximum

concentration of airborne particulate at the intake. Division I and II intake air filters will arrest 100 percent of particles 7 microns in size and 90 percent of particles 3 microns in size. Division III intake air filters will arrest over 99 percent of airborne dirt particles of all sizes.

There are no flow control devices (louvers, dampers, etc.) in the intake air system.

The air intake system has a combustion air intercooler-heater to cool the compressed air so that it has adequate density to provide enough oxygen for combustion. The heater portion warms the intake air at starting to increase first-try starting reliability.

The Division I and II diesel generators are designed for the following service conditions:

Ambient air intake temperature range: -20°F to 100°F

Maximum humidity: 100%

They are designed for a tornado pressure transient causing an atmospheric pressure reduction of 3 psi in 3 sec. Being of turbocharged design, they will be able to provide full-rated load when subjected to a low-pressure storm such as a hurricane, resulting in ambient pressure of not less than 26 in Hg for a minimum duration of 2 hr, followed by a pressure of no less than 26 to 27 in Hg for an extended period of time (approximately 12 hr).

The Division III diesel generator is designed for the following service conditions:

Ambient air intake temperature range: Subzero to 120°F

Maximum humidity: 90%

It is designed for a tornado pressure transient causing an atmospheric pressure reduction of 3 psi in 3 sec. Being of turbocharged design, it will be able to provide full-rated load when subjected to a low-pressure storm such as a hurricane, resulting in ambient pressure of not less than 26 in Hg for a duration of 12 hr.

The effects of high- and moderate-energy piping in the diesel generator building are discussed in Section 9.5.5.5.

Originally, the FMEA of the balance-of-plant instrumentation and controls components of the diesel generator combustion air intake and exhaust system was contained in the Unit 2 FMEA document, which is historical. FMEAs for plant systems are now performed and controlled by the design process.

9.5.9 Emergency Diesel Generator Cranes

9.5.9.1 Design Basis

Each of the three emergency diesel generator cranes is designed in accordance with the following criteria:

1. Applicable design requirements of AWS D14.1, NEMA MG1, NFPA 70, and CMAA Specification No. 74 as a light-duty crane.

2. Requirements of ANSI B30.11.

9.5.9.2 Description

Each diesel generator crane consists of two end truck assemblies, connected by a single girder bridge assembly from which the main trolley-hoist assembly, two lever-operated auxiliary chain hoists, and bridge and pendant festooning are supported.

The end trucks hang from runway beams that are supported from the emergency diesel generator (EDG) building structure. The main electric wire rope hoist is rated at 5 tons, and the auxiliary hoists at 1 ton each. The crane, trolley, and hoist are controlled from the floor using a pendant control. The EDG crane is used to service the diesel, generator, or any other equipment within reach of the crane hook.

9.5.9.3 Safety Evaluation

The runway beams, end trucks, and bridge girder are seismically designed to withstand SSE in the unloaded stored location, except the electric wire rope hoist, push trolley with track clamps, bridge span festooning, and pendant festooning.

The festooning is not considered a significant mass which could damage the diesel, and the crane will be stored in a location where loss of a hoist or trolley will not damage the diesel.

9.5.10 Auxiliary Electric Boiler

9.5.10.1 Design Bases

9.5.10.1.1 Safety Design Basis

The auxiliary electric boiler is not required to effect or support safe shutdown of the reactor or to perform in the operation of reactor safety features.

9.5.10.1.2 Design Basis

The auxiliary boiler system is designed for use during plant shutdown conditions and is not normally required to supply steam during normal plant operation.

The auxiliary electric boilers (2ABM-B1A, B1B) are capable of supplying 40,500 lb/hr of steam each for a total of 81,000 lb/hr when both boilers are operating. The steam is supplied at operating conditions of 150 psig and 366°F. The boiler design pressure is 175 psig at 377°F.

The auxiliary electric boilers provide steam to the following components when the normal sources (main steam or extraction steam) are not available:

1. Radwaste system waste evaporator reboiler (2LWS-E4) and regenerant evaporator reboiler (2LWS-E7).

2. Building heating auxiliary heat exchangers (2HVH-E3A, E3B).

3. Warmup of offgas preheaters (2OFG-E1A, E1B).

4. Clean steam reboilers (2TME-E1A, E1B) for turbine gland sealing.

Additionally, auxiliary steam is supplied to the auxiliary boiler deaerator (2ABF-DA1).

The auxiliary boilers are designed to conform to the ASME Boiler and Pressure Vessel Code, Section I, Power Boilers. The separators removing moisture from the boiler steam and the deaerator are designed in accordance with ASME Section VIII, Pressure Vessels. System piping is designed in accordance with ANSI B31.1, Power Piping.

The auxiliary boiler chemical feed system is designed to control the boiler water dissolved oxygen conductivity and pH in the auxiliary boiler by maintaining the proper concentrations of sodium sulfite and sodium phosphate, respectively. The sodium sulfite/oxygen scavenging and conductivity control system and the sodium phosphate/conductivity and pH control system are manual.

As previously stated, the auxiliary boiler system is not used during normal plant operation. During these periods one boiler may be in hot standby while the other is being maintained under a nitrogen blanket. To accomplish this, a permanently installed, manually-initiated nitrogen system is provided.

9.5.10.2 System Description

The auxiliary boiler system is shown on Figure 9.5-52. Two 40,500-lb/hr high-voltage electrode boilers are provided to supply steam during plant shutdown, startup, and outages.

<u>Plant Outage</u>

During a plant outage auxiliary boiler steam is supplied to:

1. Building heating auxiliary heat exchangers (2HVH-E3A, B).

2. Radwaste waste evaporator reboiler (2LWS-E4) and radwaste regenerant evaporator reboiler (2LWS-E7).

3. Auxiliary boiler deaerator (2ABF-DA1).

Plant startup steam is supplied to:

1. Radwaste area as available (2LWS-E4, 7). The radwaste reboilers may be shut down if steam is required elsewhere.

2. Building heating auxiliary heat exchangers (2HVH-E3A, B) as available.

3. Offgas system preheaters (2OFG-E1A, B) for preheating.

4. Clean steam reboilers (2TME-E1A, B) to produce turbine gland seal steam. This precludes cold air, dirt, and debris from leaking into the turbine when a vacuum is drawn on the condenser.

5. Steam jet air ejectors (SJAE) (2ARC-J1A, B, J2A, B). Auxiliary boiler steam will be used as motivating steam for the SJAEs for the period when the reactor is not at a high enough pressure to operate the SJAEs.

