Appendices

*** Underlined sections –Title only, no entry for design certification.**

**** Section number in parentheses – Section, under which the subject is covered.**

1.0 Introduction

This document provides the certified design material for the Advanced Boiling Water Reactor (ABWR); U.S. NRC Docket No. 52-001.

Table 2.2.4 Standby Liquid Control System

Inspections, Tests, Analyses and Acceptance Criteria

Design Commitment	Inspections, Tests, Analyses	Acceptance Criteria
1. The basic configuration of the SLC System is shown in Figure 2.2.4.	1. Inspections of the as-built system will be conducted.	1. The as-built SLC System conforms with the basic configuration shown in Figure 2.2.4.
2. The ASME Code components of the SLC System retain their pressure boundary integrity under internal pressures that will be experienced during service.	2. A hydrostatic test will be conducted on those Code components of the SLC System that are required to be hydrostatically tested by the ASME Code.	2. The results of the hydrostatic test of the ASME Code components of the SLC System conform with the requirements in the ASME Code, Section III.
3.	3.	3.
a. A test tank and associated piping and valves permit testing of the SLC System during plant operation. The tank is supplied with demineralized water, which is pumped in either a closed loop or is injected into the reactor.	a. Tests will be conducted on each division of the as-built SLC System using installed controls, power supplies and other auxiliaries. The following tests will be conducted:	a.
	(1) Demineralized water will be pumped against a pressure greater than or equal to 8.72 MPaA in a closed loop on the test tank.	(1) Demineralized water is pumped with a flow rate greater than or equal to 189 L/min in the closed loop.
	(2) Demineralized water will be injected from the test tank into the reactor.	(2) Demineralized water is injected from the test tank into the reactor.
b. The SLC System delivers at least 378 L/min of solution with both pumps operating when the reactor pressure is less than or equal to 8.72 MPaA.	b. Tests will be conducted on the as-built SLC System using installed controls, power supplies and other auxiliaries. Demineralized water will be injected from the storage tank into the reactor with both pumps running against a discharge pressure of greater than or equal to 8.72 MPaA.	b. The SLC System injects greater than or equal to 378 L/min into the reactor with both pumps running against a discharge pressure of greater than or equal to 8.72 MPaA.

Table 2.2.4 Standby Liquid Control System (Continued)

Inspections, Tests, Analyses and Acceptance Criteria		
Design Commitment	**Inspections, Tests, Analyses**	**Acceptance Criteria**
c. The SLC System delivers at least 189 l/min of solution with either pump operating when the reactor pressure is less than or equal to 8.72 MPaA.	c. Tests will be conducted on the as-built SLC System using installed controls, power supplies and other auxiliaries. Demineralized water will be injected from the storage tank into the reactor with one pump running against a discharge pressure of greater than or equal to 8.72 MPaA.	c. The SLC System injects greater than or equal to 189 l/min into the reactor with either pump running against a discharge pressure greater than or equal to 8.72 MPaA.
d. The SLC System can be manually initiated from the main control room.	d. Tests will be conducted on the as-built SLC System using the manual initiation switch.	d. Each division of the SLC System initiates when the manual initiation switch for that division is actuated.
e. Both divisions of the SLC System are automatically initiated during an ATWS.	e. Tests will be conducted on the as-built SLC System using simulated ATWS signals.	e. Upon receipt of a simulated ATWS signal, both divisions of SLC automatically initiate.
f. Each SLC System pump has an interlock which prevents operation if both the test tank outlet valve and the pump suction valve are closed.	f. Tests will be conducted on each SLC System pump start logic using simulated valve position signals	f. Each SLC System pump is prevented from operating unless signals indicative of one of the following conditions exist: (1) A suction path from the storage tank is available (the pump suction valve is fully open). (2) A suction path from the test tank is available (the test tank outlet valve is fully open).

2.2.8 Recirculation Flow Control System

Design Description

The Recirculation Flow Control (RFC) System controls reactor power by controlling the recirculation flow rate through the reactor core. This is achieved by modulating the recirculation internal pump (RIP) speeds using voltage and frequency modulation of adjustable speed drive (ASD) outputs.

The RFC System consists of redundant microprocessor-based controllers, adjustable speed drives, and motor generator (MG) sets. There are two MG sets, each of which supplies three of the ten ASDs which power the ten RIPs. The other four ASDs receive power directly from the power supply bus. No more than three RIPs are connected to any one power supply bus.

The RFC System operates in either manual or automatic control modes and has the control interfaces shown on Figure 2.2.8.

Except for the core plate differential pressure sensors provided for the Neutron Monitoring System (NMS), the RFC System is classified as non-safety-related. The four core plate differential pressure sensors for the NMS are classified as Class 1E safety-related.

The RFC System has the logic to generate the following signals to mitigate an anticipated transient without scram (ATWS) event:

(1) A signal to open the alternate rod insertion (ARI) valves in the Control Rod Drive (CRD) System on a high reactor vessel pressure signal, a low reactor water level signal, or a manual RFC System signal.

(2) A signal to the Rod Control and Information System (RCIS) to initiate electrical insertion of all control rods on a high reactor vessel pressure signal, a low reactor water level signal, or a manual control rod insertion signal.

(3) A signal to trip the four RIPs not connected to MG sets on either a high reactor vessel pressure signal or a low reactor water level signal (the latter is not an ATWS mitigation feature).

(4) A signal to trip the six RIPs connected to MG sets on a low reactor water level signal. Three of the six RIPs are tripped after a preset time delay.

(5) A manual RFC System signal to Safety System Logic and Control (SSLC) to initiate the Standby Liquid Control (SLC) System and to initiate Feedwater Control (FDWC) System runback of feedwater flow.

The RFC System logic issues a signal to the RCIS for selected control rod run-in (SCRRI) to provide stability control when the following conditions occur:

(1) Two or more RIPs are tripped, and

(2) The reactor power is at or above the preset level, and

(3) Core flow is at or below the preset level.

The RFC System has the logic to generate the following protective signals:

(1) A signal to reduce all RIP speed on receipt of a signal from the RCIS that an all-rod insertion condition exists (which includes conditions of high reactor vessel pressure, low reactor vessel water level or manual RFC System initiation).

(2) A signal to trip four RIPs when Reactor Protection System (RPS) provides an RIP trip signal.

When the RIP MG set's power supply breakers open, the MG sets are capable of holding the connected RIPs at their original speeds for at least one second and, after 1 second, assure the speed is at or above a speed coastdown curve defined by a rate of speed decrease of 10% per second for an additional two seconds.

Each channel of the RFC System controller is powered by separate non-Class 1E uninterruptible power supplies. Each of the four safety-related RFC System core plate differential pressure sensors is powered from its respective divisional Class 1E power supply. In the RFC System, independence is provided between the Class 1E divisions, and also between the Class 1E divisions and non-Class 1E equipment.

The RFC System digital controllers are located in the Control Building. The ASDs and core plate differential pressure sensors are located in the Reactor Building.

Inspections, Tests, Analyses and Acceptance Criteria

Table 2.2.8 provides a definition of the inspections, tests, and/or analyses, together with the associated acceptance criteria, which will be undertaken for the RFC System.

2.6.2 Fuel Pool Cooling and Cleanup System

Design Description

The Fuel Pool Cooling and Cleanup (FPC) System (Figure 2.6.2) removes decay heat generated by the spent fuel assemblies in the spent fuel storage pool. The system also maintains the water quality and monitors and maintains the water level above the spent fuel in the spent fuel storage pool. Figure 2.6.2 shows the basic FPC System configuration and scope.

The FPC System is classified non-safety-related, except for piping connections and valves for safety-related fuel pool makeup and supplemental cooling by the Residual Heat Removal (RHR) System.

The safety-related makeup water source for the spent fuel storage pool is provided by the RHR System, which pumps suppression pool water to the FPC System.

The spent fuel storage pool has no piping connections (inlet, outlet, drains or other piping) located below a point 3m above the top of active fuel located in the spent fuel storage racks.

The FPC System components, with the exception of the filter/demineralizer unit, are classified as Seismic Category I. Figure 2.6.2 shows the ASME Code class for the FPC System piping and components.

The FPC System is located in the Reactor Building.

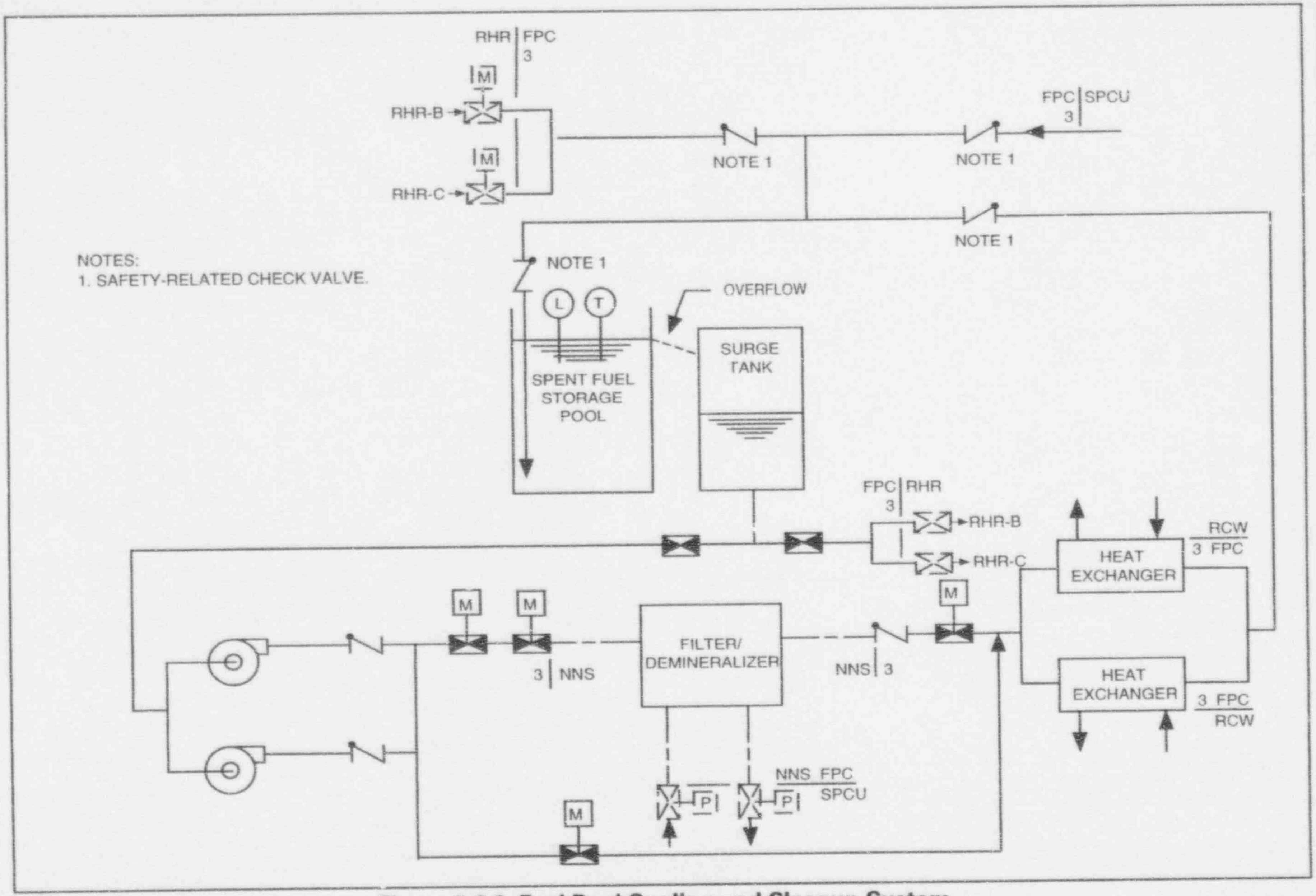
The FPC System has parameter displays in the main control room for instruments shown on Figure 2.6.2.

The check valves (CVs) shown on Figure 2.6.2 have active safety-related functions to open, close, or both open and close under system pressure, fluid flow, and temperature conditions.

The piping and components of the FPC System at the suction side of the RHR System from the upstream isolation valve have a design pressure of 2.82 MPaG for intersystem LOCA (ISLOCA) conditions.