6. Auxiliary boiler deaerator (2ABF-DA1).

Plant shutdown steam is supplied to:

1. Clean steam reboiler 2TME-E1A, 1B.

2. SJAE 2ARC-J1A, B, J2A, B.

3. Auxiliary boiler deaerator (2ABF-DA1).

Normal Plant Operation

During normal plant operation, one boiler may be placed in hot standby condition by use of its immersion heater. The other may be placed under a nitrogen blanket. The standby boiler will be used when nuclear steam is unavailable to bring the turbine to a shutdown without damage, which could result from loss of seals and/or condenser vacuum resulting in large temperature changes across the turbine rotor.

Both auxiliary boilers are normally fed by two out of three 50-percent pumps (2ABF-P1A, B, C) which draw from a single deaerator (2ABF-DA1). The pumps and deaerator are sized on the basis that both boilers are operating.

The auxiliary boiler chemical feed system consists of two self-contained units with totally enclosed metering pumps mounted on stainless steel chemical solution tanks. The tanks have hinged covers and motor-operated agitators on mounting brackets. Suction piping and strainers are assembled and piped for easy installation upon arrival.

Sodium Sulfite Packaged System

A 150-gal sodium sulfite feed tank (2ABH-TK2) is provided to store a sodium sulfite solution for injection into the deaerator and/or into the auxiliary boilers. One metering pump (2ABH-P2) is provided to pump the solution from the sodium sulfite tank (2ABH-TK2) to the deaerator and/or to each auxiliary boiler. An agitator is provided to mix the sodium sulfite solution. A floating roof prevents the air from contacting the surface of the solution. Water is mixed in the tank with solid sodium sulfite to produce a sodium sulfite solution.

Sodium Phosphate Package System

A 150-gal sodium phosphate feed tank (2ABH-TK1) is provided to store a sodium phosphate solution for injection into the auxiliary boilers. The sodium phosphate tank is filled with a mixture of Di and Tri sodium phosphate. One metering pump (2ABH-P1) is provided to pump the solution at 0.083 gpm to each auxiliary boiler. An agitator mixes sodium phosphate mixture with demineralized water. The pH level of the auxiliary boiler water is manually controlled to between 8.5 and 11.0. Batch additions of both phosphate and sulfite may be added to either tank as needed to circumvent equipment failure and/or correct water chemistry in a more expeditious manner.

9.5.10.3 Safety Evaluation

The auxiliary boilers, auxiliary boiler deaerator, and auxiliary boiler chemical feed systems are not safety related or required for the safe shutdown of the reactor. The auxiliary boilers are protected from overpressurization by safety valves 2ABM-SV20A and 2ABM-SV21A for boiler 2ABM-B1A, and safety valves 2ABM-SV20B and 2ABM-SV21B for boiler 2ABM-B1B. All associated piping is also protected by the safety valves. The auxiliary boiler deaerator (2ABF-DA1) is protected by safety valve 2ABM-SV102. Steam to the deaerator is limited to 10 psig by safety valve 2ABM-SV109. In addition, a vacuum breaker is provided for the deaerator to protect the tank from collapsing due to a vacuum caused by condensing steam. The auxiliary boiler chemical feed system pumps are limited in discharge by relief valves 2ABH-RV115 and 2ABH-RV106 for pumps 2ABH-P1 and 2ABH-P2, respectively. All safety valves discharge to contact condensers, except that safety valves associated with the chemical feed pumps discharge back to fluids source tanks. During operation or standby, radioactive water and steam are present in the system. Makeup feedwater is

supplied from either MWS or CNS. Shielding and controlled access are provided as necessary (Section 12.1).

9.5.10.4 Inspection and Testing Requirements

Field tests are performed after equipment installation to check satisfactory operation and functioning of control equipment, as well as to demonstrate performance. Major components in the system are hydrostatically tested by the vendor prior to installation. Routine inspection and maintenance provide for acceptable reliability.

9.5.10.5 Instrumentation Requirements

Description

Instruments and controls are provided for automatic and manual control of the feedwater and steam. Blowdown for the auxiliary boiler system is manually controlled. Chemical feed control is also manual. The controls are located on local panels. The monitor described below is located in the main control room. The control logic is shown on Figure 9.5-53.

Operation

Initially a feedwater pump is started manually, provided the deaerator water level is not low. Additional feedwater pumps start automatically when the running feedwater pump discharge pressure is low. Each feedwater pump stops automatically when the deaerator water level is low or the feedwater pump discharge pressure is sustained low. Each feedwater pump can also be controlled manually.

Each building heating auxiliary heat exchanger drain control valve is controlled automatically by the associated heat exchanger water level.

The auxiliary boiler steam supply to each building heating auxiliary heat exchanger is controlled automatically by the associated heat exchanger temperature control valves to regulate the temperature of the water leaving the heat exchangers supplying the hot water heating system.

The auxiliary boiler transfer pump is controlled manually. The auxiliary boiler deaerator pressure is controlled automatically by the deaerator steam inlet pressure control valve.

Each auxiliary boiler blowdown valve opens manually for a preset time period and closes automatically after the preset time period.

The sodium phosphate feed pump is started manually, provided the feed tank level is not low and a feedwater pump is running. The sodium phosphate feed pump stops automatically when the feed tank

level is low or a feedwater pump is not running. The sodium phosphate feed pump can also be stopped manually.

The sodium sulfite feed pump is started, provided the feed tank level is not low and a feedwater pump is running. The sodium sulfite feed pump stops automatically when the feed tank level is low or a feedwater pump is not running. The sodium sulfite feed pump can also be stopped manually.

The sodium sulfite feed tank mixer is controlled manually.

The sodium sulfite discharge valves are controlled manually.

Monitoring

An alarm is provided in the main control room for auxiliary boiler system trouble.

9.5.11 Zinc Injection Passivation System

Investigations have shown that plants with a high zinc content (approximately 20 percent) in the inner corrosion layer have a recirculation pipe dose rate significantly lower than plants with essentially no zinc in the inner corrosion film.

9.5.11.1 Design Bases

9.5.11.1.1 Safety Design Basis

The zinc injection passivation (ZIP) system is not required to effect or support safe shutdown of the reactor or to perform in the operation of reactor safety features.

9.5.11.1.2 Design Basis

The ZIP system is designed to maintain zinc concentration in the reactor recirculation water between 5 to 10 ppb.

9.5.11.2 System Description

The ZIP system consists of a passive zinc injection system, one zinc analyzer, and associated piping and valves for zinc injection and sampling (see Figure 10.1-6e).

The passive zinc injection system consists of a skid-mounted dissolution vessel, a manual flow control valve that controls the flow of water through the skid, a strainer on the discharge of the vessel, and block valves at the inlet and the outlet of the skid. No electrical power is required to operate the passive injection skid. A dilute solution of zinc in water is obtained by passing a small stream of feedwater through the dissolution vessel containing pelletized zinc oxide. Depleted zinc oxide (DZO), depleted in the Zn-64 isotope, may be utilized. The zinc solution is returned to the feedwater pump suction. The nominal

feedwater flow to the skid is 50 to 100 gpm. The zinc concentration is controlled by adjusting the flow rate through the skid which, in turn, controls the rate of zinc oxide dissolution. Additional control of zinc concentration can be obtained by adding or removing zinc oxide pellets from the dissolution vessel.

A reactor water sample can be taken from the recirculation system sample point. The sample is cooled after being withdrawn from the main process line and analyzed for zinc concentration by an ion chromatograph analyzer. The analyzer is capable of taking samples at intervals as short as 30 min.

The ZIP system indicators are located in a skid-mounted panel and not in the main control room. Surveillance walkdowns for the zinc injection and analyzer equipment will be performed to monitor and adjust the addition rate of zinc as required. Instrumentation consists of a flow orifice and indicator, a differential pressure indicator, and a dissolution column thermometer.

9.5.12 Reference

1. General Electric Company Licensing Topical Report, NEDO-10466-A, Power Generation Control Complex Design Criteria and Safety Evaluation.

TABLE 9.5-1

LIGHTING SYSTEM POWER SOURCE, PERCENTAGE, AND TYPE OF DISTRIBUTION

Area	Power Source					
		Emergency			Distribution	
	Normal Percent	Percent	Level of Illumination From Each Division Foot-Candle[10]	Essential Percent	Interleave	Zonal
Turbine Building						
General area lighting	100			(1)		X
Working areas	100			(1)		X
Electrical equipment areas	100			(1)		X
El 250'						
Truck aisle	100			(1)		X
Clean area	100			(1)		X
Equipment removal area	100			(1)		X
Clean oil storage and air compressor area	100			(1)		X
Safe shutdown path	100			(12)		X
El 277'-6"						
Hoist area	100			(1)		X
Switchgear room	100			(1)		X
Air ejector rooms	100			(1)		X
Clean area	100			(1)		X
El 306'						
Generator area	100			(1)		X
Turbine area	100			(1)		X
Equipment laydown area	100			(1)		X
Hoist area	100			(1)		X
Equipment access areas	100			(1)		X
Moisture separator rooms	100			(1)		X
Clean steam reboiler rooms	100			(1)		X
Clean access area						
General area lighting	100			(1)		X
Decontamination area	100			(1)		X
Decontamination area instrumentation room	100			(1)		X
Safe shutdown path	100			(12)		X

TABLE 9.5-1 (Cont'd.)

Area	Power Source					
		Emergency			Distribution	
	Normal Percent	Percent	Level of Illumination From Each Division Foot-Candle[10]	Essential Percent	Interleave	Zonal
<u>Reactor Building</u>						
General area lighting	100			(1)		X
Working areas	100			(1)		X
Electrical equipment areas	100			(1)		X
Primary containment	100			(1)		X
El 175'						
CSH pump room	100			(1)		X
ICS pump room	100			(1)		X
El 196'						
ICS pump room	100			(1)		X
RHS piping area	100			(1)		X
El 215'						
RWCU pump room	100			(1)		X
Pipe chases	100			(1)		X
Spent fuel pool heat exchanger area	100			(1)		X
Primary containment access hatches	100			(1)		X
Safe shutdown path	100			(12)		X
El 240'						
Equipment access areas	100			(1)		X
Equipment laydown areas	100			(1)		X
Main steam tunnel	100			(1)		X
Safe shutdown path	100			(12)		X
El 261'						
Equipment access areas	100			(1)		X
Equipment laydown areas	100			(1)		X
Standby gas treatment area	100			(1)		X
Railroad passage	100			(1)		X
Access hatch area	100			(1)		X
Safe shutdown path	100			(12)		X

TABLE 9.5-1 (Cont'd.)

Area	Power Source					
	Normal Percent	Emergency		Essential Percent	Distribution	
		Percent	Level of Illumination From Each Division Foot-Candle[10]		Interleave	Zonal
Reactor Building (cont'd.)						
El 289'						
Equipment access areas	100			(1)		X
Equipment laydown areas	100			(1)		X
Switchgear room	100			(1)		X
Phase separator room	100			(1)		X
HVAC area	100			(1)		X
CRD storage and work area	100			(1)		X
Safe shutdown path	100			(12)		X
El 306'-6"						
Equipment access areas	100			(1)		X
Equipment laydown areas	100			(1)		X
Safe shutdown path	100			(12)		X
El 328'-10"						
Equipment access areas	100			(1)		X
Contaminated equipment storage	100			(1)		X
Change room	100			(1)		X
New fuel storage vault	100			(1)		X
RWCU resin motor and precoat room	100			(1)		X
Spent fuel pool demineralizer room	100			(1)		X
Spent fuel pool filter room	100			(1)		X
Safe shutdown path	100			(12)		X
El 353'-10"						
Equipment access areas	100			(1)		X
Equipment laydown areas	100			(1)		X
Refueling platform[2]	100					X
Spent fuel storage pool[2]	100					X
Crane[2]	100					X
Safe shutdown path	100			(12)		X

TABLE 9.5-1 (Cont'd.)

Area	Power Source					
	Normal Percent	Emergency		Essential Percent	Distribution	
		Percent	Level of Illumination From Each Division Foot-Candle[10]		Interleave	Zonal
<u>Auxiliary Bays</u>						
El 175' and 198'						
RHS heat exchanger rooms	100			(1)		X
RHS pump rooms	100			(1)		X
CCP heat exchanger rooms	100			(1)		X
CSL pump rooms	100			(1)		X
Equipment removal area	100			(1)		X
El 215' and 240'						
Equipment removal area	100			(1)		X
MCC rooms	100			(1)		X
Switchgear panel front areas	100			(1)		X
Safe shutdown path	100			(12)		X
<u>Auxiliary Services Building South</u>						
El 261'						
RP calibration room	100			(1)		X
RP storage room	100			(1)		X
Men’s decontamination room	100			(1)		X
Women’s decontamination room	100			(1)		X
Hallway	100			(1)		X
CO_2 area	100			(1)		X
Safe shutdown path	100			(12)		X
<u>Screenwell Building</u>						
El 261'						
General area lighting	100			(1)		X
Working areas	100			(1)		X
Electrical equipment areas	100			(1)		X
Truck aisle	100			(1)		X
Safe shutdown path	100			(12)		X

TABLE 9.5-1 (Cont'd.)