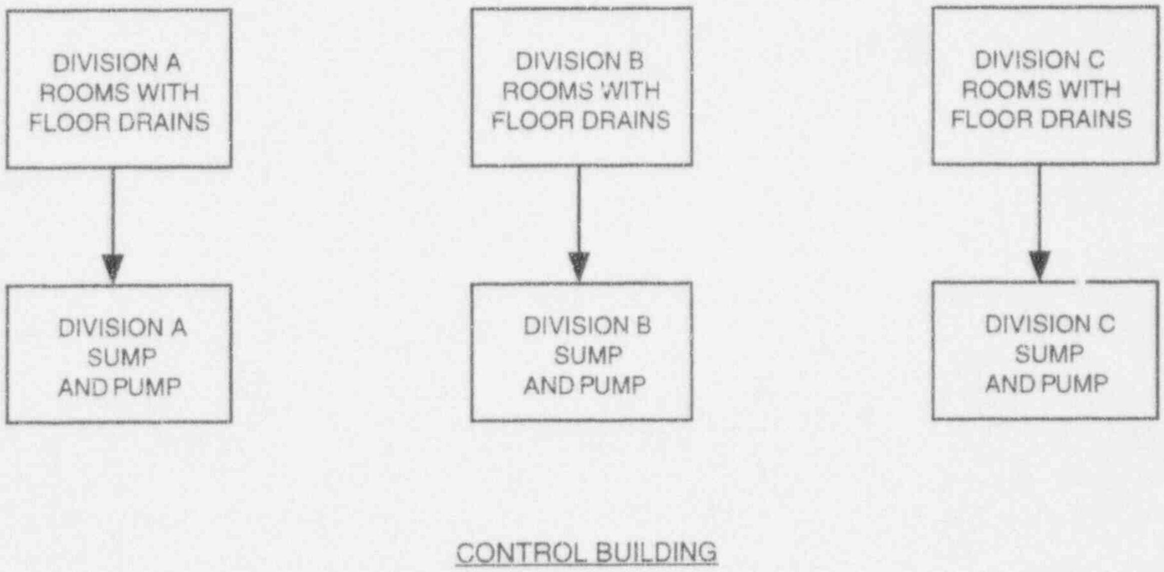
Inspections, Tests, Analyses and Acceptance Criteria

Table 2.6.2 provides a definition of the inspections, tests and/or analyses, together with associated acceptance criteria, which will be undertaken for the FPC System.



NOTES:
1. SAFETY-RELATED CHECK VALVE.

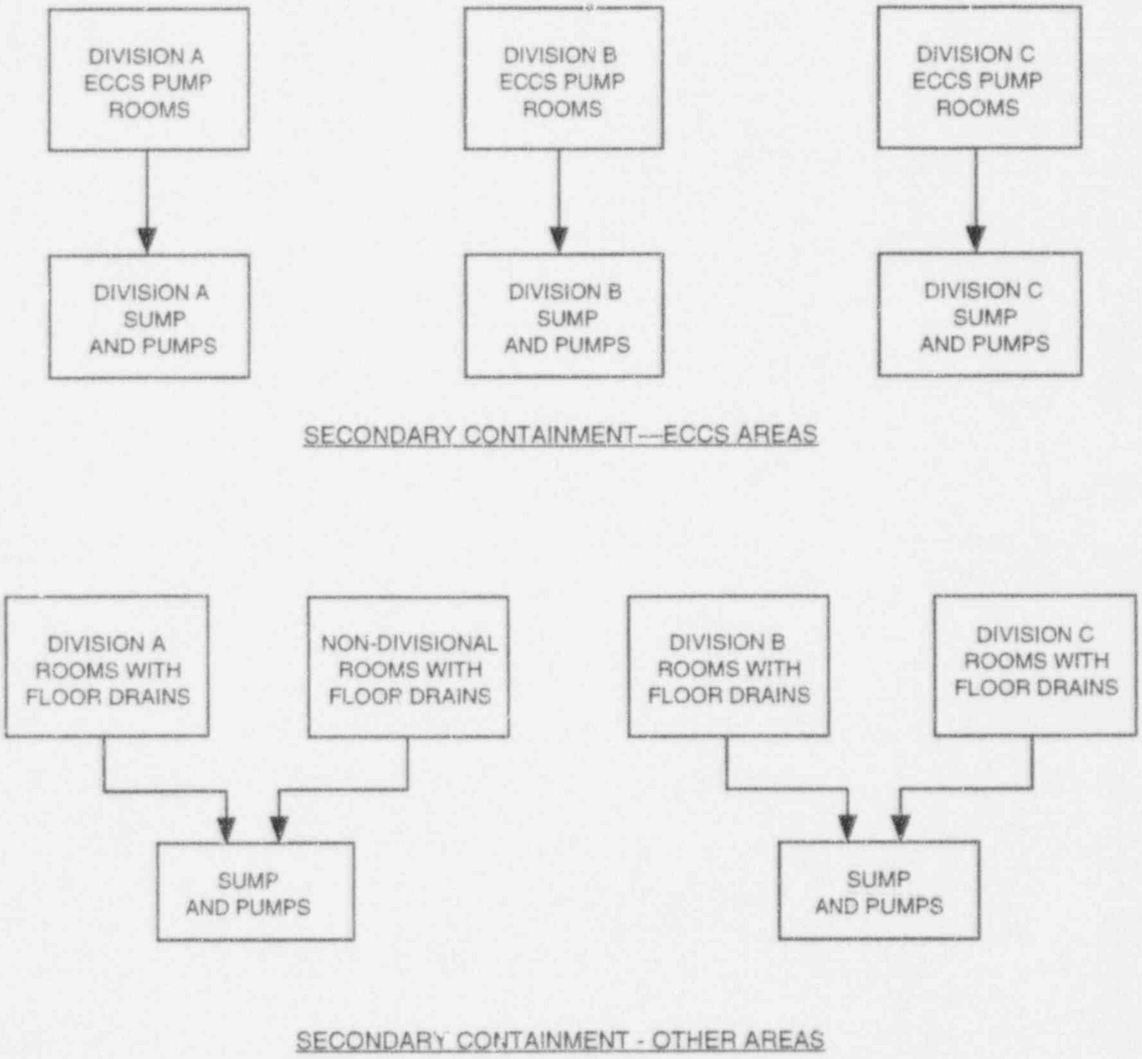
Figure 2.6.2 Fuel Pool Cooling and Cleanup System



NOTES:

1. THE SYSTEM HAS NO VALVES, PUMPS, OR OTHER ACTIVE COMPONENTS IN THE DRAINAGE PATHS.

Figure 2.9.1a Radioactive Drain Transfer System



NOTES:

1. THE SYSTEM HAS NO VALVES, PUMPS, OR OTHER ACTIVE COMPONENTS IN THE DRAINAGE PATHS.

Figure 2.9.1b Radioactive Drain Transfer System

2.10.2 Condensate Feedwater and Condensate Air Extraction System

The Condensate Feedwater and Condensate Air Extraction (CFCAE) System consists of two subsystems: the Condensate and Feedwater System (CFS) and the Main Condenser Evacuation System (MCES).

Design Description

Condensate and Feedwater System

The function of the CFS is to receive condensate from the condenser hotwells, supply condensate to the Condensate Purification System (CPS), and deliver feedwater to the reactor. Condensate is pumped from the main condenser hotwell by the condensate pumps, passes through the low pressure feedwater heaters to the feedwater pumps, and then is pumped through the high pressure heaters to the reactor. Figure 2.10.2a shows the basic system configuration. The CFS boundaries extend from the main condenser outlet to (but not including) the seismic interface restraint outside the containment.

The CFS is classified as non-safety-related.

The CFS is controlled by signals from the Feedwater Control System.

The CFS is located in the steam tunnel and Turbine Building.

The CFS has parameter displays for the instruments shown on Figure 2.10.2a in the main control room.

Main Condenser Evacuation System

The MCES removes the hydrogen and oxygen produced by the radiolysis of water in the reactor, and other power cycle noncondensable gases. The system exhausts the gases to the Off-Gas System (OGS) during plant operation, and to the Turbine Building compartment exhaust system at the beginning of each startup. The MCES consists of redundant steam jet air ejector (SJAE) units for power plant operation, and a mechanical vacuum pump for use during startup. Figure 2.10.2b shows the basic system configuration.

The MCES is classified as non-safety-related.

The MCES is located in the Turbine Building.

Steam supply to the SJAE provides dilution of the hydrogen and prevents the offgas from reaching the flammable limit of hydrogen. When the steam flow drops below the setpoint for stream dilution, the Off-Gas System is isolated.

The vacuum pump is tripped and its discharge valve is closed upon receiving a main steamline high radiation signal.

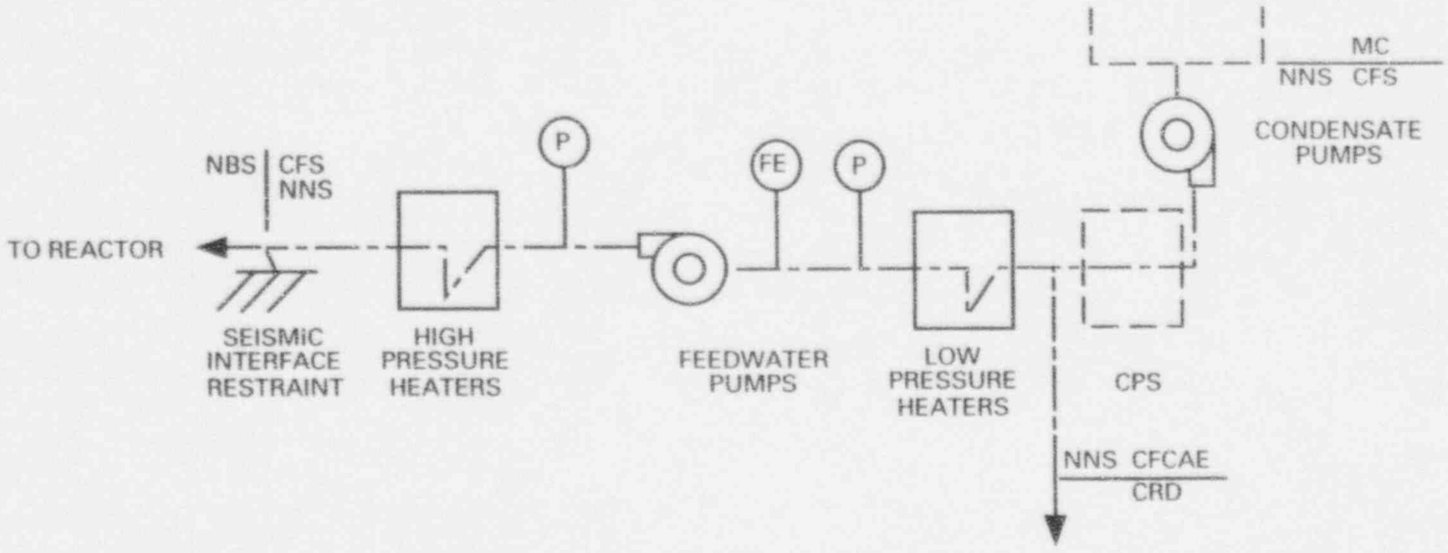
The MCES has the following displays in the main control room:

(1) Parameter displays for the instruments shown on Figure 2.10.2b.

(2) Status indication for the vacuum pump and SJAE discharge valves.

Inspections, Tests, Analyses and Acceptance Criteria

Tables 2.10.2a and 2.10.2b provide a definition of the inspections, tests, and/or analyses, together with associated acceptance criteria, which will be undertaken for the CFCAE System, respectively.



NOTES:
1. RELIEF VALVE DISCHARGE AND VENTS ARE CHANNELED THROUGH CLOSED SYSTEMS.
2. FEEDWATER AND CONDENSATE PUMP REDUNDANCY IS PROVIDED.