Area	Power Source					
	Normal Percent	Emergency Percent	Emergency Level of Illumination From Each Division Foot-Candle[10]	Essential Percent	Distribution Interleave	Distribution Zonal
Service Water Pump Room						
El 261' and 226'-10"						
General area lighting	90			10		X
Working areas	90			10		X
Electrical equipment areas	90			10		X
Trash rake area	100			(1)		X
Category I service water pump areas	100			(1)		X
Water Treating Area						
El 261'						
General area lighting	100			(1)		X
Working areas	100			(1)		X
Electrical equipment areas	100			(1)		X
Trash areas[2]	100					X
Filter bed area	100			(1)		X
Storage area	100			(1)		X
Heater Bay						
El 250'						
General area lighting	100			(1)		X
Working area lighting	100			(1)		X
Electrical equipment lighting	100			(1)		X
Control room	100			(1)		X
Sample room	100			(1)		X
Safe shutdown path	100			(12)		X
El 277'-6"						
Condensate demineralizer tank room	100			(1)		X
Ventilation room	100			(1)		X
Resin and cleaning area	100			(1)		X

TABLE 9.5-1 (Cont'd.)

Area	Power Source					
		Emergency			Distribution	
	Normal Percent	Percent	Level of Illumination From Each Division Foot-Candle[10]	Essential Percent	Interleave	Zonal
<u>Ventilation Equipment Room</u>						
El 288'-6" and 306'						
General area lighting	100			(1)		X
<u>Offgas Building</u>						
El 261'						
General area lighting	100			(1)		X
<u>Control Building</u>						
<u>Control Room</u>						
El 306'[13]						
Relay panel area[3]	50	40[3]	16	10	X	
Operating area[3,4]	50	40[3]	16	10	X	
Work release office	100					X
Toilet room (Men)[2]	100					X
Janitor's closet[2]	100					X
Cable chase areas[2]	100					X
Corridors	100			(1)		X
Shift Manager office[3]	50	40[3]	16	10	X	
HVAC room	100			(5)		X
Operator lunch room	100			(1)		X
Training room[2]	100					X
Toilet room (Ladies)[2]	100					X
Safe shutdown path	100			(12)		X

TABLE 9.5-1 (Cont'd.)

	Power Source					
		Emergency			Distribution	
Area	Normal Percent	Percent	Level of Illumination From Each Division Foot-Candle(10)	Essential Percent	Interleave	Zonal
<u>Relay and Computer Room</u>						
El 288'-6"(13)						
Computer room	100			(12)		X
Corridor	90			10		X
Relay panels(3)	60	40(3)	6	(12)	X	
HVAC room	100			(5)	X	
General area lighting	100			(1)		X
Safe shutdown path	100			(12)		X
<u>Standby Switchgear Rooms</u>						
El 261'(13)						
General area lighting	100			(1)		X
Switchgear panel front areas		100(8)	30			X
Battery rooms	100			(1)		X
Corridors	100			(1)	X	
HPCS switchgear room(6)	60	40(6)	14	(1)	X	
Remote shutdown room(7)		100(7)	16.5			X
MCC front(8)		100(8)	35			X
Safe shutdown path				(12)		
El 237'						
Cable routing area	100			(1)		X
Cable chase	100			(1)		X
Safe shutdown path				(12)		
El 214'						
Cable routing area	100			(1)		X
Storage vault	100			(1)		X

TABLE 9.5-1 (Cont'd.)

Area	Power Source					
	Normal Percent	Emergency Percent	Emergency Level of Illumination From Each Division Foot-Candle[10]	Essential Percent	Distribution Interleave	Distribution Zonal
Normal Switchgear Building						
El 237' and 261'						
General area lighting	100			(1)		X
Switchgear panel front areas[2]	100					X
Corridor	90			10		X
Battery rooms[2]	100					X
Radwaste Building						
General area lighting	100			(1)		X
Working areas	100			(1)		X
Electrical equipment areas	100			(1)		X
Inspection areas	100			(1)		X
El 261'						
Storage tank area	100			(1)		X
Sample room	100			(1)		X
Truck dock and adjacent ramp	100			(1)		X
Monorail[2]	100					X
Decontamination area	100			(1)		X
Tank rooms	100			(1)		X
El 245’						
Low level radwaste storage area/SRV test and storage facility	100			(1)		X
El 279'						
Tank rooms	100			(1)		X
Control room	90			10		X
El 309'						
Monorail area[2]	100					X
Tank rooms	100			(1)		X
HVAC equipment areas	100			(1)		X

TABLE 9.5-1 (Cont'd.)

Area	Power Source					
	Normal Percent	Emergency		Essential Percent	Distribution	
		Percent	Level of Illumination From Each Division Foot-Candle[10]		Interleave	Zonal
Service Building and Foam Room						
El 261'						
Foam room	100			(1)		X
I&C shop	100			(1)	X	
Auxiliary Boiler Building						
El 261' and 275'						
Heater bay area	100			(1)		X
Working areas	100			(1)		X
Mezzanine area	100			(1)		X
Electrical equipment areas	100			(1)		X
Diesel Generator Building[9]						
El 261'[13]						
General area lighting	90			10		X
Working areas	70	20[9]	11[11]	10		X
Electrical equipment areas	70	20[9]	11[11]	10		X
Safe shutdown path				(12)		
Operating Personnel Access Between Buildings						
Truck aisle	100			(1)		X
Walkways and hallways	100			(1)		X
Safe shutdown path				(12)		
Electrical Bay						
El 261'	100			(1)		X

TABLE 9.5-1 (Cont'd.)

Area	Power Source					
	Normal Percent	Emergency: Percent	Emergency: Level of Illumination From Each Division Foot-Candle[10]	Essential Percent	Distribution: Interleave	Distribution: Zonal
Common Inside Areas						
Stairways[14]				100		X
Egress paths				100		X
Exit signs				100		X
Safe shutdown path				(12)		
El 214'-6"						
Electrical tunnels	100			(1)		X
HVAC equipment area	100			(1)		X
El 183', 239', 244', 245', and 250'						
Pipe tunnels	100			(1)		X

(1) As required for egress lighting.
(2) No egress lighting.
(3) 20 percent Division I, 20 percent Division II.
(4) Dimmer controlled.
(5) As required for egress lighting and panels.
(6) Division III.
(7) 50 percent Division I, 50 percent Division II.
(8) 100 percent from respective division.
(9) Emergency lighting for each diesel generator room will be supplied by its own diesel, and control panel fronts will be lighted from essential lighting.
(10) Measured at a work plane 2 ft 6 in above floor level.
(11) With only the emergency lights on, 11 foot-candles will be maintained in the working areas and electrical equipment areas of the diesel generator rooms.
(12) 8-hr battery-pack lighting provided for access/egress.
(13) 8-hr battery-pack lighting is provided wherever operation of safe shutdown equipment in this area is required.
(14) Stairways which are part of safe shutdown pathway are provided with normal and 8-hr battery-pack lighting. The remaining stairways are provided with essential lighting.

TABLE 9.5-2

LIGHTING SYSTEM FIXTURE TYPE AND LIGHTING INTENSITY

Area	Fixtures and Lamps	Desired Average Foot-candle
Turbine Building		
General area lighting	1b, 1a	20[1]
Working areas	1b	30[1]
Electrical equipment areas	1a, 1b	30[1]
El 250'		
Truck aisle	1b	20
Clean area	1b, 3a	30[1]
Equipment removal area	1b	20[1]
Clean oil storage and air compressor area	1d	20[1]
El 277'-6"		
Hoist area[2]	1b	20[1]
Switchgear room	1b, 3a	30[1]
Air ejector rooms	1b	20[1]
Clean area	1b, 3a	30[1]
El 306'		
Generator area	1a	30
Turbine area	1a	30
Equipment laydown area	1a	30[1]
Hoist area[2]	1a	30[1]
Equipment access areas	1a	30[1]
Moisture separator rooms	1b	30[1]
Clean steam reboiler rooms	1b	30[1]
Clean access area		
General area lighting	3a	30[1]
Decontamination area	3c	30[1]
Decontamination area instrumentation room	3a	100[1]
Offgas Building		
El 261'		
General area lighting	1b	20[1]

TABLE 9.5-2 (Cont'd.)

Area	Fixtures and Lamps	Desired Average Foot-candle
Reactor Building[3]		
General area lighting	1e	20[1]
Working areas	1e	30[1]
Electrical equipment areas	1e, 3c	30[1]
Primary containment[4]	2e	20[1]
El 175'		
CSH pump room	3c	20[1]
ICS pump room	3c	20[1]
El 196'		
ICS pump room	3c	20[1]
RHS piping area	3c	20[1]
El 215'		
RWCU pump room	3c	20[1]
Pipe chases	2e	10[1]
Spent fuel pool heat exchanger area	3c	20[1]
Primary containment access hatches	2e	20[1]
El 240'		
Equipment access areas	1e	20[1]
Equipment laydown areas	1e	10[1]
Main steam tunnel	2e	10[1]
El 261'		
Equipment access areas	1e	30[1]
Equipment laydown areas	1e	30[1]
Standby gas treatment area	1b	20[1]
Railroad passage	1b	20[1]
Access hatch area	2e	20[1]
El 289'		
Equipment access areas	1e	20[1]
Equipment laydown areas	1e	20[1]
Switchgear room	1b	20[1]
Phase separator rooms	1e	20[1]
HVAC area	1e	20[1]
CRD storage and work area	1e, 3c	100[1]
El 306'-6"		
Equipment access areas	1e	20[1]
Equipment laydown areas	1e	20[1]

TABLE 9.5-2 (Cont'd.)

Area	Fixtures and Lamps	Desired Average Foot-candle
El 328'-10"		
Equipment access areas	1e	20[1]
Contaminated equipment storage	2e	20[1]
Change room	3c	30[1]
New fuel storage vault	2e	20[1]
RWCU resin motor and precoat room	3c	20[1]
Spent fuel pool demineralizer room	3c	20[1]
Spent fuel pool filter room	2e	20[1]
El 353'-10"		
Equipment access areas	1e	35[1]
Equipment laydown areas	1e, 5	35[1]
Refueling platform	1e	35[1]
Spent fuel storage pool[5]	5	
Crane	1e	50[1]
Auxiliary Bays[3]		
El 175' and 198'		
RHS heat exchanger rooms	1e	20[1]
RHS pump rooms	1e	20[1]
CCP heat exchanger rooms	1e	20[1]
CSL pump rooms	1e	20[1]
Equipment removal area	1e	20[1]
El 215' and 240'		
Equipment removal area	1e	20[1]
MCC rooms	1b	20[1]
Switchgear panel front areas[7]	3a	30[1]
Auxiliary Service Building South		
El 261'		
RP calibration room	3b	40
RP storage room	3b	30
Men’s decontamination room	3b	20
Women’s decontamination room	3b	20
Hallway	3b	30
CO_2 area	1b	20[1]

TABLE 9.5-2 (Cont'd.)

Area	Fixtures and Lamps	Desired Average Foot-candle
Screenwell Building		
El 261'		
General area lighting	1b, 1a	20[(1)]
Working areas	1b, 1a	30[(1)]
Electrical equipment areas	1b, 3a, 1a	30[(1)]
Truck aisle	1b, 1a	20[(1)]
Service Water Pump Room[(3)]		
El 261' and 226'-10"		
General area lighting	1b	20[(1)]
Working areas	1b	30[(1)]
Electrical equipment areas	1b, 3a	30[(1)]
Trash rake area	1b	20[(1)]
Category I service water pump areas	1b	30[(1)]
Water Treatment Area		
El 261'		
General area lighting	1b	20[(1)]
Working areas	1b	30[(1)]
Electrical equipment areas	1b, 3a	30[(1)]
Tank areas	1b, 1e	20[(1)]
Filter bed area	1b, 1e	20[(1)]
Storage area	1b	20[(1)]
Service Building		
El 261'		
Foam Room	3a	20[(1)]
I&C Shop	3a	100[(1)]
Auxiliary Boiler Building		
El 261' and 275'		
Heater bay area	1b	20[(1)]
Working areas	1b	20[(1)]
Mezzanine area	1b	20[(1)]
Electrical equipment areas	1b, 3a	30[(1)]

TABLE 9.5-2 (Cont'd.)