Figure 2.10.2a Condensate and Feedwater System

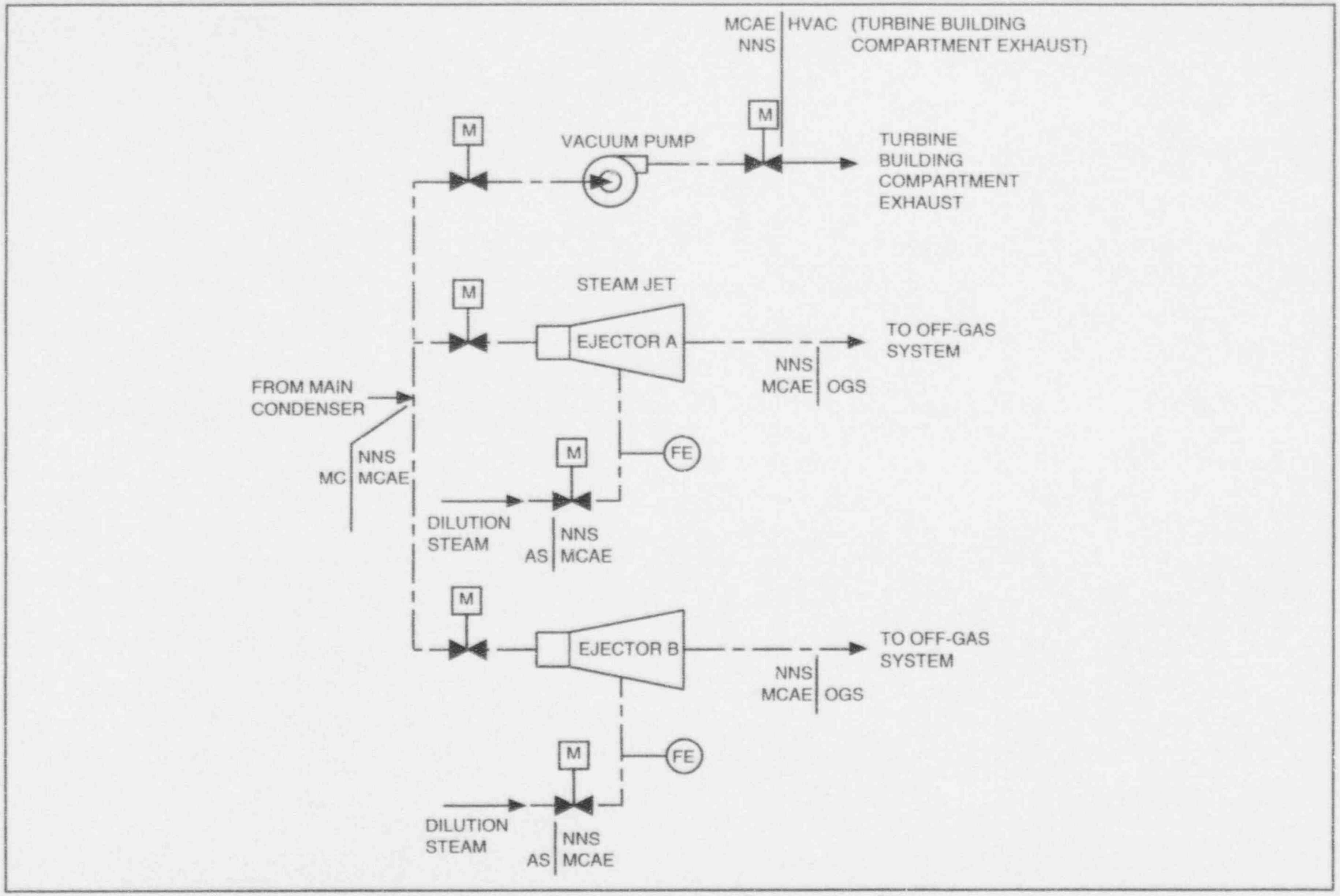
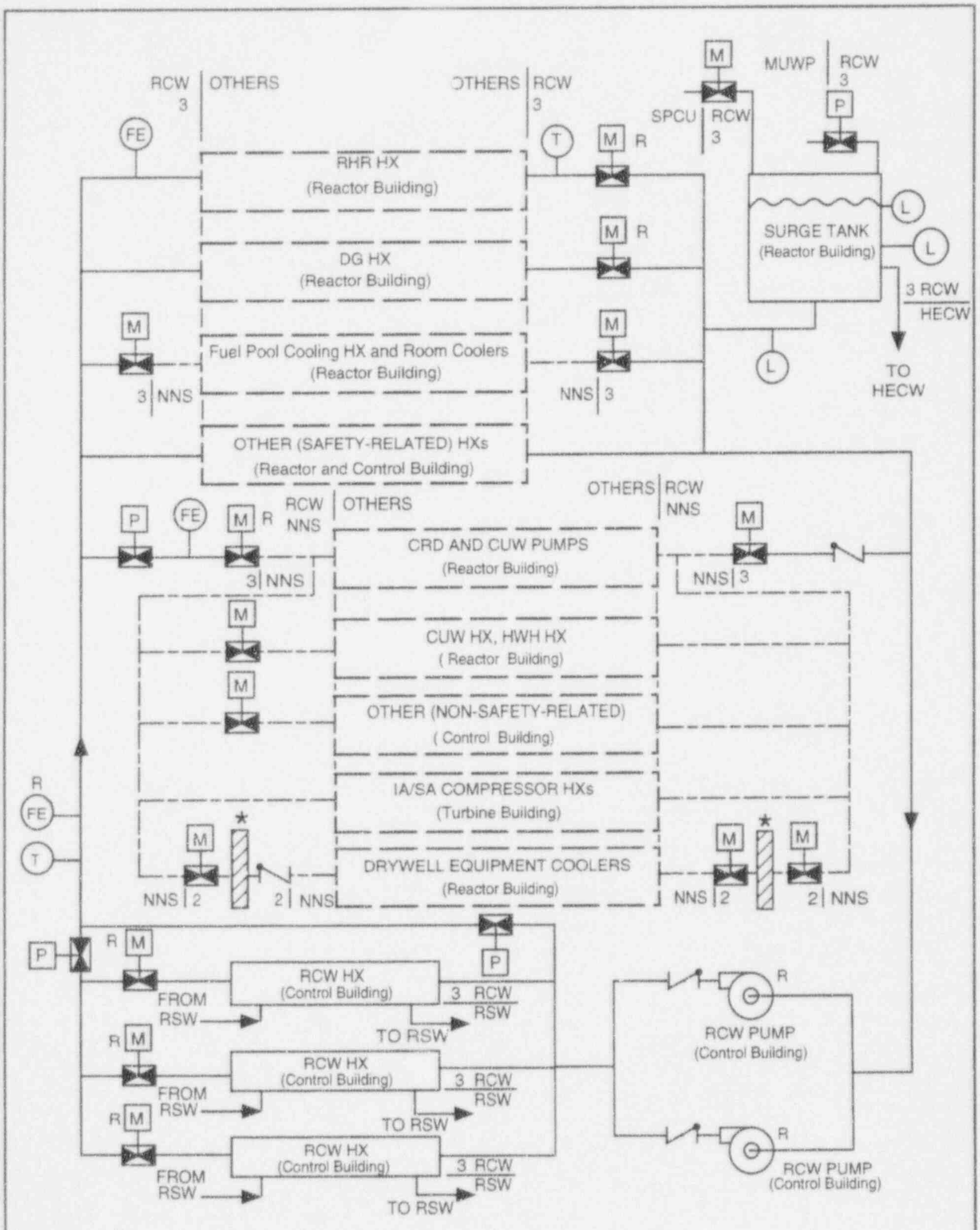


Figure 2.10.2b Main Condenser Evacuation System

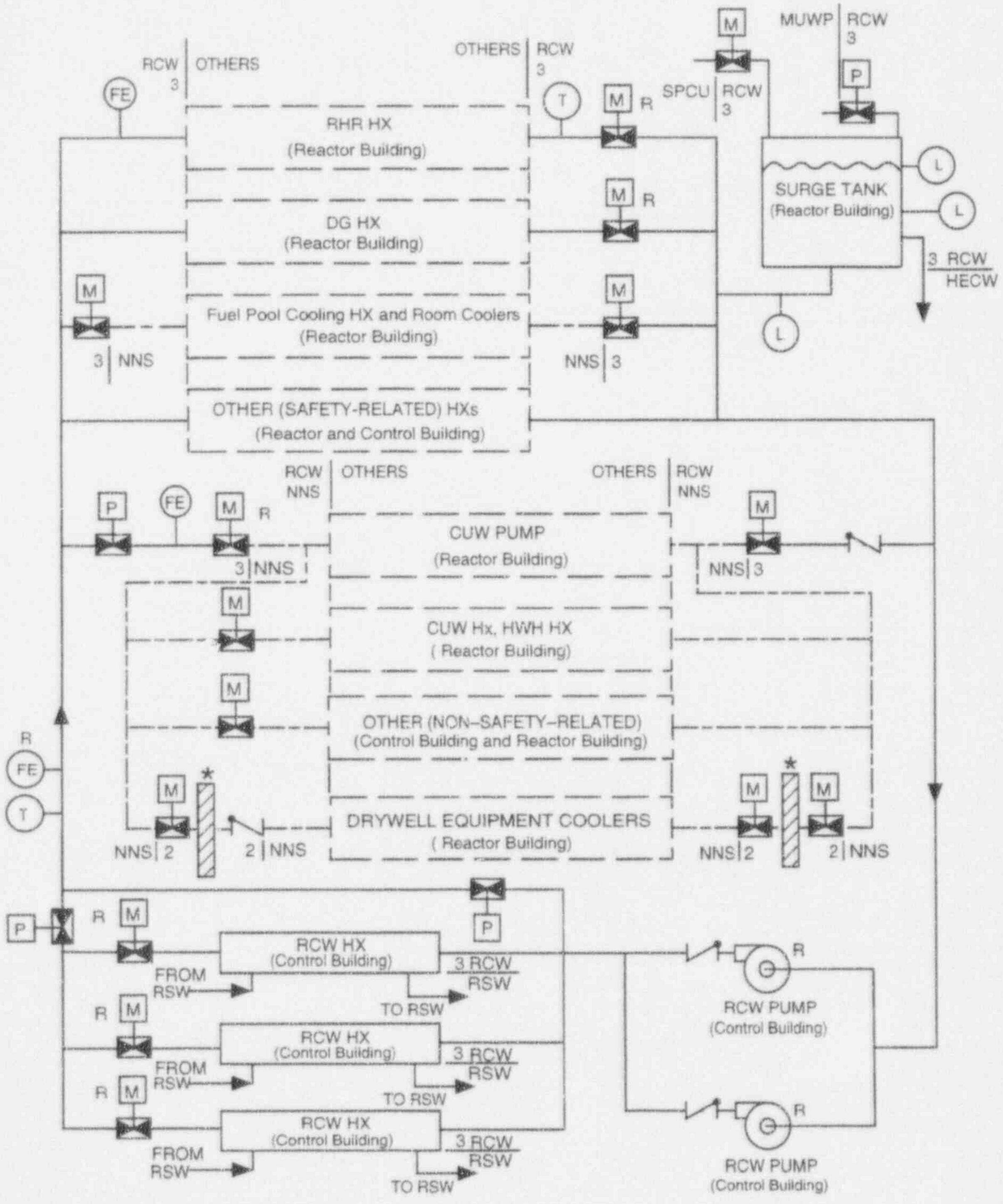


NOTES:

1. ALL ELECTRICAL POWER LOADS FROM THE CLASS 1E COMPONENTS SHOWN ON THIS FIGURE ARE POWERED FROM CLASS 1E DIVISION I EXCEPT FOR THE OUTBOARD CONTAINMENT ISOLATION VALVE, WHICH IS POWERED FROM DIVISION II.

★ = PRIMARY CONTAINMENT

Figure 2.11.3a Reactor Building Cooling Water System (RCW-A)



NOTES:
1. THIS DIVISION IS POWERED FROM CLASS 1E DIVISION II, EXCEPT FOR THE CONTAINMENT OUTBOARD ISOLATION VALVE, WHICH IS POWERED FROM DIVISION III.

★ =PRIMARY CONTAINMENT

Figure 2.11.3b Reactor Building Cooling Water System (RCW-B)

Table 2.12.1 Electric Power Distribution System (Continued)

Inspections, Tests, Analyses and Acceptance Criteria		
Design Commitment	**Inspections, Tests, Analyses**	**Acceptance Criteria**
6. UATs power feeders, and instrumentation and control circuits are separated from the RAT(s) output power feeders, and instrumentation and control circuits.	6. Inspections for the as-built UATs and RAT(s) power feeders, and instrumentation and control circuits will be conducted.	6. As-built UAT power feeders are separated from the RAT(s) power feeders by a minimum of 15.24m, or by walls or floors, except at the switchgear, where they are routed to opposite ends of the medium voltage M/C switchgear. As-built UAT instrumentation and control circuits, are separated from the RAT(s) instrumentation and control circuits by a minimum of 15.24m, or by walls or floors, except as follows: a) at the non-Class 1E DC power sources, where they are routed in separate raceways, b) inside the MCR, where they are separated by routing the circuits in separate raceways, and c) at the switchgear, where they are routed to opposite ends of the medium voltage M/C switchgear and routed in separate raceways inside the switchgear.
7. The MPT and its switching station instrumentation and control circuits are separated from the RAT(s) and its switching station instrumentation and control circuits.	7. Inspections for the as-built MPT and RAT(s) and their respective switching station instrumentation and control circuits will be conducted.	7. As-built MPT and its switching station instrumentation and control circuits, from the switchyard(s) to the MCR, are separated from the RAT(s) and its switching station instrumentation and control circuits by a minimum of 15.24m, or by walls or floors. MPT and its switching station instrumentation and control circuits, inside the MCR, are separated from the RAT(s) and its switching station instrumentation and control circuits by routing the circuits in separate raceways.

Table 2.12.1 Electric Power Distribution System (Continued)

Inspections, Tests, Analyses and Acceptance Criteria		
Design Commitment	**Inspections, Tests, Analyses**	**Acceptance Criteria**
8. Medium voltage M/C switchgear, low voltage P/C switchgear, with their respective transformers, and MCCs, and their respective switchgear and MCC feeder and load circuit breakers are sized to supply their load requirements.	8. Analyses for the as-built EPD System to determine load requirements will be performed.	8. Analyses for the as-built EPD System exist and conclude that the capacities of the Class 1E switchgear, P/C transformers, MCCs, and their respective feeder and load circuit breakers, as determined by their nameplate ratings, exceed their analyzed load requirements.
9.	9.	9.
a. Medium voltage M/C switchgear, low voltage P/C switchgear, with their respective transformers, and MCCs, are rated to withstand fault currents for the time required to clear the fault from its power source.	a. Analyses for the as-built EPD System to determine fault currents will be performed.	a. Analyses for the as-built EPD System exist and conclude that the Class 1E switchgear, with their respective transformers, and MCC, current capacities exceed their analyzed fault currents for the time required, as determined by the circuit interrupting device coordination analyses, to clear the fault from its power source.
b. The PMG output circuit breaker, medium voltage M/C switchgear, low voltage P/C switchgear and MCC feeder and load circuit breakers are rated to interrupt fault currents	b. Analyses for the as-built EPD System to determine fault currents will be performed.	b. Analyses for the as-built EPD System exist and conclude that the analyzed fault currents do not exceed the PMG output circuit breaker, and M/C, P/C switchgear, and MCC feeder and load circuit breakers interrupt capacities, as determined by their nameplating ratings.

2.12.10 Electrical Wiring Penetration

Design Description

Electrical penetrations are provided for electrical cables passing through the primary containment.

Electrical penetrations are classified as safety-related.

Electrical penetrations are protected against currents that are greater than their continuous current rating.

Electrical penetrations are classified as Seismic Category I.

Divisional electrical penetrations only contain cables of one Class 1E division. Independence is provided between divisional electrical penetrations and also between divisional electrical penetrations and penetrations containing non-Class 1E cables.

Electrical penetrations are qualified for a harsh environment.

Inspections, Tests, Analyses and Acceptance Criteria

Table 2.12.10 provides a definition of the inspections, tests, and/or analyses, together with the associated acceptance criteria, which will be undertaken for the Electrical Wiring Penetrations.

Table 2.12.10 Electrical Wiring Penetration

Inspections, Tests, Analyses and Acceptance Criteria		
Design Commitment	**Inspections, Tests, Analyses**	**Acceptance Criteria**
1. The basic configuration of the Electrical Wiring Penetration is described in Section 2.12.10.	1. Inspections of the as-built Electrical Wiring Penetration will be conducted.	1. The as-built Electrical Wiring Penetration conforms with the basic configuration described in Section 2.12.10.
2. Electrical penetrations are protected against currents that are greater than their continuous current ratings.	2. Analyses for the as-built electrical penetrations and protective features will be performed.	2. Analyses for the as-built electrical penetrations and protective features exist and conclude either 1) that the maximum current of the circuits does not exceed the continuous current rating of the penetration, or 2) that the circuits have redundant protective devices in series and that the redundant protection devices are coordinated with the penetration's rated short circuit thermal capacity data and prevent current from exceeding the continuous current rating of the electrical penetrations.
3. Divisional electrical penetrations only contain cables of one Class 1E division.	3. Inspections of the as-built divisional electrical penetrations will be conducted.	3. As-built divisional electrical penetrations only contain cables of one Class 1E division.
4. Independence is provided between divisional electrical penetrations and between divisional electrical penetrations and penetrations containing non-Class 1E cables.	4. Inspections of the as-built electrical penetrations will be conducted.	4. Physical separation exists between as-built divisional electrical penetrations. Physical separation exists between these divisional electrical penetrations and penetrations containing non-Class 1E cables.

Table 2.12.13 Emergency Diesel Generator System (Continued)

Inspections, Tests, Analyses and Acceptance Criteria		
Design Commitment	**Inspections, Tests, Analyses**	**Acceptance Criteria**
7. A manual start signal from the MCR or from the local control station in the DG area starts a DG. After starting, the DG remains in a standby mode (i.e. running at required voltage and frequency, but not connected to its bus), unless a LOPP signal exists.	7. Tests on the as-built DG Systems will be conducted by providing a manual start signal from the MCR and from the local control station, without a LOPP signal.	7. As-built DGs automatically start on receiving a manual start signal from the MCR or from the local control station and attain a voltage and frequency in ≤ 20 seconds which assures an operating voltage and frequency at the terminals of the Class 1E utilization equipment that is within the tolerance limits of the utilization equipment and remain in the standby mode.
8. When a DG is operating in parallel (test mode) with offsite power, a loss of the offsite power source used for testing or a LOCA signal overrides the test mode by disconnecting the DG from its respective divisional bus.	8. Tests on the as-built DG Systems will be conducted by providing simulated loss of offsite power and LOCA signals while operating the DGs in the test mode.	8. When the as-built DG Systems are operating in the test mode with offsite power and a loss of offsite power or a LOCA signal is received, DGs automatically disconnect from their respective divisional buses.
9. In the DG system, Class 1E DG unit auxiliary systems are supplied electrical power from the same Class 1E division as the DG unit. Independence is provided between Class 1E divisions and between Class 1E divisions and non-Class 1E equipment.	9. a. Tests will be conducted in the as-built DG Systems by providing a test signal in only one Class 1E division at a time. b. Inspections of the as-built Class 1E divisions in the DG systems will be conducted.	9. a. The test signal exists in only the Class 1E division under test in the DG System. b. In the DG systems, physical separation or electrical isolation exists between Class 1E divisions. Physical separation or electrical isolation exists between these Class 1E divisions and non-Class 1E equipment.
10. Each divisional DG (Divisions I, II, and III) with its auxiliary systems is physically separated from the other divisions.	10. Inspections of the as-built DG Systems will be conducted.	10. Each DG with its auxiliary systems is physically separated from the other divisions by structural and/or fire barriers.

Table 2.12.13 Emergency Diesel Generator System (Continued)

Inspections, Tests, Analyses and Acceptance Criteria		
Design Commitment	**Inspections, Tests, Analyses**	**Acceptance Criteria**
11. MCR displays and controls provided for the DG System are as defined in Section 2.12.13	11. Inspections will be conducted on the MCR displays and controls for the as-built DG Systems.	11. Displays and controls exist or can be retrieved in the MCR as defined in Section 2.12.13.
12. RSS displays provided for the DG System are as defined in Section 2.12.13	12. Inspections will be conducted on the RSS displays for the as-built DG Systems.	12. Displays exist or can be retrieved on the RSS as defined in Section 2.12.13.

Table 2.12.15 Instrument and Control Power Supply (Continued)

Inspections, Tests, Analyses and Acceptance Criteria		
Design Commitment	**Inspections, Tests, Analyses**	**Acceptance Criteria**
12. The Class 1E Instrument and Control Power Supply system supplies an operating voltage at the terminals of the Class 1E utilization equipment that is within the utilization equipment's voltage tolerance limits.	12. Analyses for the as-built Class 1E Instrument and Control Power Supply system to determine voltage drops will be performed.	12. Analyses for the as-built Class 1E Instrument and Control Power Supply system exist and conclude that the analyzed operating voltage supplied at the terminals of the Class 1E utilization equipment is within the utilization equipment's voltage tolerance limits, as determined by their nameplate ratings.
13. Class 1E Instrument and Control Power Supply system cables and raceways are identified according to their Class 1E division. Class 1E divisional cables are routed in Seismic Category I structures and in their respective divisional raceways.	13. Inspections of the as-built Class 1E Instrument and Control Power Supply system cables and raceways will be conducted.	13. As-built Class 1E Instrument and Control Power Supply system cables and raceways are identified according to their Class 1E division. Class 1E divisional cables are routed in Seismic Category I structures and in their respective divisional raceways.

The pneumatically-operated secondary containment isolation dampers, shown on Figure 2.15.5j, fail to the closed position in the event of loss of pneumatic pressure or loss of electrical power to the valve actuating solenoids.

R/B Primary Containment Supply/Exhaust System

The R/B Primary Containment Supply/Exhaust System removes inert atmosphere and provides air for primary containment prior to personnel entry, and consists of a supply fan, a filter unit, and an exhaust fan as shown on Figure 2.15.5j.

The R/B Primary Containment Supply/Exhaust System is classified as non-safety-related. The R/B Primary Containment Supply/Exhaust System is located in the secondary containment

R/B Main Steam Tunnel HVAC System

The R/B Main Steam Tunnel HVAC System provides cooling to the main steam tunnel and consists of two FCUs. Each FCU has two fans. The FCUs are started manually.

The R/B Main Steam Tunnel HVAC System is classified as non-safety-related. The R/B Main Steam Tunnel HVAC System is located in the Reactor Building.

R/B Non-Safety-Related Equipment HVAC System

The R/B Non-Safety-Related Equipment HVAC System provides cooling to the non-safety-related equipment rooms. There are six fan coil units, and four air handling units in the system, each consisting of cooling coil and fans.

The R/B Non-Safety-Related Equipment HVAC System is classified as non-safety-related, and is located in the Reactor Building.

Reactor Internal Pump ASD HVAC System

The Reactor Internal Pump ASD HVAC System provides cooling to the RIP ASD control panels. The system consists of a two recirculating air conditioning units with cooling coils and four supply fans.

The RIP ASD HVAC System is classified as non-safety-related, and is located in the Reactor Building.

Turbine Island HVAC System

The Turbine Island HVAC System provides heating, cooling, and ventilation for the Turbine Island. The Turbine Island HVAC System consists of the following non-safety-related systems.

(1) Turbine Building (T/B) HVAC System.

(2) Electrical Building (E/B) HVAC System.

Turbine Building (T/B) HVAC System

The T/B HVAC System provides cooling and ventilation for the Turbine Building. The T/B HVAC System consists of:

(1) T/B supply system with an air conditioning unit and three supply fans.

(2) T/B exhaust system with three exhaust fans.

(3) T/B compartment exhaust system with two exhaust fans.

(4) T/B lube oil area exhaust system with two fans.

(5) T/B unit coolers and electric unit heaters.

The T/B HVAC System is classified as non-safety-related. The T/B HVAC System is located in the Turbine Building.

Electrical Building (E/B) HVAC System

The E/B HVAC System provides cooling and ventilation for the electrical equipment rooms. The system consists of two air conditioning units, supply fans, two exhaust fans, unit coolers and electric unit heaters.

The E/B HVAC System is classified as non-safety-related. The E/B HVAC System is located in the Electrical Building of the Turbine Island.

Radwaste Building HVAC System

The Radwaste Building HVAC System provides a controlled environment for personnel comfort and safety for the Radwaste Building areas. The system consists of:

(1) An air conditioning unit and two supply fans for the Radwaste Building control room

(2) An air conditioning unit with, two supply fans, and three exhaust fans for the process areas of the Radwaste Building.

The Radwaste Building HVAC System is classified as non-safety-related, and is located in the Radwaste Building.

Service Building HVAC System

The Service Building (S/B) HVAC System provides controlled environment for personnel comfort in the S/B.

The S/B HVAC System consists of two non-safety-related systems:

(1) Clean Area HVAC System.

(2) Contolled Area HVAC System.

The S/B HVAC System is classified as non-safety-related, and is located in the Service Building.

Clean Area HVAC System

The Clean Area HVAC System provides a controlled environment for personnel comfort and safety in the Clean Area for the duration of a design basis accident. The system consisits of an air conditioning unit with two supply fans, two exhaust fans, and an emergency filtration unit with two circulating fans. The emergency filtration unit has at least 95% removal efficiency for all forms of iodine (elemental, organic, particulate, and hydrogen iodide) from the influent system.

Toxic gas monitors may be required in the outside air intake of the Clean Area HVAC System; these sensors are not in the Certified Design.

The Clean Area HVAC System is classified as non-safety-related. The Clean Area HVAC System is located in the S/B. The Clean Area HVAC System of the S/B serves the Technical Support Center (TSC) the Operational Support Center (OSC) and other clean areas inside the S/B.

On receipt of a signal from the TSC or main control room (MCR), the normal air intake damper closes, the minimum outside air intake damper opens and the ventilation air for the Clean Area is routed through the emergency filtration unit.

In the high radiation mode, a positive pressure is maintained in the Clean Area relative to the outside atmosphere.

Interface Requirements

Toxic gas monitors will be located in the outside air intakes of the Clean Area HVAC System, if the site is adjacent to toxic gas sources with the potential for releases of significance to plant operating personnel in the Clean Area. These monitors shall have the following requirements:

(1) Be located in the outside air intake of the Clean Area HVAC System.

(2) Be capable of detecting toxic gas concentrations at which personnel protective actions must be initiated.

Controlled Area HVAC System

The Controlled Area HVAC System serves the controlled access area, excluding the clean areas, and it consists of two exhaust fans. The Controlled Area HVAC System obtains its supply air from the Clean Area HVAC System. The Controlled Area HVAC System is located in the Service Building.

Inspections, Tests, Analyses and Acceptance Criteria

For portions of the CRHA HVAC system within the Certified Design, Table 2.15.5a provides a definition of the inspections, tests, and/or analyses, together with associated acceptance criteria, which will be undertaken for the CRHA HVAC Systems.

Table 2.15.5b provides a definition of the inspections, tests and/or analyses, together with associated acceptance criteria which will be under taken for the Control Building Safety-Related Equipment Area HVAC System.

Table 2.15.5c provides a definition of the inspections, tests, and/or analyses, together with associated acceptance criteria, which will be undertaken for the Reactor Building Safety-Related Equipment HVAC System.

Table 2.15.5d provides a definition of the inspections, tests, and/or analyses, together with associated acceptance criteria, which will be undertaken for the Reactor Building Safety-Related Electrical Equipment HVAC System.

Table 2.15.5e provides a definition of the inspections, tests, and/or analyses, together with associated acceptance criteria, which will be undertaken for the Reactor Building Safety-Related DG HVAC System.

Table 2.15.5f provides a definition of the inspections, tests, and/or analyses, together with associated acceptance criteria, which will be undertaken for the Reactor Building Secondary Containment HVAC System.