Area	Fixtures and Lamps	Desired Average Foot-candle
Diesel Generator Building[3]		
El 261'		
General area lighting	1b	30
Working areas	1b	30[1]
Electrical equipment areas	1b, 3a	30[1]
Control Building[3]		
Control Room		
El 306'		
Relay panel area	3a	80
Operating area[6]	3a	80
Work release office	3a	30[1]
Toilet room (Men)	3a	30[1]
Janitor's closet	3a	20[1]
Cable chase areas	3a	10[1]
Ac and dc distribution panel area	3a	50[1]
Corridors	3a	20
Shift Manager office	3a	80[1]
HVAC room	3a	20[1]
Operator lunch room	3a	100[1]
Training room	3a	80[1]
Toilet room (Ladies)	3a	30[1]
Relay and Computer Room		
El 288'-6"		
General area lighting	3a	50[1]
Corridors	3a	20
Relay panels	3a	30
Computer room	3a	100[1]
HVAC room	3a	20[1]
Standby Switchgear Rooms		
El 261'		
General area lighting	3a	35[1]
Switchgear panel front areas[7]	3a	30
Battery rooms	3c	35[1]
Corridors	3a	20
HPCS switchgear room	3a	35[1]
Remote shutdown room	3a	16.5
MCC front	3a	35

TABLE 9.5-2 (Cont'd.)

Area	Fixtures and Lamps	Desired Average Foot-candle
El 237'		
Cable routing area	3a	20[1]
Cable chase	3a	10[1]
El 214'		
Cable routing area	3a	20[1]
Storage vault	3a	35[1]
Normal Switchgear Building		
El 237' and 261'		
General area lighting	3a	35[1]
Switchgear panel front areas[7]	3a	30
Corridors	3a	20
Battery rooms	3c	20[1]
Radwaste Building		
General area lighting	1b	20[1]
Working areas	1b	30[1]
Electrical equipment areas	1b, 3a	30[1]
Inspection areas	1b	100[1]
El 245'		
Low-level radwaste storage area/SRV test and storage facility	1b	20
El 261'		
Storage tank area	1e	20[1]
Truck dock and adjacent ramp	1b	30[1]
Monorail	1b	30[1]
Decontamination area	1e	30[1]
Tank rooms	1e	20[1]
Sample room	3c	150[1]
Chemistry Lab	1e	50[1]
El 279'		
Tank rooms	1e	20[1]
Control room	3a	100[1]
El 309'		
Monorail area	1b	30[1]
Tank rooms	1e	20[1]
HVAC equipment areas	1b	20[1]

TABLE 9.5-2 (Cont'd.)

Area	Fixtures and Lamps	Desired Average Foot-candle
Heater Bay		
El 250'		
General area lighting	1b	20(1)
Working area lighting	1b	30(1)
Electrical equipment lighting	1b, 3a	30(1)
Control room	3a	30(1)
Sample room	3a	30(1)
El 277'-6"		
Condensate demineralizer tank room(8)	1b, 1e	20(1)
Ventilation room	1b	20(1)
Resin and cleaning area	1b, 1e	20(1)
Ventilation Equipment Room		
El 288'-6" and 306'		
General area lighting	1b	20(1)
Operating Personnel Access Between Buildings		
Truck aisle	1b	20(1)
Walkways and hallways	1b	20(1)
Electrical Bay		
El 261'	3a	5(1)
Common Inside Areas		
Stairways	3a	20
Emergency egress areas		0.5
Exit signs	4	3
El 214'-6"		
Electrical tunnels	3a	10(1)
HVAC equipment area	3a	20(1)
El 183', 237', 239', 244', 245', and 250'		
Pipe tunnels	3c, 2e	10(1)(9)

TABLE 9.5-2 (Cont'd.)

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(1) Switching convenience will be maintained for desired reduced lighting level.
(2) Crane lighting in this area.
(3) Seismic supports.
(4) Quartz par type.
(5) No luminaries are located directly over the spent fuel storage pool or reactor cavity. Foot-candle levels do not apply to underwater lighting.
(6) Dimmer (0-150 foot-candles).
(7) Vertical foot-candles.
(8) Bracket fixtures.
(9) Lighting is not required in the service water tunnel due to the lack of plant equipment and infrequent access to the area.

KEY FOR FIXTURES AND LAMPS:

1. High-pressure sodium
    a. High bay HPS
    b. Low bay HPS
    c. Up light
    d. Explosion-proof
    e. Enclosed and gasketed
2. Incandescent
    a. High bay
    b. Low bay
    c. Open with reflector
    d. Explosion-proof
    e. Enclosed and gasketed
    f. Dust-tight
    g. Flashing red
    h. With epoxy paint
3. Fluorescent
    a. Industrial
    b. Commercial
    c. Enclosed and gasketed
    d. Troffers
    e. Luminous ceiling
    f. Explosion-proof
4. Exit-internal illuminated
5. Underwater
6. Flood
7. Spot
8. Street lights
    a. Distribution I
    b. Distribution II
    c. Distribution III
    d. Distribution IV
9. Other

TABLE 9.5-3

DEVIATION FROM NFPA STANDARD

NFPA Standard	Section	Deviation/Justification
NFPA 10	3-1.2.1	Deviation: Complete protection of buildings with Class A extinguishers not provided. Justification: Class A units are provided where Class A materials are present; balance of stations covered by Class B-C units.
NFPA 13 (also applies to NFPA 14, 15, 16 & 24)	2-7.1	Deviation: Fire department connections are not provided at Unit 2. Justification: Backup for site pumps is provided by interconnection with Unit 1. City supply provides limited capability. The Unit 2 site 150-psi pump pressures are sufficient.
NFPA 13	3-14.2.1	Deviation: Nonlisted steel-bodied valves are used on the interior fire main loop. Justification: The interior fire main loop is of welded steel construction for reliability. Steel valves are consistent with this design.
NFPA 13 (also applies to NFPA 15 & 16)	3-17.6	Deviation: The normal solenoid valve used on the listed Viking deluge valves has been replaced with dual MOVs. Justification: There was concern for accidental system operation or premature shutdown in the event of loss of power to the valves. Dual MOVs powered by separated circuitry were therefore employed.
NFPA 13	4-3.4.1	Deviation: Sprinklers in parts of the reactor building 20-ft zone and the CST building are located up to 22 in below the floor slab. Justification: Some floor supports employ 20-in steel beams closely spaced. A 22-in slab clearance permits proper floor coverage without employing an excessive number of sprinklers.
NFPA 13	7-1.1.2	Deviation: On some cable tray nozzle drops, short 1/2-in nipples no more than 6-in long or closed 1/2-in nipples were used. Justification: To correct misinstalled cable tray sprinklers located in excess of 8 in from trays, short nipples or 1/2-in nipples increased to 1-in pipe (per Section 3.8.4) were used. The increase in friction loss is negligible.
NFPA 13	3-16.5.2	Deviation: 1/4-in orifice fused nozzles are used for cable tray sprinkler systems. Justification: Small orifice nozzles were required to meet the application criteria of NFPA 15 with reasonable water rates. Scale buildup is minimized since drops supplying nozzles are normally water filled. All such systems are provided with individual system strainers.
NFPA 14	3-2.1	Deviation: Portions of some buildings are not within 30 ft of a nozzle attached to 100 ft of 1 1/2-in hose. Justification: A permanent variance for 150 ft of hose at 14 of the plant hose stations is shown in Table 9.5-3a.