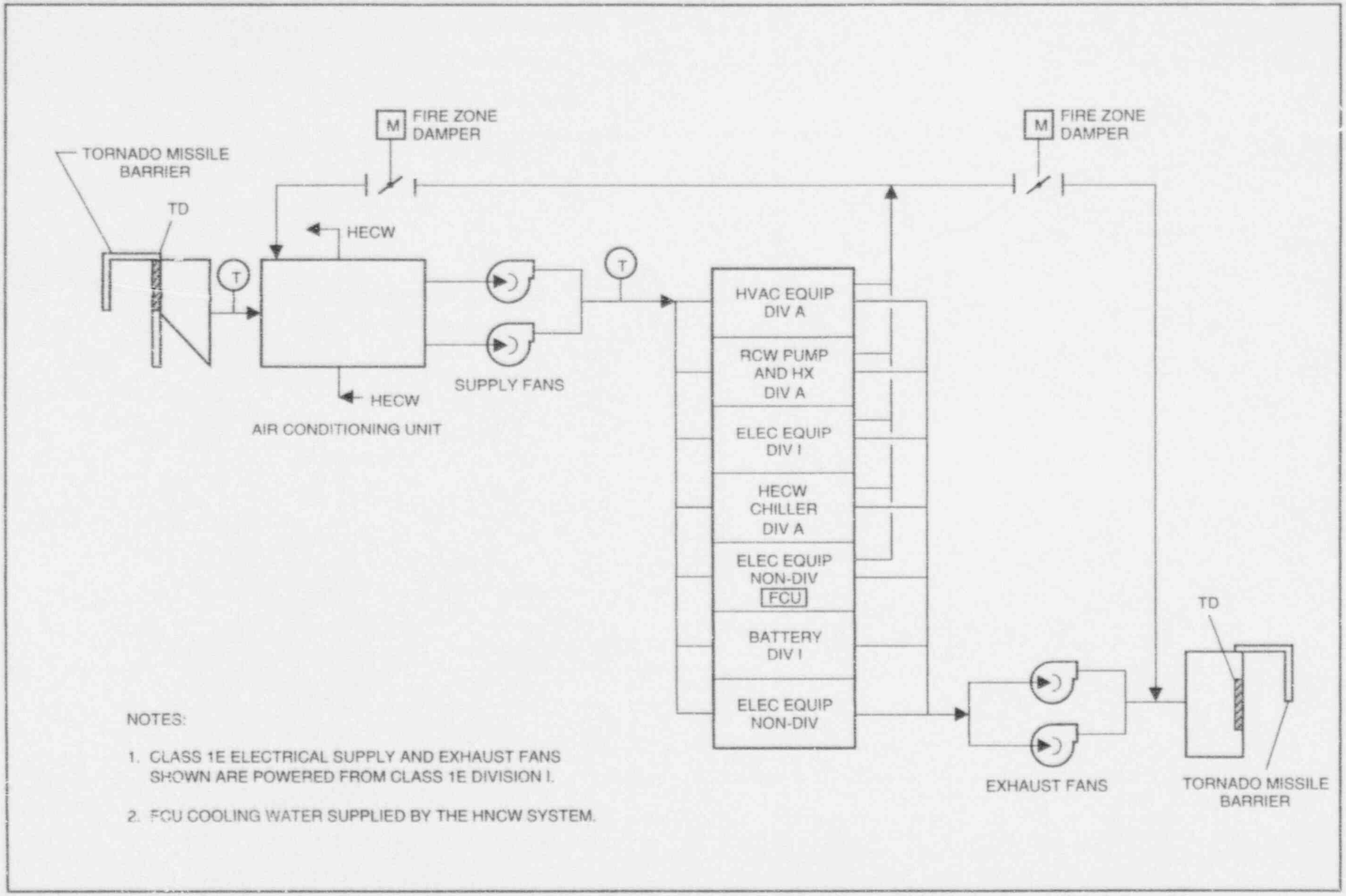
Table 2.15.5g provides a definition of the inspections, tests, and/or analyses, together with associated acceptance criteria, which will be undertaken for the Reactor Building Primary Containment Supply/Exhaust System.

Table 2.15.5h provides a definition of the inspections, tests, and/or analyses, together with associated acceptance criteria, which will be undertaken for the Reactor Building Main Steam Tunnel HVAC System.

Table 2.15.5i provides a definition of the inspections, tests, and/or analyses, together with associated acceptance criteria, which will be undertaken for the Reactor Building Non-Safety-Related Equipment HVAC System.

Table 2.15.5j provides a definition of the inspections, tests, and/or analyses, together with associated acceptance criteria, which will be undertaken for the Reactor Internal Pump ASD HVAC System.

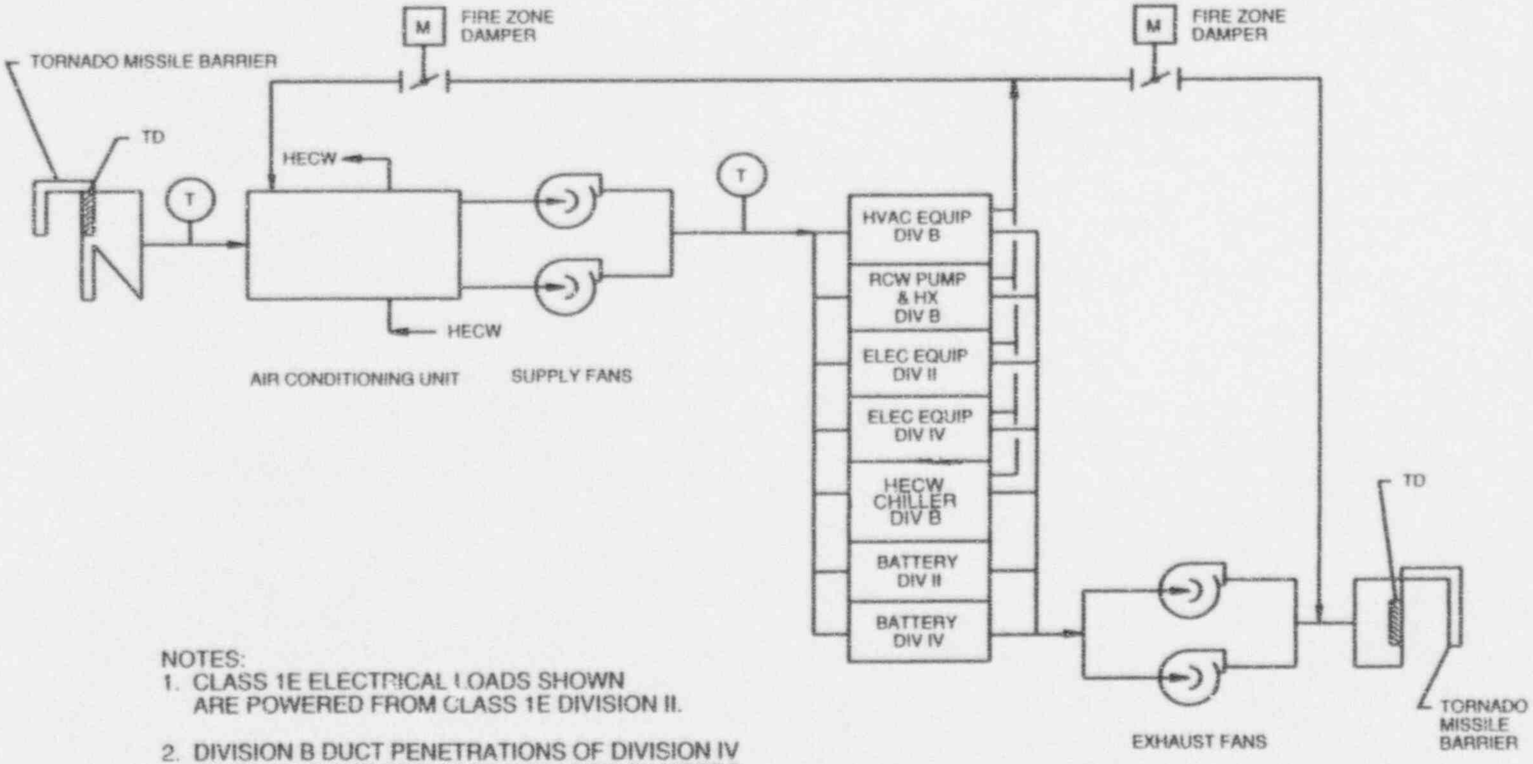
Table 2.15.5k provides a definition of the inspections, tests, and/or analyses, together with associated acceptance criteria, which will be undertaken for the Turbine Island HVAC System.



NOTES:

1. CLASS 1E ELECTRICAL SUPPLY AND EXHAUST FANS SHOWN ARE POWERED FROM CLASS 1E DIVISION I.
2. FCU COOLING WATER SUPPLIED BY THE HNCW SYSTEM.

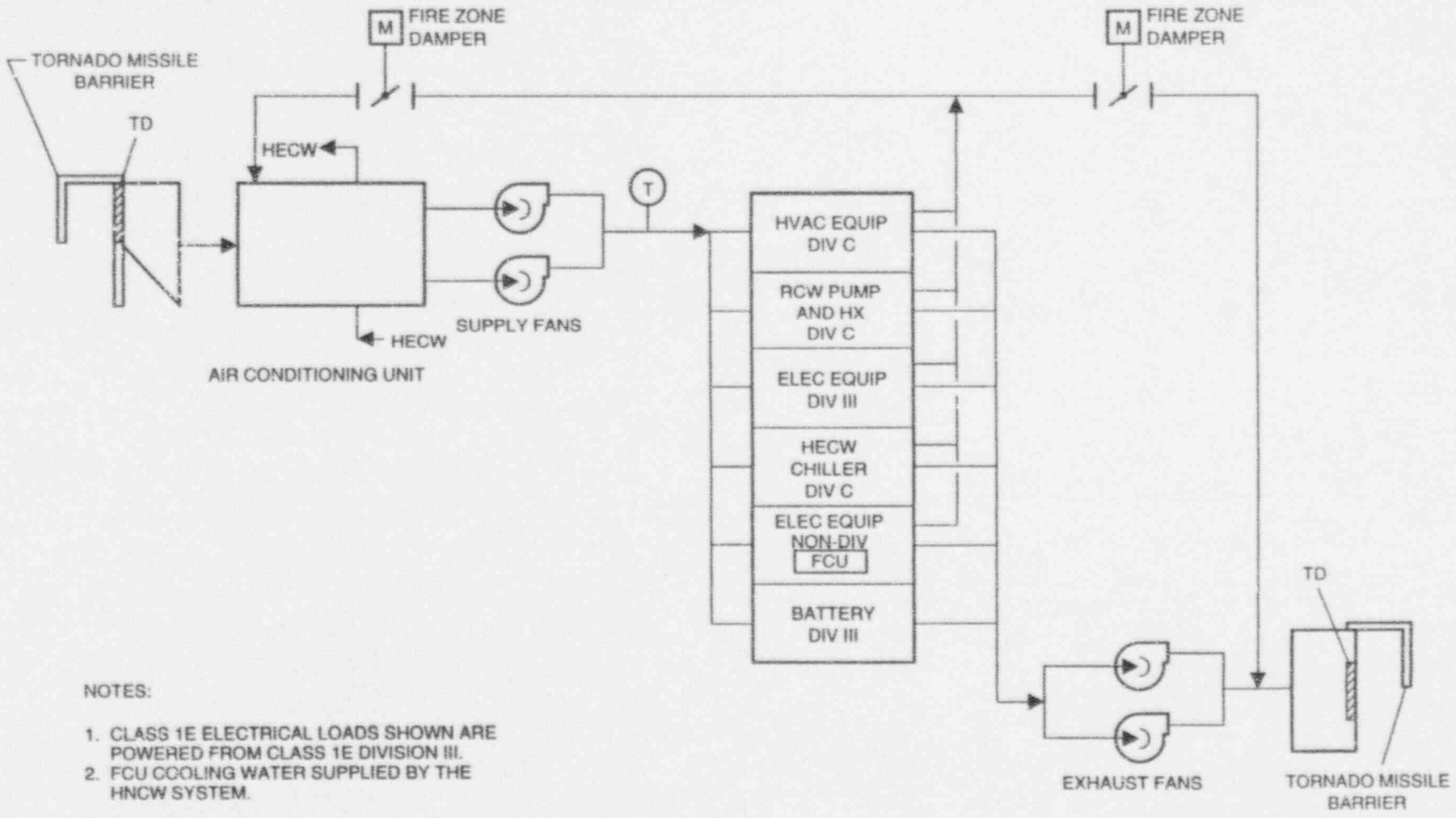
Figure 2.15.5b Control Building Safety-Related Equipment Area HVAC System (Division A)



NOTES:
1. CLASS 1E ELECTRICAL LOADS SHOWN ARE POWERED FROM CLASS 1E DIVISION II.