TABLE 9.5-3 (Cont'd.)

NFPA Standard	Section	Deviation/Justification
NFPA 14	3-2.1 (cont'd.)	A permanent deviation for the service water pipe tunnels is described below. Unit 2 has performed a hose stretch drill to determine that the service water pipe tunnels can be provided coverage from hose streams. All areas of the service water pipe tunnels can be reached with hose lines, provided that additional hose lengths (200 ft of 2 1/2-in and 200 ft of 1 1/2-in hose) and adapters are available. Hose cabinets or hose reels will be placed at appropriate locations with the additional hoses, fittings, and adapters. Breathing apparatus are available in fire cabinets. Fire preplans describe the methods for combating fires in these areas. Hydraulic calculations indicate that adequate flow and pressure are provided in the worst-case service water tunnel hose stream application. Additionally, a permanent deviation for a pipe tunnel in Zone 261 NZ on el 315'-10" is described as follows: FHR 77 provides coverage for Zone 261 NZ on el 306' in the reactor building. An additional hose reel with 100 ft of 1 1/2-in hose is to be located at azimuth 315°, el 315'-10". This requires a maximum of 200 ft of hose to reach the most remote location of the pipe tunnel with an effective hose stream. No combustibles are stored or located in pipe tunnel.
NFPA 14	4-7.1	Deviation: Fire hose stations are not provided with pressure limiting devices that reduce the water pressure, with required flow at the outlet, to 100 psi. Fire hose pressures above 100 psi cause higher nozzle reaction forces which could render the fire hose difficult to control if used by untrained personnel. Justification: Per procedure, only trained Fire Brigade personnel operate fire hose reels. The Fire Brigade periodically trains with 1 1/2 and 2 1/2-in hose lines, without pressure limiting devices, at system pressures above 100 psi without incident. For oil fires, the Fire Brigade uses an in-line foam inductor that connects to and uses the water supply of a fire hose. For proper operation of the foam inductor, fire hose pressures of above 100 psi are required. The use of a pressure limiting device that limits the water pressures to 100 psi would preclude foam inductor use and thus limit the areas of the plant that could have foam fire suppression coverage.
NFPA 14	7.7-1	Deviation: Installed pressure gauges are not provided at the top of each standpipe with the exception of the four standpipes in the reactor building. Justification: Pressure readings on all standpipe risers can be taken with a portable gauge.
NFPA 15 (also applies to NFPA 13)	4-4.1.4	Deviation: The cable tray sprinkler system employs design elements of NFPA 13 and 15. Justification: NFPA 15 specifies coverage requirements for cable trays using open nozzles. NFPA 13 deals with area protection using fused sprinklers or nozzles. Elements of both standards were employed for design as they applied. Fused nozzles were chosen to limit potential water damage to equipment.
NFPA 20	7-1.1.1 7-6	Deviation: The electric fire pump is powered by a 4-kV motor which is controlled by an unlisted circuit breaker. Justification: NFPA 20 permits use of high-voltage motor starters, none of which are UL listed. The starter used was evaluated by a UL Engineer to ensure compliance with the requirements of NFPA 20.

TABLE 9.5-3 (Cont'd.)

NFPA Standard	Section	Deviation/Justification
NFPA 20	9-5.2.7	Deviation: The diesel-driven fire pump is not equipped with a weekly program timer. Justification: Station procedure requires a 30-min operating test of the pump monthly.
NFPA 20	7-5.2.4 9-5.2.4	Deviation: Timing devices to prevent simultaneous start are not provided on the electric and diesel pump controllers. Justification: Cranking time of a diesel engine will produce a 5- to 10-sec delay in coming up to speed when compared with an electric motor-driven pump. Hence, timer devices merely complicate the control circuitry.
NFPA 20	7-3.5	Deviation: Control circuits in the motor starter are fused. Justification: This is a deviation from Standard 20 and is so listed in the UL report. Fuses are required to protect the Unit 2 125-V dc battery distribution system. During a nonfire event, fuse failure causes a trouble alarm to be transmitted to the control room. During a fire in the electric motor-driven fire pump room, area detection would provide prompt notification and manual firefighting activities would be initiated. The pump room is a 3-hr rated enclosure; therefore, the fire would be confined to the pump room. During a fire in any other plant area which disables the electric motor-driven fire pump controller (and fuses), 100-percent backup capacity exists via the diesel engine-driven fire pump. The electric motor-driven fire pump is completely isolated from the diesel engine-driven fire pump; therefore, a single fire will not affect both pumps.
NFPA 24	4-3.2	Deviation: The drain in fire hydrant 2FPW-FHY10 is not plugged and the operating valve and drain are installed below the normal site groundwater level. Freestanding water may be present in the barrel of this hydrant up to groundwater level. Justification: An engineering evaluation was conducted to establish that the presence of water in the barrel of hydrant 2FPW-FHY10 up to the normal site groundwater level (el 255’-0”) will not freeze and impair its operability. This elevation is approximately 1 ft below the maximum frost depth for the site.
NFPA 24	8-1.1	Deviation: In a few cases, the depth of cover of the underground fire mains is less than 1 ft in excess of the frost line. Justification: In all cases, the cover exceeds the worst-case frost line for the area.
NFPA 24	8-6.2.8	Deviation: Restraining devices and fasteners for portions of the underground piping were not coated with a corrosion-retarding material. Justification: An engineering analysis was conducted to establish that possible degradation of piping hardware would not adversely affect the fire system for the expected life of the plant.

TABLE 9.5-3 (Cont'd.)

NFPA Standard	Section	Deviation/Justification
NFPA 30	2-4.2	Deviation: The day tanks for the emergency diesel generators are provided with emergency vents to the day tank rooms. Justification: The day tanks are provided with adequate outside vents for normal operation. The emergency vents are equipped with oil-filled loop seals. The vents would function only if the normal vents were damaged by tornado action. The operability of the generators is thereby ensured.
NFPA 72-1993	7.3.2	Deviation: Testing of fire detectors in areas that contain no equipment important to safety are tested in accordance with Unit 2 management goals based on accepted risk and not in strict accordance with the requirements of this section. Testing of fire detectors in areas containing equipment that is important to safety is tested as follows: At annual intervals, 10 percent of the installed detectors and a minimum of one detector in each detector loop will be tested by initiating an alarm at the detector in its installed location. Should a detector fail to alarm under the simulated fire condition, it will be corrected per procedure, and an additional 20 percent, minimum of two, detectors in the affected loop will be tested. Should a failure to alarm occur in this expanded sample population, the failure will be tested per procedure, and all remaining detectors in the affected loop will be tested and corrected as necessary. This testing scheme will be cycled through all detectors in a detection loop until all detectors in the loop have been tested. The cycle will then be repeated. Justification: Based on plant-specific fire detector failure to alarm rates, the above scheme provides an equivalent level of safety as that required by the NFPA code and is in accordance with NFPA 72-1993, paragraph 7-1.1.2.
NFPA 72D	2-2.2	Deviation: The control room and local fire panels are not UL listed. Justification: The Unit 2 panels are designed to meet the operational needs of the Station, which results in the need for substantially larger-than-normal enclosures. Additionally, NEMA 4 and NEMA 12 enclosures must be used. UL-listed enclosures which satisfy these requirements are not available; therefore, nonlisted enclosures are used. The panel components are UL listed.
NFPA 72D	3-3.1	Deviation: Manual pull fire alarm boxes are not used in the Station. Justification: The Unit 2 Gaitronics two-way public address system is designed and installed to provide fire reporting capability in accordance with the intent of NFPA 72D.
NFPA 72D	2-2.2	Deviation: Position switches used on steel-body fire line valves are not listed for fire system use. Justification: Because of the difference in body size and shape of steel valves compared with UL-listed iron body valves, listed position switches cannot be satisfactorily mounted. High-grade commercial limit switches were, therefore, used on steel valves.

TABLE 9.5-3 (Cont'd.)

NFPA Standard	Section	Deviation/Justification
NFPA 72E	4-3.5.1.1	Deviation: Smoke detector spacing in primary containment exceeds the manufacturer's recommended spacing and the standard's general spacing requirements. Spacing exceeds the 21 ft required when compensating for ceiling height, and in some cases exceeds the 30 ft allowed when neglecting ceiling height. Justification: Detectors are located with ALARA considerations for personnel installing or removing them. Due to the high levels of radiation inherent in the primary containment, potential for high exposures is great. Therefore, detectors are located so that they can be easily and quickly installed and/or removed. To further minimize ALARA concerns, the number of detectors provided has been minimized. Detectors are located to detect smoke/fires where the specific hazards are most likely to be involved in a fire. During the periods that detectors are installed, the plant will be in a shutdown condition, lessening the possibility of a radioactive release to the environment (due to a fire). Furthermore, during outages the primary containment will be occupied much of the time augmenting the early-warning smoke detection capability. Additionally, the fire loading is low in the primary containment.
NFPA 72E	4-3.7	Deviation: For structural conditions involving beams in excess of 18 in deep and spaced less than 8 ft apart, smoke detectors are mounted on the bottom flange of alternate beams. Justification: NFPA 72E is silent on the acceptable coverage under the structural configuration noted. The chosen arrangement was reviewed with the 72E Chapter 4 Subcommittee Chairman and found acceptable.
NFPA 80	1-6.1	Deviation: Nonlisted fire doors are used at Unit 2. Justification: For doors with multiple requirements, including watertight, tornado, railroad access, oversized equipment, pressuretight, and radiation shielding, nonlisted doors are employed and analyses are provided to demonstrate their capability of performing satisfactorily as fire doors at the locations where installed.
NFPA 80	2-8.2.1	Deviation: Nonlisted fire door hardware is installed on certain fire doors. Justification: This is a temporary deviation until listed hardware can be obtained for 89 doors. The doors are continuously monitored and fail locked upon loss of power. Power is provided by a UPS. Upon a loss of power, a fire patrol will be established to monitor door status. This procedure will remain in effect until the door hardware is changed.
NFPA 90A	2-1.4.1	Deviation: Service openings are not provided adjacent to duct-installed smoke detectors. Justification: Duct-type smoke detectors used can be serviced from the outside of the duct.
NFPA 90A	2-1.4.3	Deviation: Service openings are not provided at 20-ft intervals along the duct and at the base of vertical risers. Justification: Service openings are provided where required for system maintenance.
NFPA 90A	3-3.7.2.2	Deviation: Fire dampers are installed in a manner similar to but not exactly in accord with manufacturers' recommendations.

TABLE 9.5-3 (Cont'd.)

NFPA Standard	Section	Deviation/Justification
NFPA 90A	3-3.7.2.2 (cont'd.)	Justification: In some instances, fire damper installations are modified to facilitate HVAC system construction. In all cases, fire dampers are installed within the plane of the fire barrier and have a rating commensurate with the rating of the barrier; except for a damper in the control building west wall which is within 20 ft of transformer 2ATX-XS3. For this case, a 3-hr rated fire damper is provided after the tornado damper inside the building, and not in the plane of the wall. In this case the missile resistance construction and geometric orientation provides sufficient assurance that a transformer fire would be highly unlikely to breach the fire barrier boundary provided by the west building wall. Examples of modifications include: use of two sleeves; use of sleeve stiffeners; closure angles which face into the barrier; and sleeve extensions of 7 in (instead of 6 in). Requested modifications received prior review and approval of the Engineers' fire protection specialist. These approvals are documented and maintained on file.
NFPA 90A	9-3	Deviation: HVAC systems fans are not arranged to shut down automatically on fire detector operation. Justification: The Unit 2 systems incorporate low flow shutoffs. For a fire in most areas, fire damper operation would cause the low flow shutoff to function. This arrangement also is employed to guarantee total damper closure and is tested where required.

TABLE 9.5-3a

DEVIATION TO NFPA STANDARD 14-3-2.1

Hose Stations With 150-ft Hose

Zone 701 NW	FHR 5
Zones 702 NZ, 703 NZ, 721 NZ	FHR 11 and 53
Zone 705 NZ	FHR 54
Zone 726 XZ	FHR 20
Zone 755 NZ	FHR 19
Zone 246 NW	FHR 25
Zone 301 NW	FHR 135
Zone 302 NW	FHR 118
Zone 327 NW	FHR 113
Zone 961 NW	FHR 59
Zone 802 NZ	FHR 51
Zone 304 NW	FHR 139
Zones 723 NZ, 724 NZ, 725 NZ	New Station - El 277'-6"