2. DIVISION B DUCT PENETRATIONS OF DIVISION IV FIREWALLS ARE PROVIDED WITH FIRE DAMPERS.

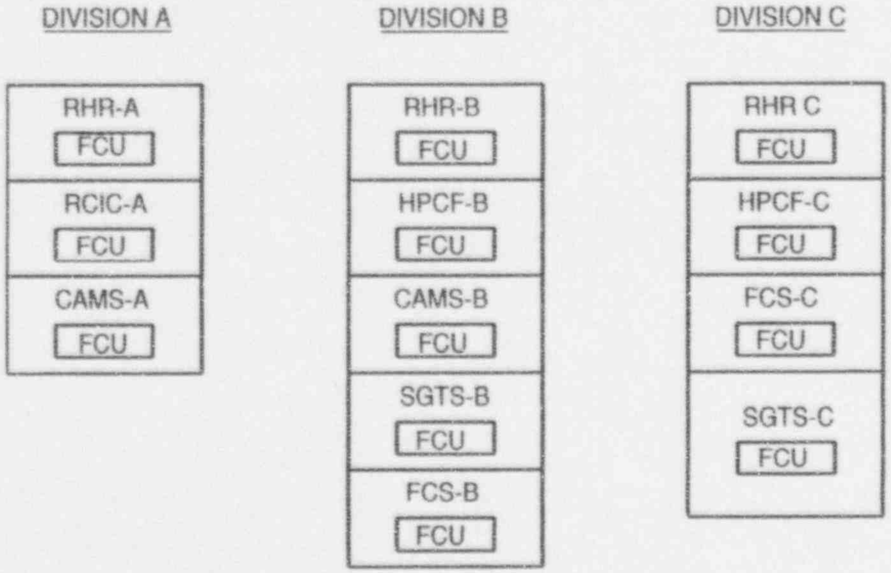
Figure 2.15.5c Control Building Safety-Related Equipment Area HVAC System (Division B)



NOTES:

1. CLASS 1E ELECTRICAL LOADS SHOWN ARE POWERED FROM CLASS 1E DIVISION III.
2. FCU COOLING WATER SUPPLIED BY THE HNCW SYSTEM.

Figure 2.15.5d Control Building Safety-Related Equipment Area HVAC System (Division C)



NOTES:

1. FCU COOLING WATER IS SUPPLIED BY THE RCW SYSTEM.
2. NORMAL VENTILATION AND SMOKE REMOVAL IS PROVIDED BY THE R/B SECONDARY CONTAINMENT HVAC SYSTEM.
3. ELECTRICAL POWER LOADS FROM DIVISIONS A, B, AND C ARE POWERED FROM CLASS 1E DIVISIONS I, II, AND III, RESPECTIVELY.

Figure 2.15.5e Reactor Building Safety-Related Equipment HVAC System

Table 2.15.5j Reactor Internal Pump ASD Control Panel HVAC System

Inspections, Tests, Analyses and Acceptance Criteria		
Design Commitment	**Inspections, Tests, Analyses**	**Acceptance Criteria**
1. The basic configuration of the RIP ASD HVAC System is as described in Section 2.15.5.	1. Inspections of the as-built system will be conducted.	1. The as-built RIP ASD HVAC System conforms with the basic configuration described in Section 2.15.5.

Table 2.15.5k Turbine Island HVAC System

Inspections, Tests, Analyses and Acceptance Criteria		
Design Commitment	**Inspections, Tests, Analyses**	**Acceptance Criteria**
1. The basic configuration of the Turbine Island HVAC System is as described in Section 2.15.5.	1. Inspections of the as-built system will be conducted.	1. The as-built Turbine Island HVAC System conforms with the basic configuration described in Section 2.15.5.

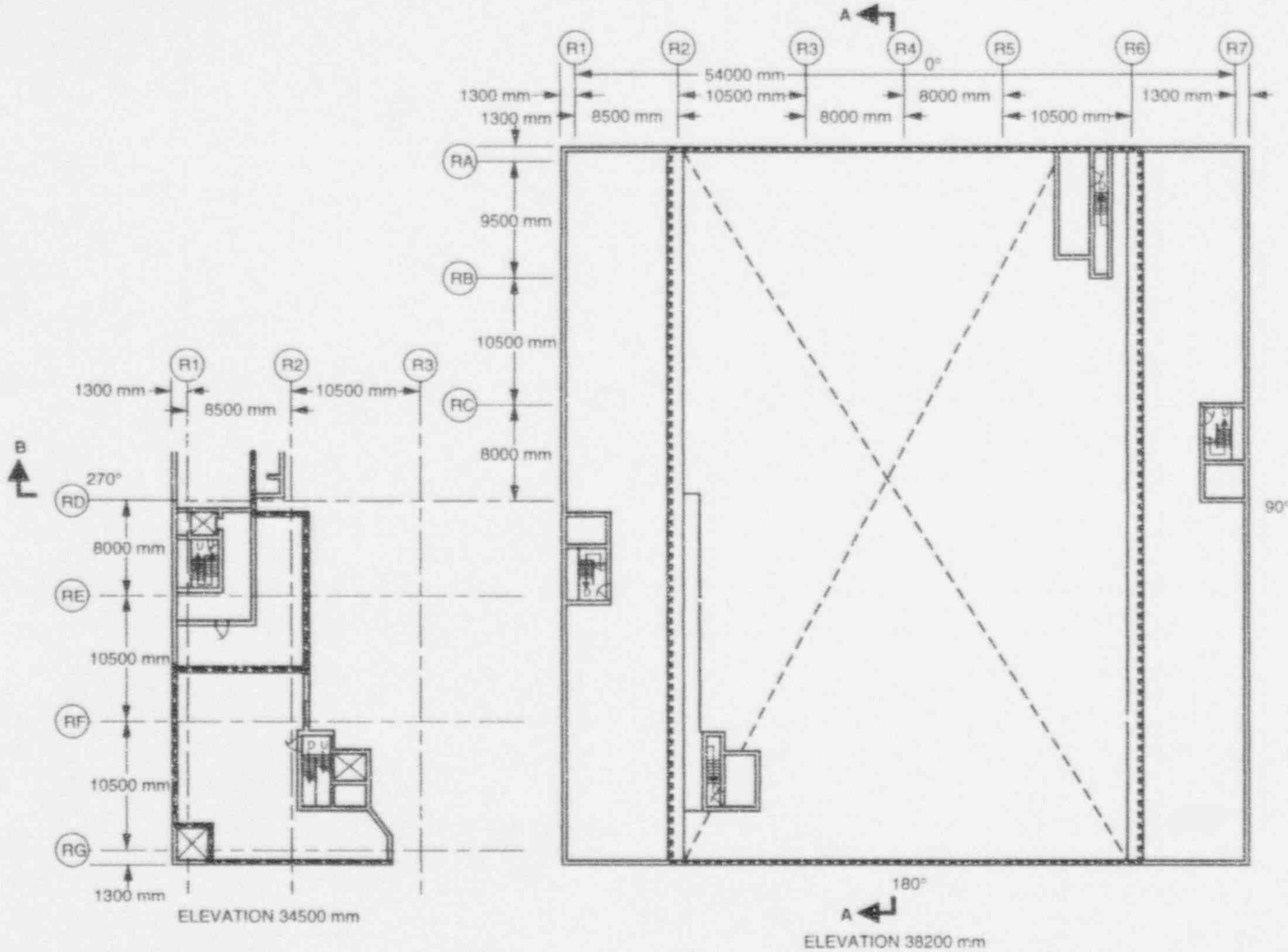


Figure 2.15.10o Reactor Building Arrangement—Elevations 34500 mm and 38200 mm

Table 2.15.10 Reactor Building

Inspections, Tests, Analyses and Acceptance Criteria		
Design Commitment	**Inspections, Tests, Analyses**	**Acceptance Criteria**
1. The basic configuration of the R/B is shown on Figures 2.15.10a through 2.15.10o.	1. Inspections of the as-built structure will be conducted.	1. The as-built R/B conforms with the basic configuration shown in Figures 2.15.10a through 2.15.10o.
2. The top of the R/B basemat is located 20.2m ±0.3m below the finished grade elevation.	2. Inspections of the as-built structure will be conducted.	2. The top of the R/B basemat is located 20.2m ±0.3m below the finished grade elevation.
3. Inter-divisional walls, floors, doors and penetrations, and penetrations in the external R/B walls to connecting tunnels, have a three-hour fire rating.	3. Inspections of the as-installed inter-divisional boundaries and external wall penetrations to connecting tunnels will be conducted.	3. The as-installed walls, floors, doors and penetrations that form the inter-divisional boundaries and external wall penetrations to connecting tunnels have a three-hour fire rating.
4. The R/B has divisional areas with walls and watertight doors are as shown on Figures 2.15.10a through 2.15.10o.	4. Inspections of the as-built walls and watertight doors will be conducted.	4. The as-built R/B has walls and watertight doors as shown on Figures 2.15.10a through 2.15.10o.
5. Main control room displays and alarms provided for the R/B are as defined in Section 2.15.10.	5. Inspections will be performed on the main control room displays and alarms for the R/B.	5. Displays and alarms exist or can be retrieved in the main control room as defined in Section 2.15.10.
6. A flooding event involving release of either the suppression pool or the CST water does not affect more than one division of safety-related equipment.	6. Inspections will be conducted of the divisional boundaries shown on Figure 2.15.10c.	6. Penetrations (except for watertight doors) in the divisional walls are at least 2.5m above the floor level of -8200 mm.
7. Except for the basement area, safety-related electrical, instrumentation, and control equipment is located at least 20 cm above the floor surface.	7. Inspections will be conducted of the as-built equipment.	7. Except for the basement area, safety-related electrical, instrumentation, and control equipment is located at least 20 cm above the floor surface.

2.15.11 Turbine Building

Design Description

The Turbine Building (T/B) includes the electrical building and houses the main turbine generator and other power conversion cycle equipment and auxiliaries. The T/B is located adjacent to the safety-related Seismic Category I Control Building. With the exception of instrumentation associated with monitoring of condenser pressure, turbine first-stage pressure, turbine control valve oil pressure and stop valve position, there is no safety-related equipment in the T/B. The electrical building houses various plant support systems and equipment such as non-divisional switchgear and chillers.

A tunnel connects the Radwaste Building, Turbine Building, Control Building and Reactor Building for the liquid radwaste system piping. The penetrations from the tunnel to the Turbine Building are watertight and have a three hour fire rating.

Flood conditions in the T/B, except for the electrical building, are prevented from propagating into the Control Building (C/B) via the Service Building. This is achieved by locating the access from the T/B to the S/B at or above grade level and providing a flood control doorway at the access location.

The T/B is not classified as a Seismic Category I structure. However, the building is designed such that damage to safety-related functions does not occur under seismic loads corresponding to the safe shutdown earthquake (SSE) ground acceleration.

Inspections, Tests, Analyses and Acceptance Criteria

Table 2.15.11 provides a definition of the inspections, tests, and/or analyses, together with associated acceptance criteria, which will be undertaken for the Turbine Building.

Table 2.15.11 Turbine Building

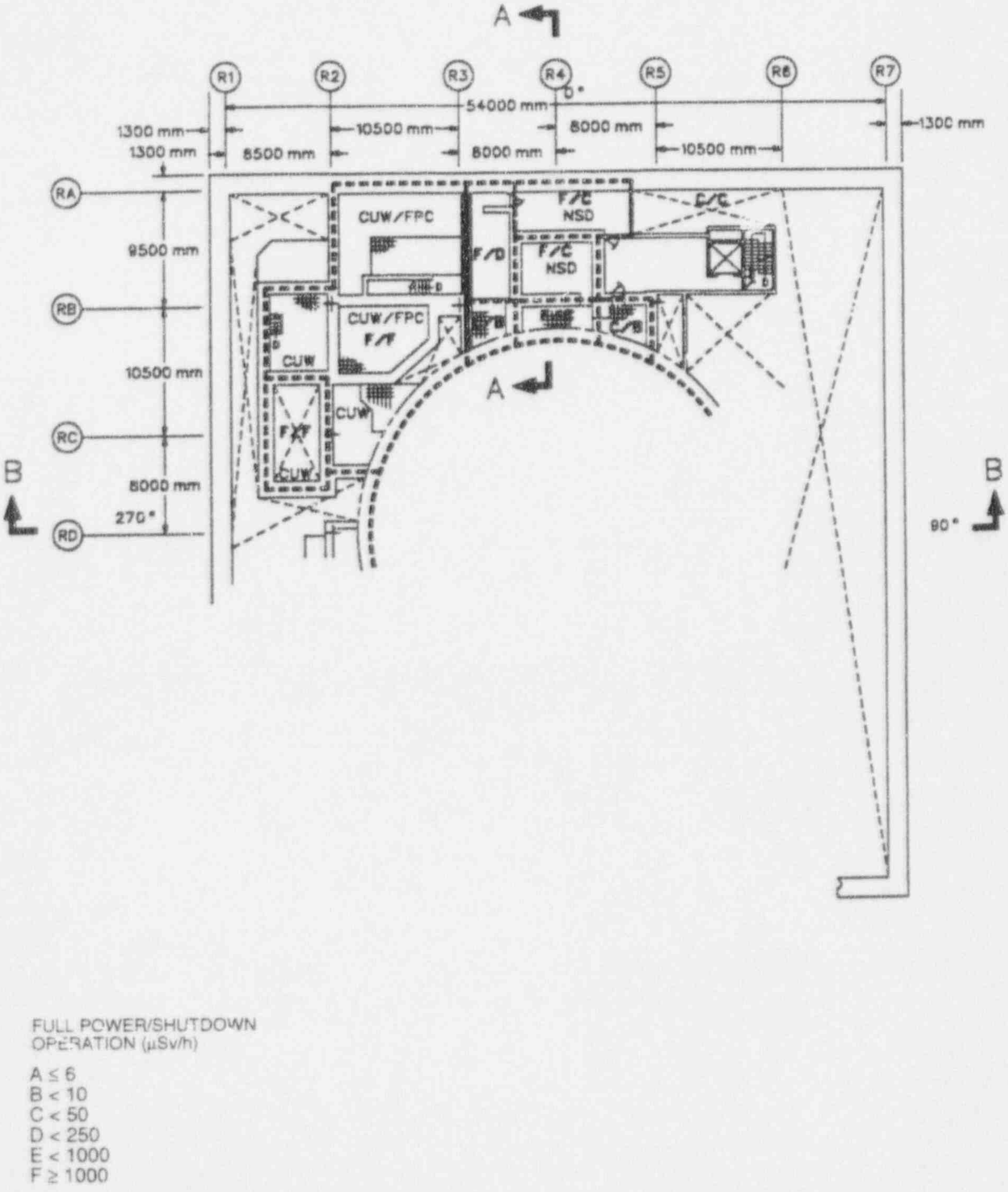
Inspections, Tests, Analyses and Acceptance Criteria		
Design Commitment	**Inspections, Tests, Analyses**	**Acceptance Criteria**
1. The basic configuration of the T/B is described in Section 2.15.11.	1. Inspections of the as-built structure will be conducted.	1. The as-built T/B conforms with the basic configuration described in Section 2.15.11.
2. The T/B is designed such that damage to safety-related functions does not occur under seismic loads corresponding to the SSE ground acceleration.	2. A seismic analysis of the as-built T/B will be performed.	2. A structural analysis report exists which concludes that under seismic loads corresponding to the SSE ground acceleration the as-built T/B does not damage safety-related functions.

Table 3.1 Human Factors Engineering (Continued)

Inspections, Tests, Analyses and Acceptance Criteria		
Design Commitment	**Inspections, Tests, Analyses**	**Design Acceptance Criteria**
6.a.Continued	6.a. Continued	6.a. Continued (3) That evaluations of the HSI equipment shall be conducted to confirm that the controls, displays, and data processing functions identified in the task analyses are provided. (4) That integration of HSI equipment with each other, with the operating personnel and with the Plant and Emergency Operating Procedures shall be evaluated through the conduct of dynamic task performance testing. The dynamic task performance tests and evaluations shall have as their objectives: (a) Confirmation that the identified critical functions can be achieved using the integrated HSI design. (b) Confirmation that the HSI design and configuration can be operated using the established MCR staffing levels.

Table 3.1 Human Factors Engineering (Continued)

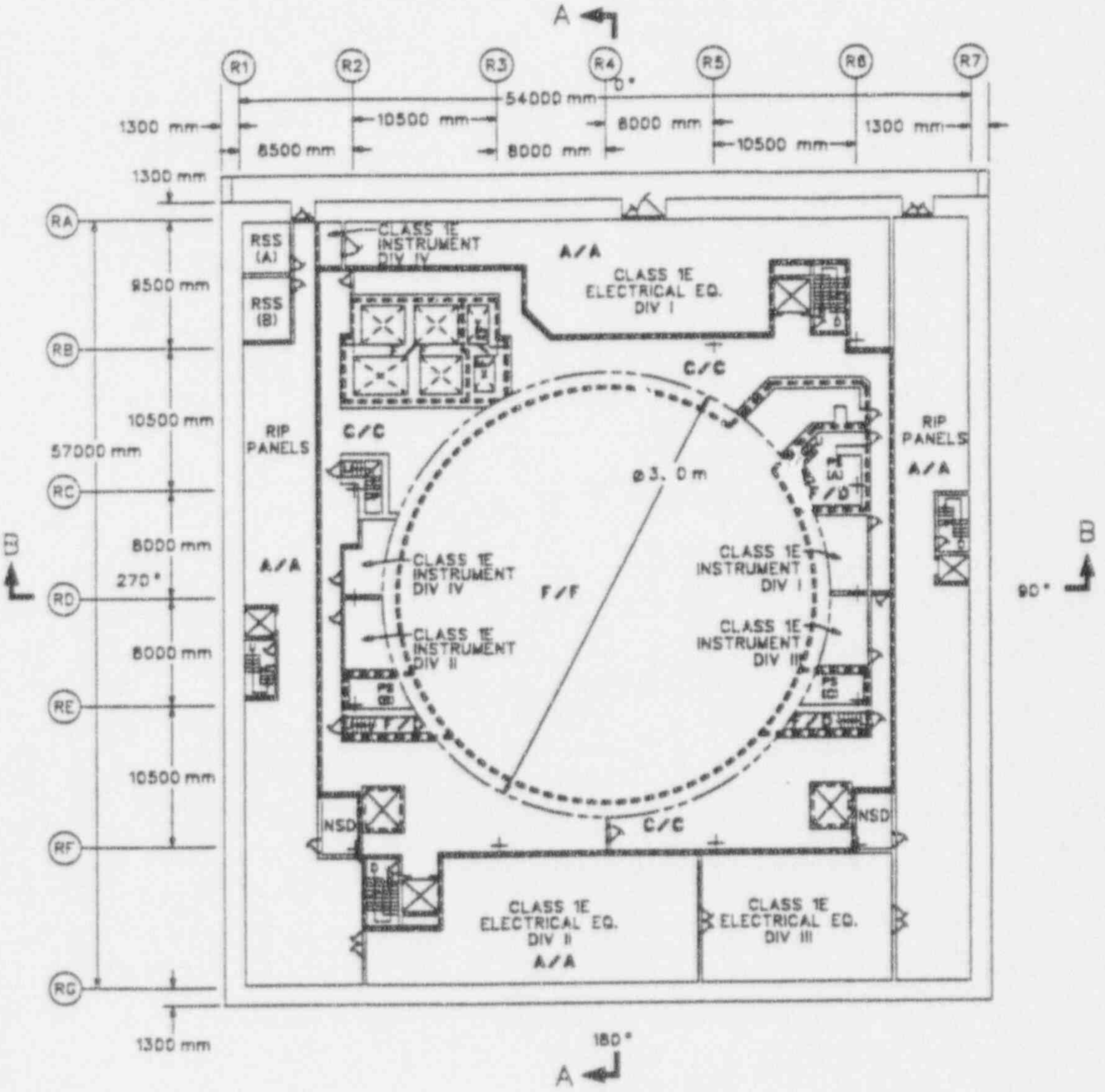
Inspections, Tests, Analyses and Acceptance Criteria		
Design Commitment	**Inspections, Tests, Analyses**	**Design Acceptance Criteria**
6.a. Continued	6.a. Continued	6.a.(4) Continued (c) Confirmation that the Plant and Emergency Operating Procedures provide direction for completing the identified tasks associated with normal, abnormal and emergency operations. (d) Confirmation that the time dependent and interactive aspects of the HSI equipment performance allow for task accomplishment. (e) Confirmation that the allocation of functions is sufficient to enable task accomplishment. (5) That dynamic task performance test evaluations shall be conducted over the range of operational conditions and upsets.



FULL POWER/SHUTDOWN OPERATION (µSv/h)

A ≤ 6
B < 10
C < 50
D < 250
E < 1000
F ≥ 1000

Figure 3.2f Reactor Building Radiation Zone Map for Full Power and Shutdown Operations—Elevation 1500 mm



FULL POWER/SHUTDOWN
OPERATION (µSv/h)

A ≤ 6
B < 10
C < 50
D < 250
E < 1000
F ≥ 1000

Figure 3.2g Reactor Building Radiation Zone Map for Full Power and Shutdown Operations, Floor B1F—Elevation 4800 mm

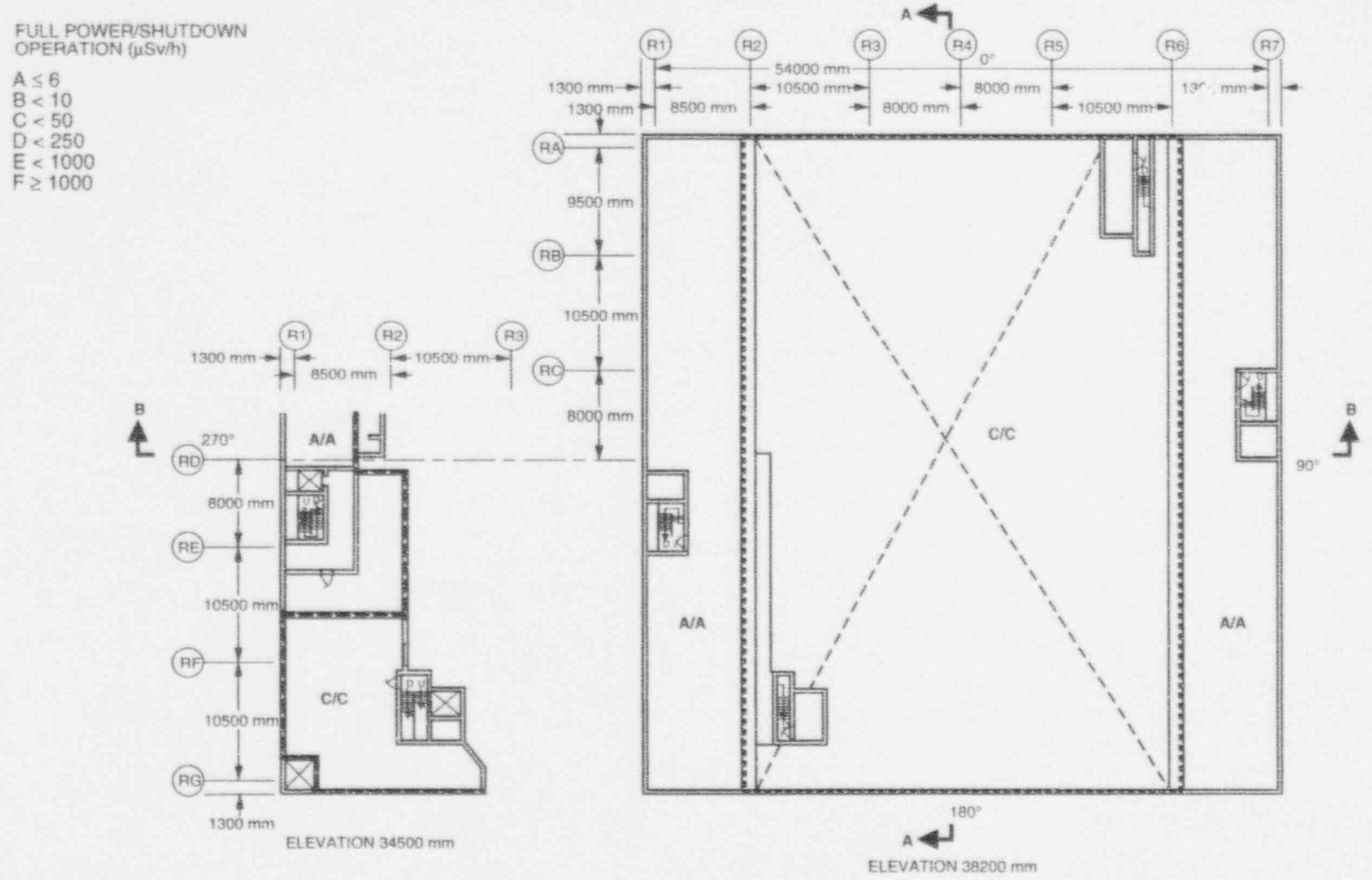


Figure 3.2n Reactor Building Radiation Zone Map for Full Power and Shutdown Operations—Elevations 34500 mm and 38200 mm

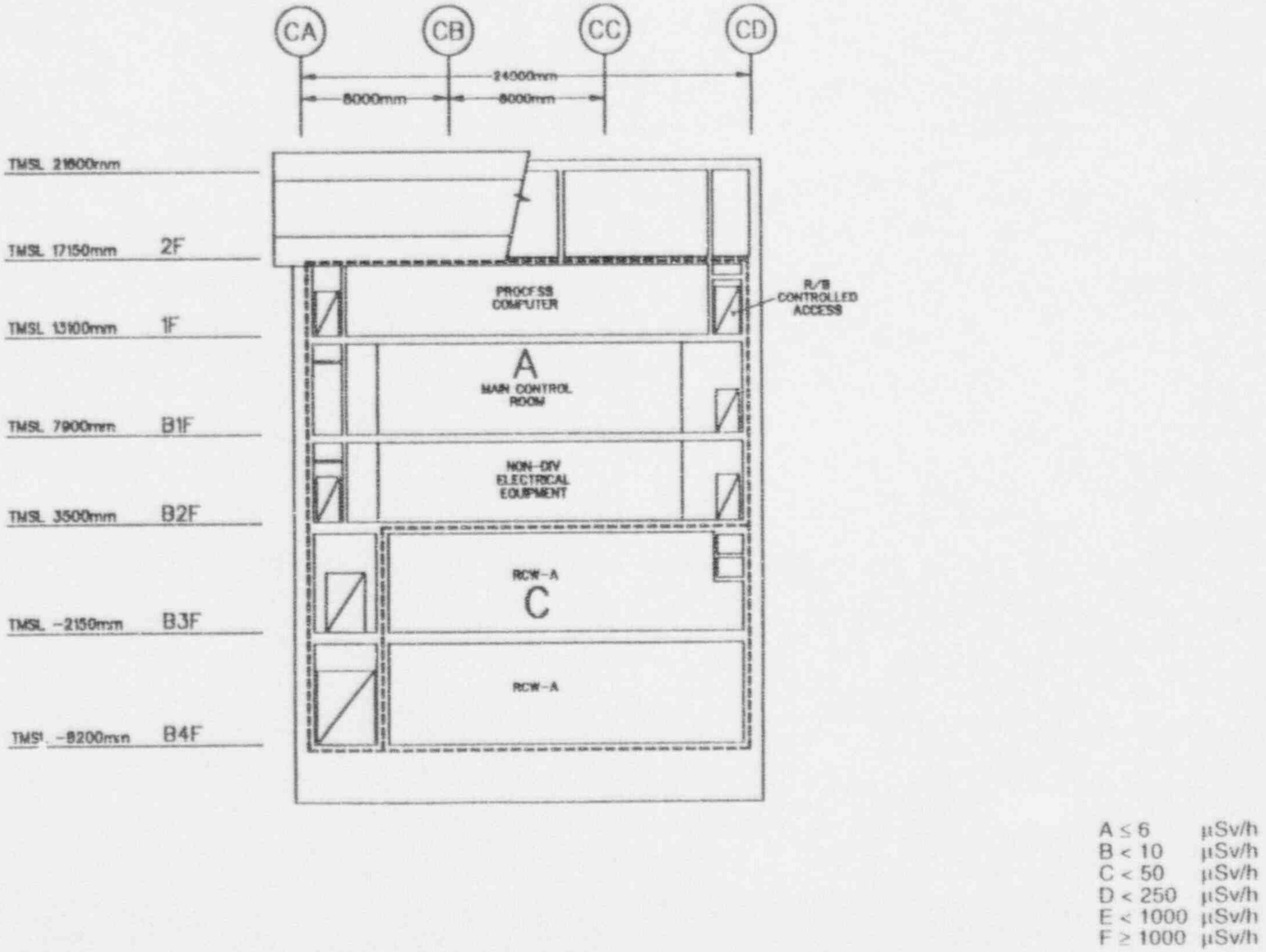


Figure 3.2o Control Building Radiation Zone Map for Full Power Operations, Section A-A

Table 3.2b Ventilation and Airborne Monitoring

	Inspections, Tests, Analyses and Acceptance Criteria	
Design Commitment	**Inspections, Tests, Analyses**	**Acceptance Criteria**
1. Plant design shall provide for containment of airborne radioactive materials and the ventilation system will maintain concentrations of airborne radionuclides at levels consistent with personnel access needs.	1. Expected concentrations of airborne radioactive material shall be calculated by radionuclide for normal plant operations and anticipated operational occurrences for each equipment cubicle, corridor, and operating area requiring personnel access. Calculations shall consider:	1. Calculation of radioactive airborne concentration shall demonstrate that:
	a. Total ventilation flow rates for each area.	a. For normally occupied rooms and areas of the plant (i.e., those areas requiring routine access to operate and maintain the plant), equilibrium concentrations of airborne radionuclides will be a small fraction (10% or less) of the occupational concentration limits listed in 10CFR20 Appendix B, January 1994.
	b. Typical leakage characteristics for equipment located in each area.	b. For rooms that require infrequent access (such as for non-routine equipment maintenance), the ventilation system shall be capable of reducing radioactive airborne concentrations to (and maintaining them at) the occupational concentration limits listed in 10CFR20 Appendix B, January 1994,during the periods that occupancy is required.
	c. A radiation source term in each fluid system based upon an assumed offgas rate of 3,700 MBq/s (30 minute decay) appropriately adjusted for radiological decay and buildup of activated corrosion and wear products.	c. For rooms where access is not anticipated to perform scheduled maintenance or surveillance (such as the backwash receiving tank room), plant design shall provide containment and ventilation to reduce airborne contamination spread to other areas of lower contamination.

Table 3.2b Ventilation and Airborne Monitoring (Continued)

Inspections, Tests, Analyses and Acceptance Criteria		
Design Commitment	**Inspections, Tests, Analyses**	**Acceptance Criteria**
2. Airborne radioactivity monitoring shall be provided for those normally occupied areas of the plant in which there exists a significant potential for airborne contamination (greater than 0.1 per year). The airborne radioactivity system shall: a. Have the capability of detecting the time integrated concentrations of the most limiting internal dose particulate and iodine radionuclides in each area equivalent to the occupational concentration limits in 10CFR20, Appendix B, January 1994, for 10 hours. b. Provide a calibrated response, representative of the concentrations within the area (i.e., air sampling monitors in ventilation exhaust streams shall collect an isokinetic sample). c. Provide local audible alarms (visual alarms in high noise areas) with variable alarm setpoints, and readout/annunciation capability.	2. An analysis shall be performed to identify the plant areas that require airborne radioactivity monitoring.	2. Airborne radioactivity monitoring system shall be installed as defined in this certified design commitment.

The plan is structured on the basis that EMC of I&C equipment is verified by factory testing and site testing of both individual components and interconnected systems to meet electromagnetic compatibility requirements for protection against the effects of:

(1) Electromagnetic Interference (EMI).

(2) Radio Frequency Interference (RFI).

(3) Electrostatic Discharge (ESD).

(4) Electrical surge [Surge Withstand Capability (SWC)].

To be able to predict the degree of electromagnetic compatibility of a given equipment design, the following information is developed:

(1) Characteristics of the sources of electrical noise.

(2) Means of transmission of electrical noise.

(3) Characteristics of the susceptibility of the system.

(4) Techniques to attenuate electrical noise.

After these characteristics of the equipment are identified, noise susceptibility is tested for four different paths of electrical noise entry:

(1) Power feed lines.

(2) Input signal lines.

(3) Output signal lines.

(4) Radiated electromagnetic energy.

Instrument Setpoint Methodology

Setpoints for initiation of safety-related functions are determined, documented, installed and maintained using a process that establishes a general program for:

(1) Specifying requirements for documenting the bases for selection of trip setpoints.

(2) Accounting for instrument inaccuracies, uncertainties, and drift.

(3) Testing of instrumentation setpoint dynamic response.

(4) Replacement of setpoint-related instrumentation.

The determination of nominal trip setpoints includes consideration of the following factors:

Design Basis Analytical Limit

In the case of setpoints that are directly associated with an abnormal plant transient or accident analyzed in the safety analysis, a design basis analytical limit is established as part of the safety analysis. The design basis analytical limit is the value of the sensed process variable prior to or at the point which a desired action is to be initiated. This limit is set so that associated licensing safety limits are not exceeded, as confirmed by plant design basis performance analysis.

Allowable Value

An allowable value is determined from the analytical limit by providing allowances for the specified or expected calibration capability, the accuracy of the instrumentation, and the measurement errors. The allowable value is the limiting value of the sensed process variable at which the trip setpoint may be found during instrument surveillance.

Nominal Trip Setpoint

The nominal trip setpoint value is calculated from the analytical limit by taking into account instrument drift in addition to the instrument accuracy, calibration capability, and the measurement errors. The nominal trip setpoint value is the limiting value of the sensed process variable at which a trip action will be set to operate at the time of calibration.

Signal Processing Devices in the Instrument Channel

Within an instrument channel, there may exist other components or devices that are used to further process the electrical signal provided by the sensor (e.g., analog-to-digital converters, signal conditioners, temperature compensation circuits, and multiplexing and demultiplexing components). The worst-case instrument accuracy, calibration accuracy, and instrument drift contributions of each of these additional signal conversion components are separately or jointly accounted for when determining the characteristics of the entire instrument loop.

Not all parameters have an associated design basis analytical limit (e.g., main steamline radiation monitoring). An allowable value may be defined directly based on plant licensing requirements, previous operating experience or other appropriate criteria. The nominal trip setpoint is then calculated from this allowable value, allowing for instrument drift. Where appropriate, a nominal trip setpoint may be determined directly based on operating experience.

Appendix C Conversion to ASME Standard Units

	From	To convert to	Divide by
(1)	**Pressure/Stress**		
	kilopascal	1 Pound/Square Inch	6.894757
	kilopascal	1 Atmosphere (STD)	101.325
	kilopascal	1 Foot of Water (39.2°F)	2.98898
	kilopascal	1 Inch of Water (60°F)	0.24884
	kilopascal	1 Inch of HG (32°F)	3.38638
(2)	**Force/Weight**		
	newton	1 Pound - force	4.448222
	kilogram	1 Ton (Short)	907.1847
	kilogram	1 Tons (Long)	1016.0047
(3)	**Heat/Energy/Power**		
	joule	1 Btu	1055.056
	joule	1 Calorie	4.1868
	kilowatt-hour	1 Btu	0.0002930711
	kilowatt	1 Horsepower(U.K.)	0.7456999
	kilowatt-hour	1 Horsepower-Hour	0.7456999
	kilowatt	1 Btu/Min	0.0175725
	joule/gram	1 Btu/Pound	2.326
(4)	**Length**		
	millimeter	1 Inch	25.4
	centimeter	1 Inch	2.54
	meter	1 Inch	0.0254
	meter	1 Foot	0.3048
	centimeter	1 Foot	30.48
	meter	1 Mile	1609.344
	kilometer	1 Mile	1.609344
(5)	**Volume**		
	liter	1 Cubic Inch	0.01638706
	cubic centimeter	1 Cubic Inch	16.38706

	From	To convert to	Divide by
	cubic meter	1 Cubic Foot	0.02831685
	cubic centimeter	1 Cubic Foot	28316.85
	liter	1 Cubic Foot	28.31685
	cubic meter	1 Cubic Yard	0.7646
	liter	1 Gallon (US)	3.785412
	cubic centimeter	1 Gallon (US)	3785.412
	E-03 cubic centimeter	1 Gallon (US)	3.785412
(6)	**Volume Per Unit Time**		
	cubic centimeter/s	1 Cubic Foot/Min	471.9474
	cubic meter/h	1 Cubic Foot/Min	1.69901
	liter/s	1 Cubic Foot/Min	0.4719474
	cubic meter/s	1 Cubic Foot/Sec	0.02831685
	E-05 cubic meter/s	1 Gallon/Min (US)	6.30902
	cubic meter/h	1 Gallon/Min (US)	0.22712
	liter/s (101.325 kPaA,15.56°C)	1 STD CFM (14.696 psia, 60°F)	0.4474
	cubic meter/h (101.325 kPaA,15.56°C)	1 STD CFM (14.696 psia, 60°F)	1.608
(7)	**Velocity**		
	centimeter/s	1 Foot/Sec	30.48
	centimeter/s	1 Foot/Min	0.508
	meter/s	1 Foot/Min	0.00508
	meter/min	1 Foot/Min	0.3048
	centimeter/s	1 Inches/Sec	2.54
(8)	**Area**		
	square centimeter	1 Square Inch	6.4516
	E-04 square meter	1 Square Inch	6.4516
	square centimeter	1 Square Foot	929.0304
	E-02 square meter	1 Square Foot	9.290304
(9)	**Torque**		
	newton-meter	1 Foot Pound	1.355818
(10)	**Mass Per Unit Time**		
	kilogram/s	1 Pound/Sec	0.4535924

	From	To Convert to	Divide by
	kilogram/min	1 Pound/Min	0.4535924
	kilogram/h	1 Pound/Min	27.215544
(11)	**Mass Per Unit Volume**		
	kilogram/cubic meter	1 Pound/Cubic Inch	27679.90
	kilogram/cubic meter	1 Pound/Cubic Foot	16.01846
	kilogram/cubic centimeter	1 Pound/Cubic Inch	0.0276799
	liter/s	1 Gallon/Min	0.0630902
(12)	**Dynamic Viscosity**		
	Pa•s	1 Pound-Sec/Sq Ft	47.88026
(13)	**Specific Heat/Heat Transfer**		
	joule/kilogram kelvin	1 Btu/Pound-Deg F	4186.8
	watt/square meter kelvin	1 Btu/Hr-Sq Ft-Deg F	5.678263
	watt/square meter kelvin	1 Btu/Sec-Sq Ft-Deg F	2.044175E+4
	watt/square meter	1 Btu/Hr-Sq Ft	3.154591
(14)	**Temperature**		
	degree celsius	Degrees Fahrenheit	$T_{°F} = T_{°C} x 1.8 + 32$
	degree C increment	1 Degree F Increment	0.555556
(15)	**Electricity**		
	coulomb	1 ampere hour	3600
	siemens/meter	1 mho/centimeter	100
(16)	**Light**		
	candels/square meter	1 candela/square inch	1550.003
	lux	1 footcandle	10.76391
(17)	**Radiation**		
	megabequerel	1 curie	37,000
	gray	1 rad	0.01
	sievert	1 rem	0.01

Note:

Rounding of Caculated values per Appendix C of ANSI/IEEE Std. 268.